Mobile Information Systems

Intelligent Indoor Mobile Communications: Architecture, Protocols and Management

Lead Guest Editor: Fusheng Zhu
Guest Editors: Ghulam Abbas and Long D. Nguyen

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Retraction

Retracted: Construction of Virtual Piano Performance System Based on Visual Gesture Recognition

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] K. Tian, "Construction of Virtual Piano Performance System Based on Visual Gesture Recognition," *Mobile Information Systems*, vol. 2022, Article ID 9446905, 12 pages, 2022.

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Retraction

Retracted: Electromagnetic Field Analysis and Optimization Method of High-Temperature Superconducting Transformer under the Influence of Abnormal Voltage

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[1] W. Zhi, Y. Zhang, and H. Yang, "Electromagnetic Field Analysis and Optimization Method of High-Temperature Superconducting Transformer under the Influence of Abnormal Voltage," *Mobile Information Systems*, vol. 2022, Article ID 8256988, 8 pages, 2022.

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Retracted: Low-Carbon Awareness Information Technology of Enterprise Executives Based on Big Data and Multimodal Information Fusion

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Research Article

Electromagnetic Field Analysis and Optimization Method of High-Temperature Superconducting Transformer under the Influence of Abnormal Voltage

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High-temperature superconducting transformers are an important research topic of superconducting technology in power applications, and electromagnetic field analysis and optimization are the basis for the design and application of high-temperature superconducting transformers. The electromagnetic field analysis of high-temperature superconducting transformers should consider the superconducting properties of the materials, that is, the properties of critical current and magnetic field. This paper aims to study the electromagnetic field analysis and optimization method of high-temperature superconducting transformer under the influence of abnormal voltage. Due to the energy loss of high-temperature superconducting transformers, in order to study the economy and reliability of high-temperature superconducting transformers, in this paper, the core loss, winding AC loss, and coil power consumption of high-temperature superconducting transformers are analyzed under normal operation and short-circuit fault conditions, respectively. The power and stress on the windings are analyzed. In order to take into account the current-carrying capacity, short-circuit loss, and short-circuit electromotive force of superconducting windings in normal operation, a concentrically placed double-cake coil structure is selected in this paper, and according to different optimization objectives, a global optimization method is used to evaluate the structure of the coil. The structural parameters of the high-temperature superconducting transformer are optimized, including the structural parameters of the magnetic conducting ring. It is found that that abnormal voltage will affect the electromagnetic field of high-temperature superconducting transformers, including winding circulating current, leakage magnetic field, and current distribution.

1. Introduction

A modern power transformer is a highly reliable, high-efficiency power device. With the rapid development of China's electric power industry and urban construction, the country is implementing the reconstruction and expansion of urban power grids and rural power grids, and the transformer industry has developed rapidly accordingly. Due to the increasing capacity of a single unit, users have higher and higher requirements for transformers. In addition to meeting the technical specifications of electricity, magnetism, force, heat and high efficiency, power transformers should also meet the requirements of small oil-free and low-noise power transformers and the requirements in order to reduce the footprint and reduce environmental pollution. Due to its inherent defects, the constant conduction transformer is difficult to meet the needs of the development of the modern power industry. Research and development of new superconducting transformers, thereby improving the performance of power transformers, has great theoretical research significance and practical application value [1, 2]. The selection of the core structure of the transformers will affect the performance of the transformer. According to the relative position of the iron core and the coil, the iron core can be divided into two main structural types: core iron core and shell iron core.

From an economic point of view, the low impedance characteristics of superconducting materials are conducive for reducing the total loss of the transformer, and the high current density can improve the efficiency of the power

system. The use of superconducting transformers will greatly save energy and reduce operating costs. From the perspective of insulation operating life, the windings and solid insulating materials of superconducting transformers operate at deep low temperatures, and there is no insulation aging problem. [3, 4]. In an emergency, a superconducting transformer can carry the load originally supplied by two transformers, which improves the safety of the system. From the perspective of its contribution to the power system, the internal resistance of the superconducting transformer is very low during normal operation, and increasing the larger voltage regulation range is conducive for improving the performance of the power system. When it comes to a short-circuited contidion, the superconductor quenches into a resistive state, which may limit the current spike. This potential fault current limiting capability separates the transformer impedance requirements from the short-circuit current requirements, and the corresponding power system components are designed according to the limited current, which reduces the investment of the entire system. From the perspective of environmental protection, the superconducting transformer adopts liquid nitrogen for cooling, which replaces the forced oil circulation cooling or air cooling used in the normal conduction transformer, which reduces the noise and avoids the possible fire hazard caused by the transformer and environmental pollution caused by flux leakage. Overall, superconducting transformers have the advantages of small size and light weight, and will become the most ideal energy-saving transformers in this century, with great potential development prospects [5, 6].

The superconducting power device is made of superconducting tape, and its main body is a superconducting coil. From the external geometry, there are many kinds of coils, such as circular coils, yin and yang coils, toroidal coils, saddle coils, etc. [7]. The superconducting axisymmetric coil is the basic coil structure and has a wide range of applications in superconducting engineering technology. It has many advantages, including being easy to manufacture, easier to wind and support the magnetic field force. The magnetic field generated by the winding is the largest. Through the combination of several coils, a highly uniform magnetic field or a magnetic field with a uniform gradient along a certain direction in space can be obtained [8, 9]. The electromagnetic problems of high-temperature superconducting transformers include the magnetic conductive ring at the coil end on the distribution of the transformer leakage magnetic field, the current distribution between the parallel superconducting strips and their influence on the transformer leakage magnetic field distribution.

With the continuous discovery of high-temperature superconducting materials, the critical current continues to increase. It is believed that with the continuous development of science and technology, the emergence of practical superconducting materials in the liquid nitrogen temperature region will certainly make the application of axisymmetric coils more extensive [10, 11]. However, the actual superconducting axisymmetric coils are all made of superconducting wires, so each turn has helicity. Since there is an insulating layer outside the superconducting wire, whether a square wire or a round wire is used, the current density of the coil is not uniformly distributed. When analyzing the magnetic field of a superconducting axisymmetric coil, the calculation of the magnetic field will be extremely complicated if the helicity and inhomogeneity are taken into account. However, in the engineering application of superconducting power devices, power devices with superconducting spiral coils as the main body appear, such as the spiral winding structure of high-temperature superconducting transformers, and the layered spiral structure of high-temperature superconducting power cables. At this time, it is necessary to analyze the general spiral coil. The magnetic field of the structure, and the constraints of the properties of the superconducting material must be considered, which will have important significance in the design of the electromagnetic parameters of the superconducting power device [12, 13]. High-temperature superconducting tapes do not have the excellent mechanical properties of low-temperature superconducting wires. Bending, twisting, and exposure to minor tensile stress will reduce its current-carrying capacity.

According to the different superconducting materials of the coils, high-temperature superconducting transformers can be divided into hybrid superconducting transformers and high-temperature superconducting transformers. The low-voltage high-current winding of the hybrid transformer adopts high-temperature superconducting winding and operates at the temperature of liquid nitrogen, while the high-voltage winding is composed of low-loss copper coils due to the low current. The high-voltage side copper winding can withstand a larger fault current than normal temperature, and the use of copper winding can also save a certain amount of superconducting wire costs [14, 15]. However, the required structure of the cryogenic container is complex, the radial size of the high-voltage winding cannot be reduced, and the resistance loss of the copper winding affects the efficiency of the transformer. This is a transitional type of superconducting transformer, while the high-temperature superconducting transformer operates at the temperature of liquid nitrogen, and the high- and low-voltage windings use high-temperature superconducting windings. According to whether there is an iron core, high-temperature superconducting transformers can be divided into iron core transformers and air-core transformers. In terms of loss, the transformer has an optimal core section. If the section is increased, the increase in core loss will exceed the reduction in winding loss and cooling loss. Conversely, the increase in winding loss and cooling loss will exceed the reduction in core loss [16, 17]. Therefore, iron-core transformers are often used in large power transformers, and air-core transformers are only used when there are special requirements for weight and structural simplicity. For core transformers, the use of superconducting materials can reduce the optimal core section by about 4 times, thereby reducing the weight of the transformer and core loss. For air-core transformers, the low-loss characteristics of superconducting materials make it possible to greatly increase the excitation current, thereby making it possible to manufacture large air-core power transformers. Due to the cancellation of the iron core, the air-core transformer has the

advantages of light weight and small volume, and there is no problem of no-load loss, electrical insulation between the winding and the iron core, inrush current caused by magnetic saturation and higher harmonics of the excitation current. High temperature superconducting transformers have inherent low impedance characteristics, and the AC loss of the winding is much smaller than that of the iron core. The empirical formula for the optimum capacity of conventional transformers is not suitable for high-temperature superconducting transformers.

Specifically, the critical current and external magnetic field of the high-temperature superconducting tape have the characteristics of anisotropy, and the critical current will be reduced to a certain extent under the influence of the external magnetic field. For superconducting transformers, the current-carrying capacity of the device windings must be attenuated by the influence of the leakage magnetic field inside the windings. Therefore, the current-carrying capacity of high-temperature superconducting tapes plays an extremely important role in the design, economic performance, and operational stability of high-temperature superconducting electrical devices. The study of the electromagnetic properties of the superconducting electrical device must be based on the anisotropy of the critical current and magnetic field of the high-temperature superconducting tape, and the analysis of the magnetic field distribution of the high-temperature superconducting electrical device is the basis for the analysis and design of the electromagnetic properties of the high-temperature superconducting electrical device [18, 19].

2. Electromagnetic Field Finite Element Analysis of Leakage Magnetic Field of High-Temperature Superconducting Transformer

High-temperature superconductors are nonideal second-class superconductors, and they are all changing during the excitation process of their magnet applications or superconducting power applications such as superconducting transmission cables, superconducting current limiters, superconducting transformers, superconducting motors, and other power equipment. In the magnetic field. Compared with conventional transformers, superconducting transformers have inherent low impedance characteristics, and their AC losses are also much smaller than the copper losses of conventional transformers, so the number of turns of the windings can be increased, thereby reducing the cross-sectional area and volume of the core. And no-load loss. Superconducting transformers also have a much higher operating current density than conventional transformers, which greatly increases the ampere-turns of the transformer windings, thereby increasing the electrical load of the transformer. In proportion to the square, when the transformer fails, the problem of short-circuit force and thermal stability will be more prominent. At the same time, since the average radius of the winding decreases with the cross-sectional area of the iron core, the width of the winding is reduced due to the high current density of the superconducting tape. The electromagnetic problems of high-temperature superconducting transformers include the influence of core operating temperature, core type, coil type, and others such as magnetic field, electric field, and so on.

Electromagnetic field optimization is the goal that electromagnetic engineering technicians strive to pursue. On the premise of meeting the requirements of electromagnetic characteristics, our design goals are either to minimize the volume of the device, minimize the loss, and minimize the amount of materials, or to make the device economical and technically superior. High-temperature superconducting devices have unique electromagnetic properties, that is, the critical current and magnetic field of high-temperature superconducting wires are anisotropic, which must be considered when analyzing the electromagnetic properties of high-temperature superconducting devices. At present, high-temperature superconducting devices are mainly composed of high-temperature superconducting coils, and their structures may be very complex, such as hybrid spiral coils, which make full use of the different advantages and characteristics of various coils to meet the special requirements of engineering electromagnetic fields. Based on the latest optimization technology of electromagnetic field, electromagnetic field optimization technology has a very important position in electromagnetic engineering design. (1) According to the law of mechanics, it is extended to the field of electromagnetic field, and the stress distribution optimization technology of the hybrid coil is proposed, that is, the virial theorem of electromagnetic field. (2) By using the genetic algorithm toolkit of Matlab, the corresponding method can be realized.

The leakage magnetic field of a high-temperature superconducting transformer can be expressed by Maxwell's equations:

$$\begin{aligned} \nabla \times H &= J_0 + \frac{\partial D}{\partial t}, \\ \nabla \cdot B &= 0, \\ \nabla \times E &= -\frac{\partial B}{\partial t}, \end{aligned} \tag{1}$$

where B is flux density, E is electric field, H is magnetic field strength, and J is current density.

In an isotropic electromagnetic medium, the relationship between the field quantities E and D, B and H, J and E in the electromagnetic field is represented by the auxiliary equation of the electromagnetic field. Its relationship is

$$\begin{aligned} D &= \varepsilon E, \\ B &= \mu H, \\ J &= \sigma E, \end{aligned} \tag{2}$$

where μ is permeability and ε is conductivity.

The equivalent conductivity of the high-temperature superconducting tape can be expressed as

$$\sigma = \lambda_{sc}\sigma_{sc} + (1 - \lambda_{sc})\sigma_{ag}. \tag{3}$$

Among them, λ is the silver-to-super ratio, and σ is the electrical conductivity. In practical engineering calculations, the equivalent electrical conductivity of high-temperature superconducting tape is often given by the E-J characteristic curve of the high-temperature superconducting tape measured experimentally:

$$\sigma = \frac{J}{E}. \tag{4}$$

Under normal working conditions, that is, when the current in the high-temperature superconducting coil satisfies $J < J_c$, then

$$E = E_c\left(\frac{J}{J_c}\right)^n. \tag{5}$$

In this way, the equivalent conductivity of the high-temperature superconducting tape under normal working conditions can be expressed as

$$\sigma = \frac{J_c^n}{E_c}J^{1-n}, \tag{6}$$

where J_c is the critical current density of the high-temperature superconducting tape. In order to describe the basic properties such as the magnetization characteristics of high-temperature superconductors, some scholars have proposed different critical state models. The most commonly used is the critical state model proposed by (7), which assumes that the current density in the superconductor is independent of the applied external field, namely,

$$J_c = C. \tag{7}$$

It is proposed as a model of the critical state, arguing that the critical current varies with the external field, namely,

$$J_c(H) = \frac{J_0}{(1 + |H|/H_0)}. \tag{8}$$

The calculation of the electromagnetic force in the high-temperature superconducting transformer has a guiding role for the winding design and fixing of the transformer. It is considered a prerequisite for designing HTS transformer protection devices.

3. Abnormal Voltage Analysis

In a power transformer, the coil completes the transmission and conversion of electrical energy through an electromagnetic field. The electrical energy of the system is introduced into the transformer by the primary coil and transmitted by the secondary coil. Common coil forms are continuous, tangled, and spiral. The gaps between the wire cakes directly lead to the uneven distribution of the magnetic field near the inner diameter of the wire cakes. In order to study the effect of the air gap on the magnetic field distribution, we compare it with the magnetic field produced by the helical winding.

3.1. Continuous Coil. The continuous coil is composed of several continuously wound wire cakes distributed along the axial direction. This structure can adapt to the requirements of various voltage levels and capacities in a wide range. It has high mechanical strength and good manufacturability, but the impulse voltage distribution is not good.

3.2. Tangled Coil. Tangled coils are mainly used on high-voltage coils of transformers of 220 kV and above. As for the tangled continuous coil, it is often divided into several areas, some areas adopt a tangled structure, and some areas adopt a continuous structure. This kind of coil is called a tangled continuous coil.

3.3. Spiral Coil. The helical coil is the simplest form of coil structure. It is formed by winding one or more wires in the form of a solenoid, usually multiple wires are wound in parallel.

3.4. Double-Layer Spiral Coil. Also known as U-shaped coil, it combines the characteristics of helical coils and layered coils. Each layer of helical type adopts multi-helix, and the second layer is wound through the lifting process. There are both axial oil gaps and radial oil gaps; the head positions are all on the same side.

Alternating magnetic fields or transport currents cause energy losses in the second type of superconductors, which are called AC losses. It should be noted that the AC loss is different from others since it is influenced by the frequency. The coil height refers to the dimension occupied by the coil in the axial direction. In addition, there is a concept of electrical height, which refers to the height of pure copper wire after removing the upper and lower end rings or electrostatic rings. The radial dimension is also called the width dimension, which refers to the width occupied by the wire cake on the plane perpendicular to the axis along the radial line of the center of the circle. The wire is wound around the mold for one turn, which is called a turn. For tangled or continuous coils, there are integer turns and fractional turns, full turns and unsatisfactory turns. The winding direction of the coil refers to the advancing direction of the turns during winding, which is divided into left winding direction and right winding direction.

There are many factors that cause abnormal voltage, and the common reasons are as follows:

3.5. Treatment of Winding Short-Circuit Point. There are actually many ways to wind multiple flat copper wires in parallel. The most common method is to produce flat copper wires into composite wires, winding a single composite wire or winding multiple composite wires in parallel. This belongs to the category of parallel winding of multiple flat copper wires. We can use a 500 V megohmmeter to check for shorts in parallel wires. If there is a short circuit between the wires, the pointer of the megohmmeter will indicate very little or zero. The method of determining the short-circuit point with multiple wires is parallel: if it is not at the outgoing position, we can calculate and analyze the internal position of the short-circuit point on the line segment.

3.6. The Number of Turns. When the test result of the semi-finished transformer is the wrong number of turns, it is not possible to accurately determine which line segment has wrong turns, but only to determine that there is an error in a certain winding tap area. Many turns and few turns may be in the normal line segment or in the special line segment, but from experience, the situation of how many turns is likely to occur in the special line segment, and it is very likely to occur in the first few lines of the special line segment.

3.7. Poor Winding Insulation Condition. When there is moisture in the transformer winding or abnormal changes in temperature and electric field environment, the insulation performance of the transformer winding will be reduced. Since the insulation performance of the windings is greatly reduced after being damp, moisture is the most important factor affecting the insulation performance of the transformer windings. When the transformer is not tightly sealed, it is easy to cause moisture to enter the transformer and affect the winding insulation.

3.8. Transformer Windings Are Deformed by Short-Circuit Electromotive Force. The short-circuit current flows through the transformer windings, and acts together with the leakage magnetic field to make the windings subject to the short-circuit electromotive force. Taking the double-winding transformer as an example, when the amplitude-direction electromotive force acts on the high-voltage winding, the high-voltage winding is subjected to outward pulling force, and the deformation trend is outward expansion. When the amplitude-direction electromotive force acts on the low-voltage winding, the low-voltage winding is subjected to inward tension, and the deformation trend is concave deformation. The abnormal voltage and current are shown in Figures 1 and 2.

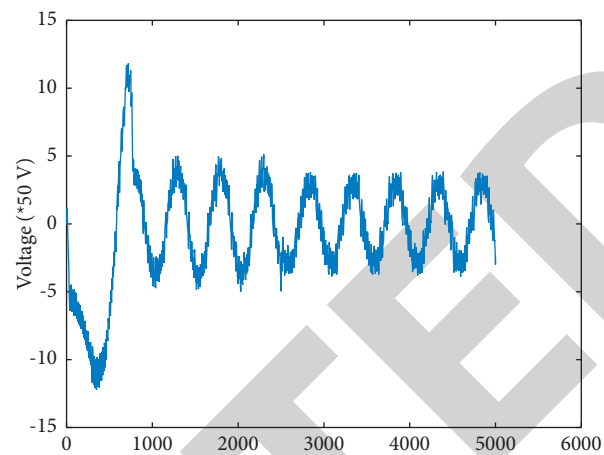

Figure 1: Abnormal voltage.

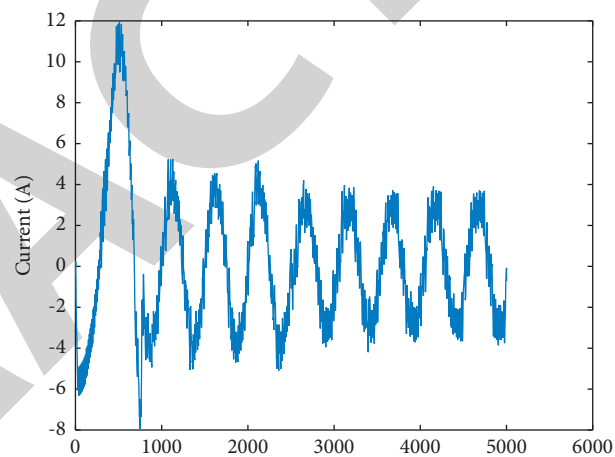

Figure 2: Abnormal current.

4. Electromagnetic Field Analysis and Optimization Method of the High-Temperature Superconducting Transformer under the Influence of Abnormal Voltage

Generally speaking, the electromagnetic field problem is the problem of solving Maxwell's equations. There are usually two methods: one is the direct method, which is solved directly from Maxwell's equations; the other is the indirect method, which is solved by the potential function.

4.1. Winding Circulation. Compared with the normal conduction transformer, the superconducting transformer winding design has two obvious characteristics: one is to minimize the leakage magnetic field in the winding area, especially its radial component, so as to increase the critical current and reduce the AC loss; the other is to minimize the leakage field. A small unbalance of leakage reactance between branches of windings may cause considerable circulating current. In recent years, research on superconducting transformers, such as the influence of winding form on leakage magnetic field, AC loss calculation, quench test and protection, performance of insulation and core materials at low temperature, optimization design and hollow superconducting transformers, etc., are rather common. Much literature has been published but relatively few studies have been done on circulation.

Figures 3 and 4 list the calculation results of the circulating current in various situations, namely, with or without abnormal voltage. We can see the following: ① The difference in the circulating current is obvious in various situations, and whether the wire is transposed or not has a great influence on the circulating current. ② In terms of the circulating current distribution, among the three types of windings, the layered winding is the most suitable for the situation where multiple wires are wound in parallel, the spiral winding is the second, and the pie winding is the worst. It can be seen that from the perspective of reducing the circulating current, the layered winding is most suitable for the situation where multiple wires are wound in parallel, because it can better balance the reactance of each branch by transposing the wires between the winding layers. However, considering the circulating current and the manufacturing

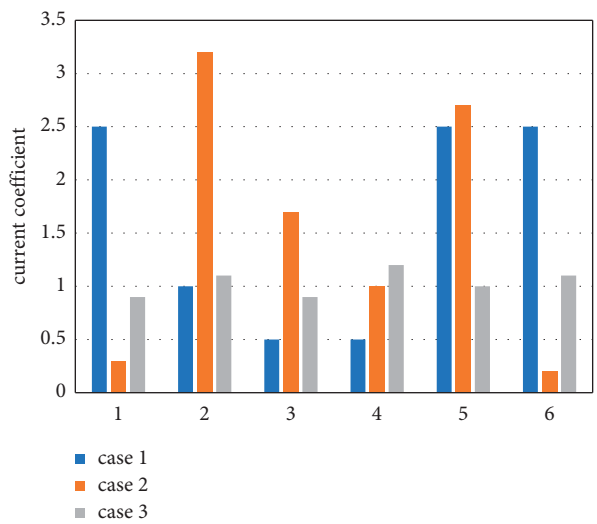

Figure 3: Current distribution of each branch.

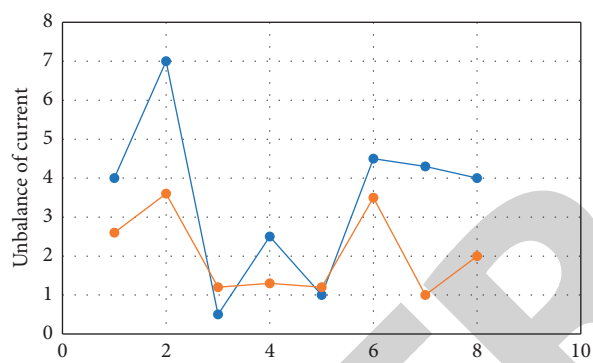

Figure 4: Unbalance of current.

process, the spiral winding should be used, because if the conductors are properly transposed, the circulating current of the spiral winding can be controlled to be smaller. It is also important that the welding points required by the spiral winding are far more than that of the layered winding. Winding is less. At the same time, it is proved that from the consideration of circulating current distribution, it is impossible to short-circuit the two ends of each layer of the secondary side layer winding and then use copper wire to transition to the adjacent layer to replace the transposition of the superconducting wire between the layers.

4.2. Nonlinear Harmonic Analysis of Leakage Magnetic Field of the High-Temperature Superconducting Transformer. The magnetic field problem of superconducting current conductors is a boundary value problem, which can be summed up in three categories: analytical method, numerical method, and semi-analytical numerical method. The magnetic field of the high-temperature superconducting transformer changes with the sinusoidal current under normal working conditions, and the iron core of the transformer is in a saturated state. Since the core and windings of the transformer are axisymmetric structures, the 3D model can be simplified into a 2D model for calculation. The calculation process is basically similar, with the following differences: 1. Thanks to the iron yoke, it is no longer necessary to divide the far-field region. 2. With the presence of a saturated core, the analysis becomes nonlinear and the B–H curve of the core needs to be defined in the material properties. 3. Since the winding is composed of one wire cake, and each wire cake has a small cross section, the mesh should be divided as carefully as possible. 4. Since the high-temperature superconducting tape is in the superconducting state, the voltage is very small, but the current is very large, so we choose the current density as the excitation.

4.3. Current Distribution. When the cable conductor of the high-temperature superconducting cable passes through the AC current, the current-carrying capacity of the conductor is significantly reduced, the current distribution of each layer is extremely uneven, and the AC loss increases, thus affecting the stable operation of the cable conductor, or greatly reducing the ideal of the cable conductor. It can be inferred that the sinusoidal AC waveform passing through the cable conductor must be distorted at this time. According to Ohm's law, the current distribution of conductors in each layer is determined by joint resistance, flow resistance, self-inductance and mutual inductance. The inductive reactance per unit length of each layer of the conductor is about two orders of magnitude larger than the joint resistance or flow resistance. Therefore, in the case of AC, the actual current-carrying capacity of each layer of tape is mainly determined by the self-inductance and mutual inductance of each layer. Self-inductance and mutual inductance are structural parameters, which are determined by physical characteristics such as the shape, structure size, and winding arrangement of each layer of tape.

In addition, the contact resistance also has a certain influence on the current distribution. Assuming that the high-temperature superconducting cable does not have a helical structure, but has an n-layer parallel conductor structure, the current will be distributed in the outer layer of the cable as much as possible. When the outer layer current exceeds its critical current value, the electric field will increase and the outer layer will be rapidly saturated, resulting in the AC loss increases, but little current flows through the inner layer, resulting in extremely uneven current distribution in the cable. Foreign experiments show that increasing the contact resistance between the power supply and the superconducting tape can also make the current distribution as uniform as possible, but it will increase the ohmic loss of the current lead and increase the cooling cost. Therefore, the factors of uniform current distribution are generally analyzed from the structural parameters of the high-temperature superconducting cable.

When the current I = 40A is applied to the winding, the magnetic field distribution on the vertical path at the inner diameter of the winding is obtained as shown in Figures 5 and 6. It can be seen that the maximum value of the axial radial magnetic field experienced by the helical winding and the pie winding is approximately equal. However, the

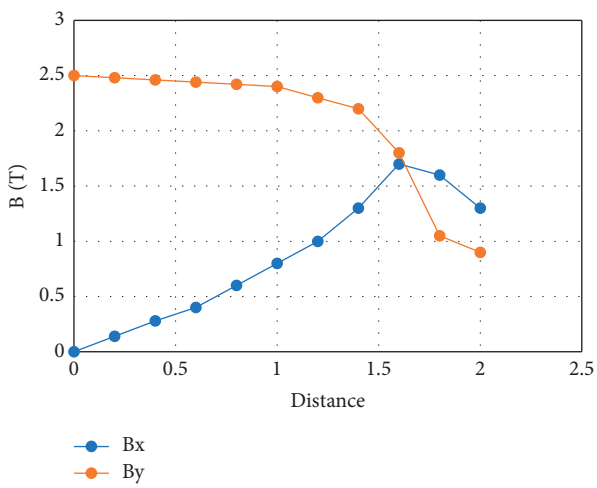

Figure 5: Flux density vs distance in helical winding.

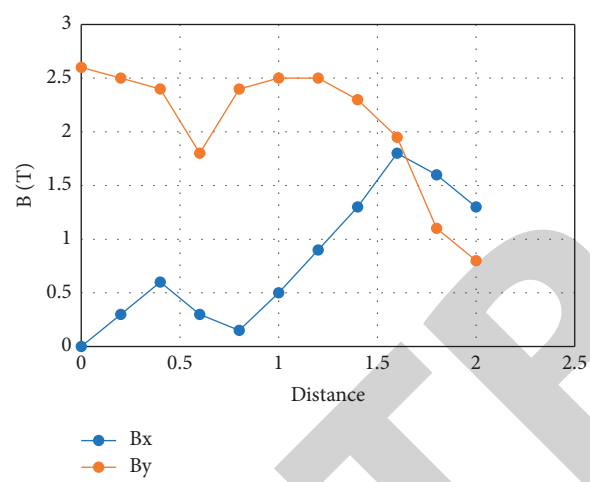

Figure 6: Flux density vs distance in pie winding.

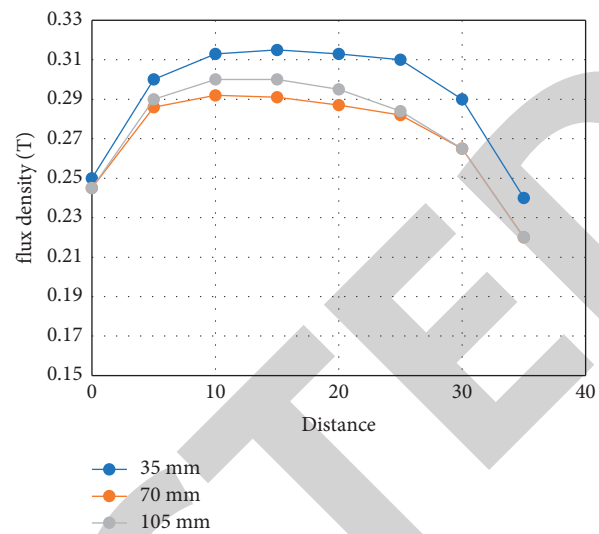

Figure 7: Flux density vs distance in different gaps.

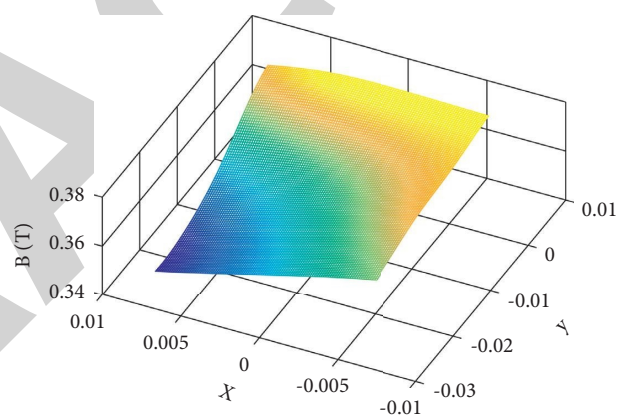

Figure 8: Flux density vs position.

magnetic field distribution of the pie winding shows obvious periodicity, the peaks always appear near the wire pie, and the troughs appear at the gap between the wire pie and the wire pie. Although the critical current attenuation under the influence of the magnetic field is roughly equal for the two winding methods as a whole, for the wire cake located in the middle of the entire winding, since the position of the wire cake is in the peak section of the magnetic field, they are affected by the magnetic field. Pie winding is larger than spiral winding, and the relative current margin is also lower. Due to the difference in the magnetic field distribution, there must also be a difference in the AC losses of the two windings. By expanding the length of the air gap between the high-voltage winding and the low-voltage winding, it is hoped that the leakage magnetic field near the high-voltage winding and the low-voltage winding can be reduced. It expands the air gap between the high- and low-voltage windings from 35 mm to 70 mm and 105 mm, respectively, and then we can obtain the magnetic field distribution near the low-voltage winding, as shown in Figure 7. The warm superconducting tape has anisotropy, and the increased radial leakage magnetic field due to the inconsistency between the iron core and the coil will reduce the critical current of the superconducting tape and increase the AC loss of the superconducting winding.

As shown in the figure, increasing the length of the air gap between the high-voltage winding and the low-voltage winding can reduce the leakage magnetic field near the winding, but the effect is not very obvious. When the air gap is increased to three times the original air gap, it takes up a lot of space and increases the volume of the entire transformer, but the radial component of the leakage magnetic field is reduced by less than 10%. It can be seen that this optimization method is too inefficient and not desirable. Besides, the flux density versus different position is shown in Figure 8.

5. Conclusion

In this paper, the core loss, the AC loss of the winding, the electric power received by the coil, and the stress on the winding of the high-temperature superconducting transformer are analyzed under the normal operating state and

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Retraction

Retracted: Construction of Virtual Piano Performance System Based on Visual Gesture Recognition

Mobile Information Systems

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] K. Tian, "Construction of Virtual Piano Performance System Based on Visual Gesture Recognition," *Mobile Information Systems*, vol. 2022, Article ID 9446905, 12 pages, 2022.

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Research Article

Construction of Virtual Piano Performance System Based on Visual Gesture Recognition

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In order for computers to understand people's gestures through cameras and react accordingly, through in-depth research, gesture recognition technology in natural human-computer interaction is proposed. Combining natural human-computer interaction technology with music performance, using computer vision-based gestures, music is played in a virtual environment. Experiments show that the virtual piano has 14 piano keys. For the realization of piano performance, it is each piano key; once the piano key is greater than the set value, just call m_Wave.Load() to make a sound. According to the CWave class in the object-oriented MFC class library under VC++, create an object m_Wave of class CWave. Then, according to the m_Wave.Load() function of the CWave class, the connection of the sound is realized. It successfully solves the troubles of music lovers, enriches people's spiritual life, and has certain practicability and scalability.

1. Introduction

Human-computer interaction technology is the interaction between human and computer [1]. This technology is increasingly becoming an important part of people's lives; in particular, computer and information technology, intelligent technology, biotechnology, and other technical fields have developed rapidly, as shown in Figure 1. Virtual technology started in the 1990s; the latest development is advanced human-computer interaction technology, which is an effective simulation of human activities in the real world. Advanced human-computer interaction includes techniques for behaviors, such as listening, speaking, and grasping. It is a collection of various technologies, such as artificial intelligence, computer graphics, human-machine interface, and network technology [2]. Virtual technology is a technology of great significance; it is important for defense, military, aerospace, medical, education, manufacturing, art, entertainment, and even people's daily lives, where all have great connections and effects. Computer vision is also a subject area at the forefront of knowledge. During the past thirty or forty years of development, it has been applied to important fields, such as robot navigation, industrial inspection, and medical image processing [3]. It has become one of the important and widely applied disciplines in people's daily life, national economy, national defense science and technology research, and other fields. More than 85% of human perception of external information is obtained through vision. Therefore, in the application of virtual reality technology, visual communication has become the most important sensory interaction link in virtual reality technology, and visual technology has naturally become an important support technology for virtual reality [4]. In the early days of virtual reality technology research, the pioneer of computer graphics, Ivan Sutherland, in the Sword of Damocles system, realizes 3D stereoscopic display; the suspended objects in the air were observed with the human eye, which was very noticeable. Many mainstream virtual reality systems now support visual technology without exception. In the technology of virtual reality visual interaction, using noncontact methods, for example, the camera lens, and so on, to observe the user's actions to realize human-computer interaction, has become an increasingly promising 3D interactive technology [5].

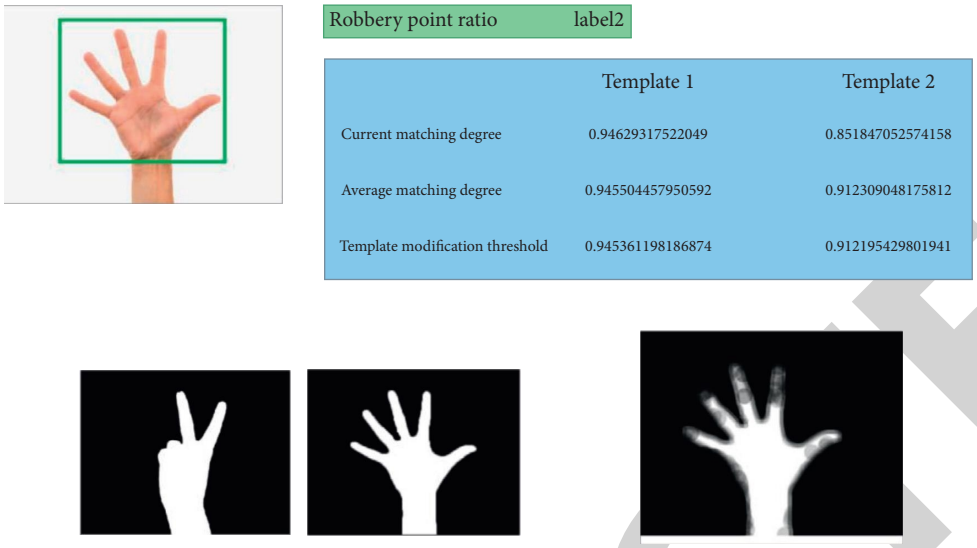

Figure 1: Human-computer interaction technology.

2. Literature Review

Music is the language of the human mind. Every country and every nation have their own unique and wonderful music. After thousands of years of development, music has developed into a systematic, complete, and diverse discipline. Lee and others found that in order to play music well, it is necessary to accept certain training and guidance [6]. Zhu and others found that in this era of extremely rich material life and spiritual life, more and more people like music, like to play music, and like to express their feelings through music. In traditional music performance, people usually get all kinds of wonderful music by playing various musical instruments [7]. Khan et al. found that due to the economy, for various reasons, such as playing skills and types of instruments, many people cannot get their favorite instruments to play. The authors propose to combine computer gesture-driven technology with the music performance process; the user only needs to step into the virtual scene, move the palm left and right to simulate plucking the strings, just can play the basic scales of various tones: do, re, mi, fa, so, la, si, and do. These basic scales are connected to make beautiful music, without direct contact with various musical instruments [8]. Kim et al. found that this method not only meets the needs of music fans for music performance, but also solves the inconvenience caused by playing various musical instruments, and has high usability and practical significance; it can be applied to some entertainment venues as well as music academies, music museums, and other places [9]. Traver et al. found that computer trend recognition technology is a new type of natural human-computer interaction. Different from the traditional machine-centered human-computer interaction method, natural human-computer interaction is a multimedia and multimode interaction technology, which emphasizes more on the user-centered, using computer-controlled technology that conforms to natural communication habits, and provides users with a natural and effective human-machine communication interface [10]. Zheng et al. found that in the process of research and development of natural human-computer interaction systems, human-virtual device interface become an important part of the research center. Particularly in recent years, with the rapid development of computer technology, research into new human-computer interaction technology that conforms to human-computer communication habits become extremely active and also made gratifying progress [11]. Joglekar et al. found that, among them, computer gesture recognition technology is a natural, intuitive, and easy-to-learn means of human-computer interaction [12]. Perrett et al. found that in the process of gesture recognition, the human hand is directly used as the input device of the computer, and the communication between the human and the computer will no longer require an intermediate medium; the user can simply define an appropriate gesture in order to control the surrounding machines [13]. Wibisono found that current computer gesture recognition technology is mainly used in multichannel user interface, postoperative human rehabilitation, virtual environment interaction, intangible heritage protection, blind sign language recognition, and so on [14]. In the field of music digitization and virtual performance, gesture recognition also has great usability and advantages. Mo and Sun found that applying gesture recognition technology to virtual performance technology, the virtual performance of music can be realized, allowing more music lovers to engage in music performance and research [15].

3. Methods

Virtual technology is essentially a human-computer interaction technology, and it is an advanced human-computer interaction technology (because it requires interaction in a purely natural way and for multichannel information). The virtual reality system is a concrete embodiment of the application of virtual technology; it is input and output device

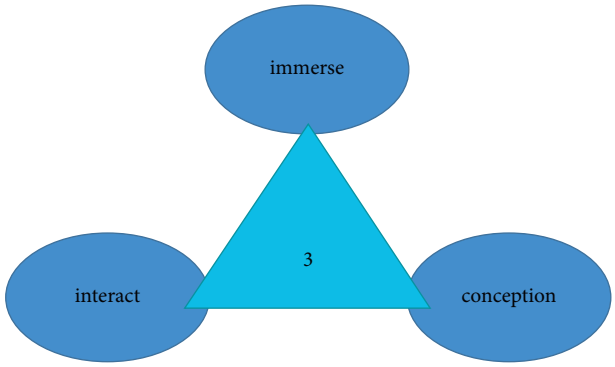

Figure 2: Three "I" diagrams.

by various sensors, and computer-built virtual scenes, a system implementation of virtual technology composed of virtual objects. The usual virtual reality system has three basic characteristics, namely, "Immersion-Interaction-Imagination"; in 1993, Burdea proposed the "Triangle of Spiritual Technology," and it is as shown in Figure 2.

Immersion is the operator in the virtual reality system, immersion when interacting with computer-generated virtual environments; Interaction is the interaction between input and output devices and the virtual environment; and Imagination is a variety of "ideas" based on computer simulations.

These three characteristics are the basic characteristics of virtual reality system, the role of humans in virtual reality systems is emphasized. In the past, people could only observe the results of calculation and processing from outside the computer system so that people can walk into the virtual scene and immerse themselves in the environment created by the computer system. In the past, people could only use the keyboard, mouse, interact with single-dimensional digitized information in a computer environment; now people use virtual reality interactive technology, being able to use a variety of sensors to interact with a diverse information environment. The purpose of people is that, in a virtual reality system, information processing systems consist of computers and other equipment in order to try to "meet" people's needs, rather than forcing people to serve those computer systems. The feeling that people can get through the virtual reality system, feel as close as possible to what they get in the real world. Enabling people to immerse themselves in virtual reality systems, and through the virtual reality system, we can get the feeling that cannot be experienced in the real world. Breaking through the limitations of physical space and time and avoid dangers involving life, it makes the virtual reality system have the virtuality of "beyond reality." The basic means and fundamental purpose of constructing a virtual reality system, it is to use high-performance computer software and hardware and integrate various advanced equipment, in order to achieve an immersive sense of immersion for the operator, a virtual reality system with perfect interaction capability [16]. At present, in countries all over the world, researchers are making efforts and attempts [17].

Generally speaking, to build a complete virtual reality system, it is necessary to have the overall division of hardware and software in terms of hardware, such as a tracking system that can detect the operator's head, hands, body, and other positions' information. Force feedback system that can provide force sense and touch; audio system that can provide sound; image generation and display systems capable of producing three-dimensional stereoscopic images; and tracking systems that provide vision, as the author did. In terms of software, there is generally a software support environment, there are also toolsets that can generate virtual scenes and virtual objects; it can also receive various high-performance sensor information functions (e.g., helmet tracking information, visual image processing information, etc.). The ability to generate and display three-dimensional graphics (such as virtual hands, virtual piano, etc.); with the development of virtual reality technology today, a lot of applicable results have been achieved, and virtual reality technology is popularizing to the market; with the multidimensional information space, it can gradually provide an application environment for virtual reality systems. Future virtual reality technology will be like other current science and technology; it has become the most common and best method and tool for human beings to understand and transform the world [18].

(1) If decomposed from the perspective of the system, the virtual reality system mainly includes VR scene observation system, VR scene generation and accelerated display system, high-performance computer processing system, audio system, tracking system, and haptic and force feedback system, as shown in Figure 3:

(1) VR scene observation system: it is used to observe the VR graphics scene output by the computer, such as helmet display and stereo glasses.

(2) VR scene generation and accelerated display system: it generates visual images and stereographic display, such as graphics subsystems in workstations and professional stereoscopic 3D graphics accelerators.

(3) High-performance computer processing system: it is a computer system with high processing speed, large storage capacity, and strong networking characteristics, such as a high-performance PC.

(4) Audio system: it provides stereo source and determine spatial position, such as stereo, speakers, headphones, and so on.

(5) Tracking system: it is used in order to determine the position of the participant's head, hands, and body, such as space tracking locator and space trackball.

(6) Haptic and force feedback system: it provides force and pressure feedback, such as data gloves with force or haptic feedback, robotic arms, and so on.

The closed virtual reality system does not directly interact with the real world, and any operation does not have a direct effect on the real world [19]. The closed virtual reality system consists of three parts: modeling module, 3D model library, and interaction module. The modeling module can use knowledge base, pattern recognition,

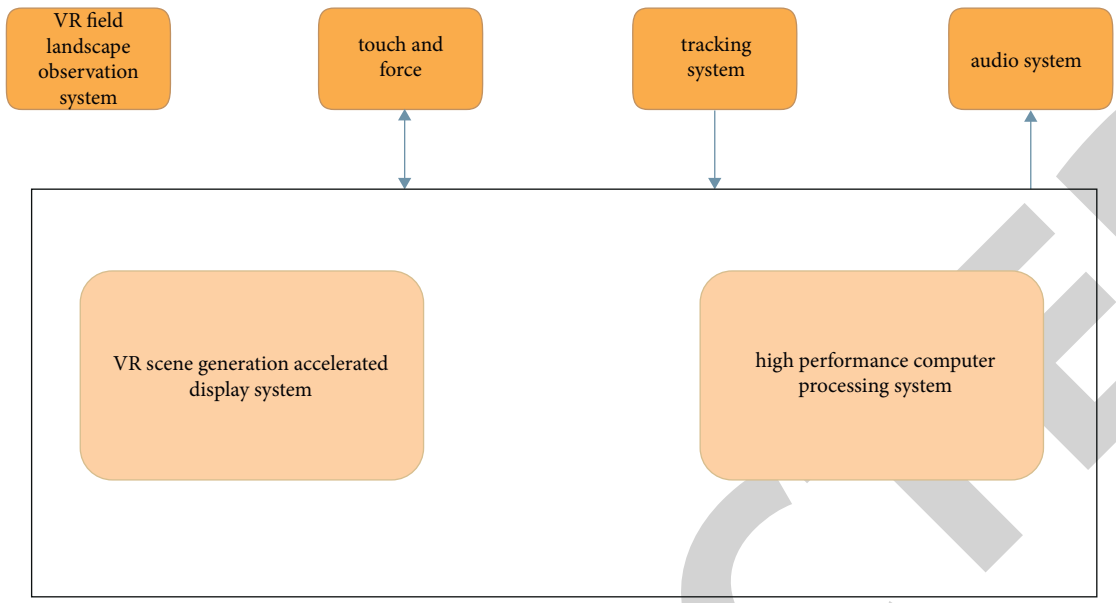

Figure 3: Schematic diagram of virtual reality system.

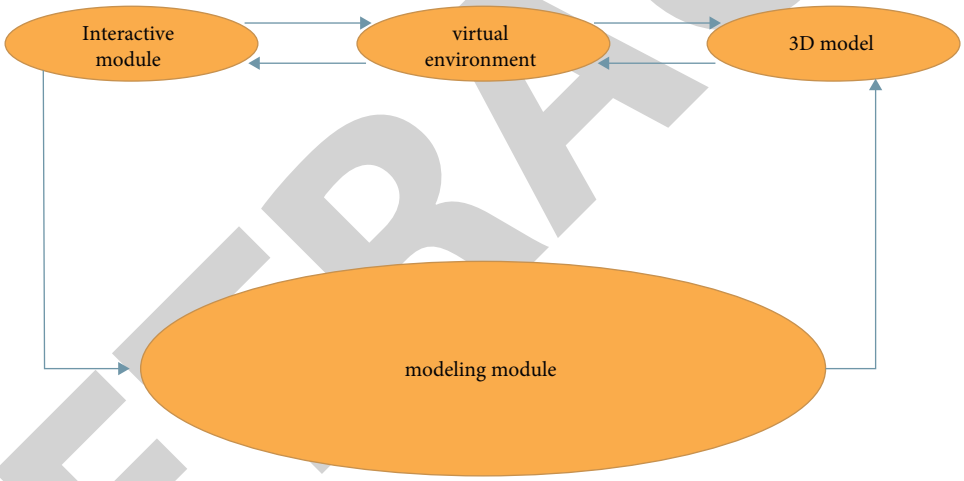

Figure 4: Composition of a closed virtual system.

artificial intelligence, and other technologies to build models, visual simulation of virtual scene through 3D animation, and sound simulation through sound production. The 3D model library is the 3D representation of the components of the real world, which can constitute the corresponding virtual environment. The interaction module contains several submodules, such as sensor, signal detection and control, and signal feedback and control. Human movements can be detected by sensors, and then the virtual environment can be operated by controlling submodules; at the same time, the feedback gives people the feeling of movement, touch, force, and so on. The composition of the closed virtual reality system is shown in Figure 4.

Open virtual reality system; then a feedback closed loop can be formed through sensors and the real world; therefore, the virtual environment can be used for the purpose of direct operation and remote operation of the real world. Sensor devices include the abovementioned visual sensor devices and auditory and tactile system sensors.

Given the virtual reality system hardware equipment, virtual worlds are often created and drawn using a variety of applications and toolboxes, and an interface with the virtual world is realized [20]. Drawing is the process of creating a sensory image that describes a virtual world and belongs to the software-generated virtual environment, build virtual worlds, and virtual scenes and virtual objects. First of all, the model of its virtual object must be established; when the virtual object is created according to various tools such as CAD, OpenGL, and so on, generate virtual pairs that can be viewed in virtual scenes; then store them as separate files in the model library. In virtual reality technology, the modeling and rendering of virtual scenes and virtual objects has always been the focus of research; it is also the primary core issue. At present, the world is around the virtual environment modeling problem. There are mainly two solutions: one is

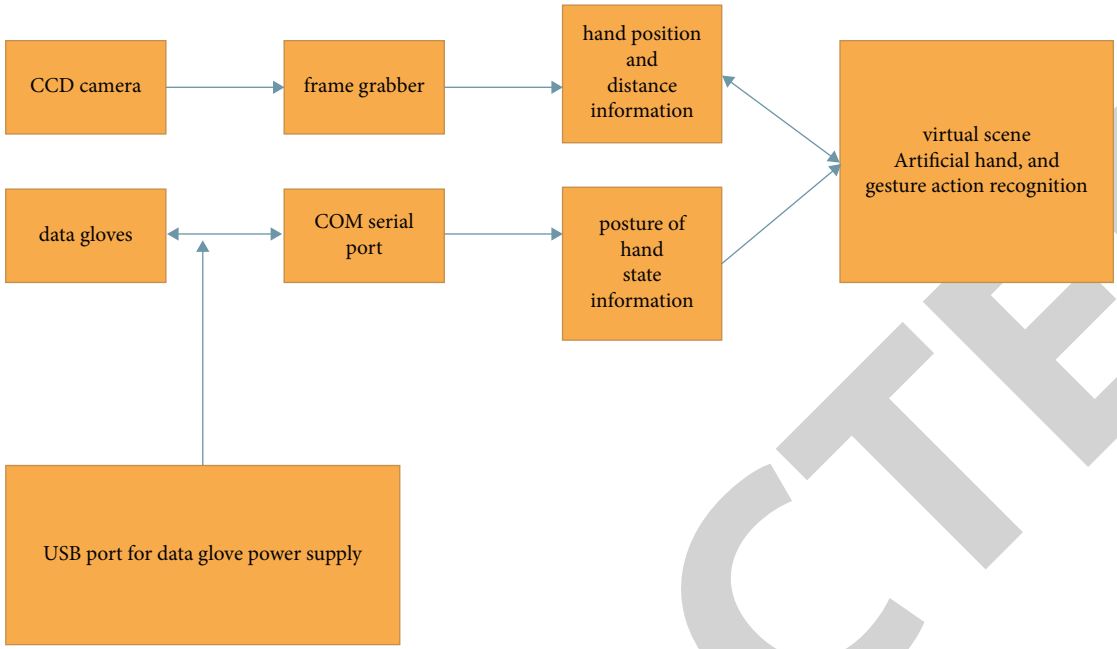

Figure 5: Schematic diagram of virtual system composition.

the modeling and drawing based on geometry (graphics) based on traditional computer graphics; the second is image-based modeling and rendering based on image sampling of the 3D environment. Both methods have advantages and disadvantages. Each object in the virtual environment contains two aspects: shape and appearance. Model files used to store geometric models in virtual environments should be able to provide information on both. At the same time, it must meet three common indicators of virtual modeling technology: interactive display ability, interactive manipulation ability, the ability to easily construct, and the requirements for virtual object models. Open GL is a common tool software for drawing virtual devices; the author's virtual scene and virtual hands, as well as the virtual piano, are drawn with Open GL. Open GL is a set of graphics rendering algorithms, providing a standard cross-platform programming interface. It is easy to implement various transformations, shading, lighting, textures, interaction operations, and animations of models in Open GL, but it can only provide modeling functions of basic geometric elements, which makes the modeling of complex models relatively difficult. 3D graphics modeling tools such as 3DMAX can be used. It is convenient to establish various complex special body models, but it is difficult to carry out program control. After the complex model is established, it can be easily controlled and transformed in Open GL.

The hardware environment in which the author works is a Pentium four-processor PC, one-color CCD camera, one CG300 Daheng frame grabber, CAS-GLOVE data gloves, and a virtual software platform developed by the Chinese Academy of Sciences. The software development tool is VC++6.0, and the system composition diagram is shown in Figure 5.

Software development interface and schematic diagram of virtual world, as shown above, the composition principle of the virtual system software development platform of this department, it consists of the following modules:

(1) Initialization (OpenGL, communication port, etc.) module: complete the automatic initialization before running.

(2) Control module: the overall control system operation and the coordination and scheduling between each module.

(3) Communication module: organize the computer to communicate with the DSP controller through the serial port.

(4) Drawing output module: control the real-time drawing of virtual hands.

(5) Data processing module: the sensor information sent from the serial port of the computer, converted to bending angle information.

(6) Force feedback output module: set the force feedback mode and output port.

(7) Calibration module: calibrate the data glove before use and determine the maximum/minimum bend angle of the sensor.

(8) Data acquisition module: after the sensor information of the data glove is processed by the DSP signal, it is sent to the serial port of the computer.

(9) Angle calibration module: in the debugging stage, it is used to calibrate the value of each bending angle.

The interconnection between them is shown in Figure 6.

The author, on the basis of the original system software platform, shows that the introduction of visual target tracking and recognition system enables the system to process information from the visually collected images; fused with the object parameters of the virtual scene, it can

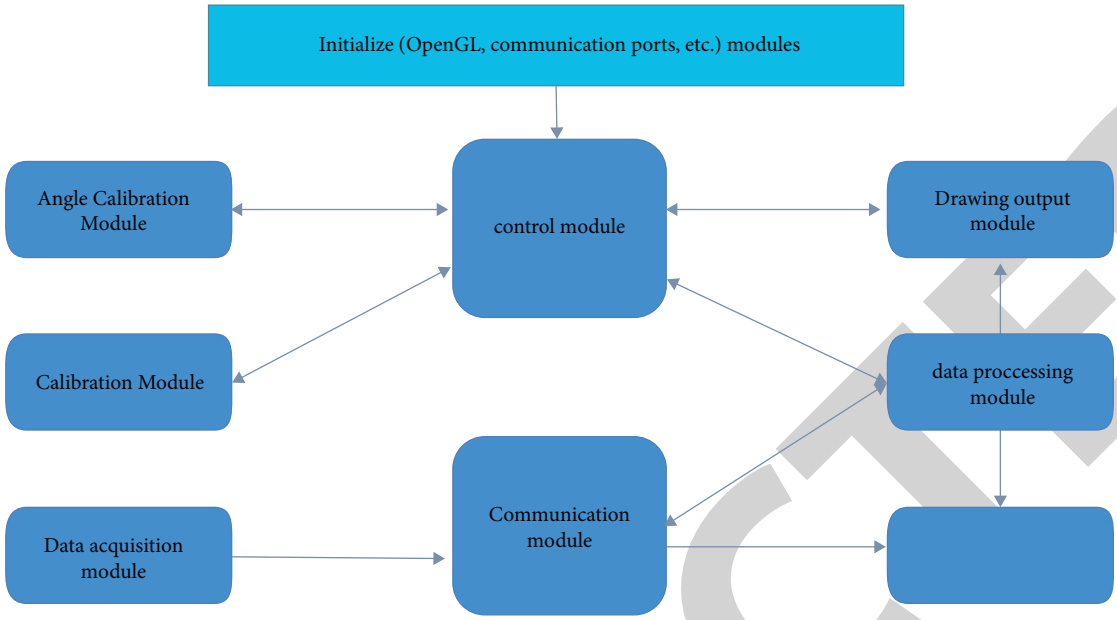

Figure 6: Schematic diagram of virtual development software platform modules.

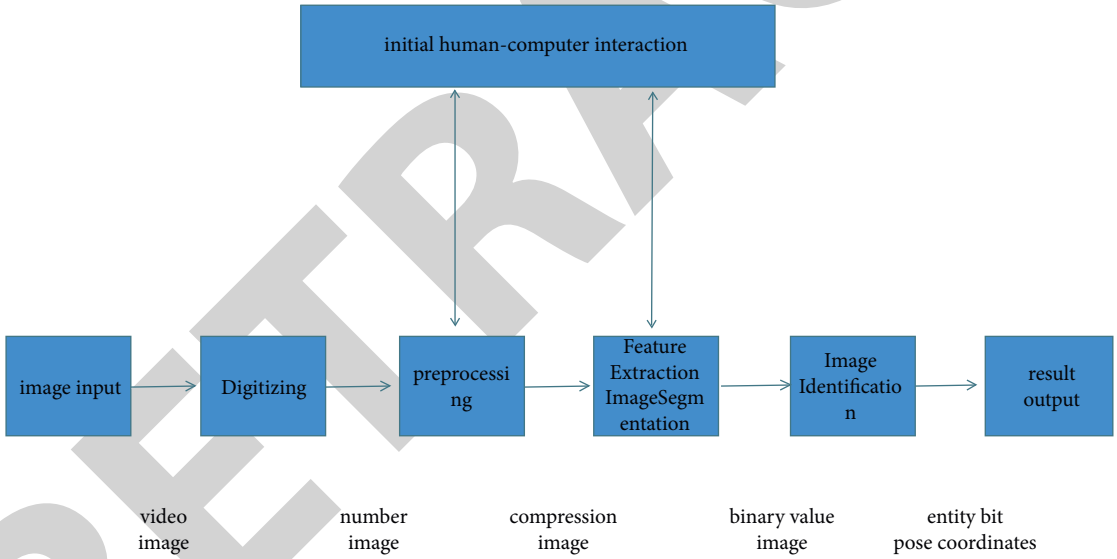

Figure 7: The working process of the vision system.

effectively realize the tracking of real-time motion positioning of virtual objects under vision. The process is as follows: the camera captures the target image to the frame acquisition card, the image information is converted from analog signal to digital signal, and the digital signal is sent to virtual software platform for processing. The data of the data glove passes through the PC COM port, the virtual hand that transmits data to the virtual world in the virtual platform, the sensor data of the data glove is transmitted to the virtual hand. The author's work is to use a video camera and a frame grabber in order to obtain the image information required for the three-dimensional spatial positioning of the virtual hand, image processing, target color recognition, state filtering; then according to the image centroid and distance information, real-time tracking of the coordinates and state of the hand under vision, and according to the real-time tracking, the virtual hand is moved above the virtual piano to realize the virtual piano performance. A typical working process of a vision system is shown in Figure 7.

Generally, in a visual system, we collect images through cameras; the camera can convert the light signal it feels into the corresponding electrical signal. This electrical signal is sent to the TV screen, and the ingested image can be presented. Such images are generally referred to as video images. When the camera acts as the "eye" of the visual system, when the ingested image is sent to the "brain" computer that processes the image for recognition, the first problem to be solved is how to turn a video image into a digital image that a computer can process. Currently in image input and digitization, the commonly used method is a CCD camera plus

an image acquisition card (grabber) [21]. The camera obtains the analog video image, and the image acquisition card completes the analog/digital (AD) conversion, digitizing the video signal. It can be seen that ordinary vision is composed of three parts: camera, frame grabber, and computer.

In the whole process of vision system work, feature extraction, image segmentation, and image recognition are the core tasks, in order to carry out these tasks quickly and efficiently, we can take advantage of the unique functions of the image device in the system, properly adjusting the volume and quality of the captured image. This process belongs to the preprocessing of the image, such as denoising, filtering, histogram averaging, and so on. In order to separate the target from the image background, the process of finding differences between targets and nontargets is called feature extraction. There are many ways to extract image features; the two main ones are image-based brightness features and image-based texture features; brightness-based feature extraction methods include histogram feature extraction. The texture-based feature extraction method is more flexible in the specific method, such as the contour features of the specific target image, the region growth of the target image, fractal method of image splitting and merging, and so on. And according to some feature differences between the different extracted targets, the area division of an image is called image segmentation. There are many methods of image segmentation, among which the simplest image segmentation is the binarized image; that is, all pixels in the image are divided into two categories: target and nontarget. If the point corresponding to the target pixel is set to 1, and the other pixels are set to 0, then the image of the target area is white, and the other areas are black. Initialize the human-computer interaction process, mainly complete the process of image preprocessing, feature extraction and image segmentation, and some parameter selection or parameter passing. Like: Modify the parameters of the chromaticity and brightness of the frame acquisition card through the man-machine interface; the capture effect of the image can be changed. Another example is using a keyboard or a mouse to draw a target image area in the image.

The image acquisition system is the first step in the work of the robot vision system; it is also a step that has an important impact on the subsequent processing effect.

The quality of the collected images is good or bad; it directly affects the correctness of the final image processing and 3D reconstruction results. It consists of camera, frame grabber, computer, and image collection software. Its main function is to convert the analog video signal acquired by the vision sensor in real time, convert it into a digital image signal, and directly transmit the image to the computer for display and processing, or transfer the digital image to a dedicated image processing system, perform real-time front-end processing of visual signals.

Color space is a three-dimensional linear space, any kind of color light with a certain brightness, both are a point or a vector in a space, and this space is the color space. Modern chromatic theory states that a person's perception of any color can be weighted by three monochromatic colors of red, green, and blue; therefore, the three monochromatic colors of red, green, and blue are called three primary colors. This is the three-color principle; our color threshold is carried out in a three-dimensional color space. There are many types of color spaces; the more commonly used are Hue-Saturation-Intensity space (HIS for short), YUV space, and Red-Green-Blue space (RGB).

When we choose the three primary colors of red, green, and blue with definite luminous flux as the basis of the three-dimensional color space, it constitutes the RGB color space. But the RGB color mode is susceptible to lighting effects. In visual color recognition, color recognition is done through different color markers. However, the light intensity of different positions on the playing field varies greatly, making the R, G, and B values of a color vary greatly at different positions on the field. In this way, the color cannot be judged by a single set of thresholds, the robustness of the identification procedure is also out of the question. Its color space model is shown in Figure 8.

The HSI color space model is a color representation system corresponding to the characteristics of human perception; it has a directional arrangement for color awakening, which is very beneficial to the extraction of color information. In the HIS color model, H (hue) is the essential characteristic of color in hue, corresponding to the dominant wavelength of light; S (saturation) is saturation, indicating the degree to which a color is blended with white, that is, the purity of the color; and I (intensity) is the light intensity, the brightness of the light. The HIS color space model is shown in Figure 9.

The YUV model is the color space used by European television systems (PAL format). Under normal circumstances, the camera takes the captured color image signal, after color separation, amplification, and correction, to obtain RGB signal, after being transformed by the matrix transformation circuit, obtain the luminance signal Y and the two color-difference signals R-Y and B-Y. Finally, the sender encodes the luminance and color-difference signals respectively, sent on the same channel.

Unlike the RGB space, the HSI and YUV color spaces represent the spectrum in two dimensions; the third dimension is used to represent the intensity of the color; for example, in HSI, H and S represent color information, I represents intensity. In YUV, U and V represent color, and Y represents intensity. Therefore, these two color spaces, compared to the RGB mode, are more suitable for occasions where the light intensity changes. In practical applications, RGB signals can be converted into HSI signals or YUV signals. In order to do this, coordinate transformation is needed to find an easy-to-analyze color space; it can exclude the influence of lighting and extract the nonluminance information of the color.

In addition to the need for purpose, the conversion of the color space model must follow certain principles.

First, for the reversibility of the conversion, there are color space models S and D. If there is a conversion $D = f(S)$, there must be $s = f^{-1}[D]$; the transformation f can be a transformation between the color space models S and D.

Second, for the lossless conversion, because RGB space is a set of integers obtained by a sample quantizer, any

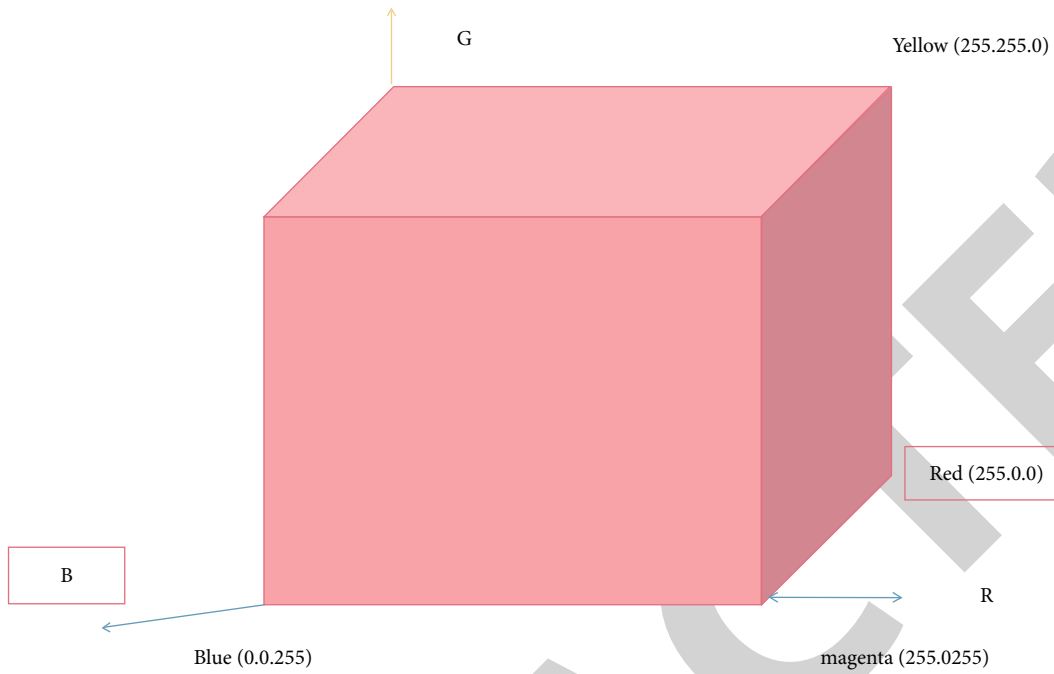

Figure 8: RGB color model.

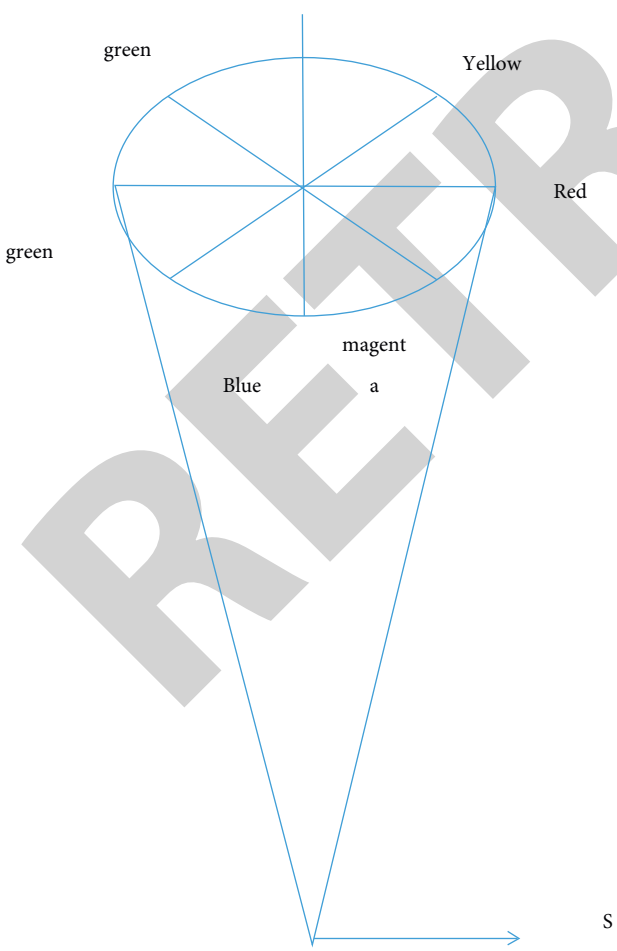

Figure 9: HIS color model.

conversion to and from RGB space, both must be invertible transformations from integers to integers.

RGB to HIS conversion:

$$\begin{cases} H = \operatorname{arctg}\left[\dfrac{\sqrt{3}\,(G-B)}{2R-G-B}\right], \\ S = I - 3\min(R,G,B)(R+G+B), \\ I = \dfrac{1}{3}(R+G+B). \end{cases} \tag{1}$$

RGB to YUV conversion:

RGB image obtained from the camera is converted to YUV values in the program. Here is a more recognized conversion formula:

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.586 & 0.113 \\ -0.168 & -0.332 & -0.5 \\ 0.5 & -0.418 & 0.082 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}. \tag{2}$$

4. Experiments and Discussion

The images collected by the DH-QP300 image acquisition card selected in the experiment are color images, usually developed by image processing programs, both requiring that the object to be processed is a grayscale image; color images should be converted to grayscale images before image preprocessing [22].

Color images are obtained by mixing red (R), green (G), and blue (B) as primary colors in different proportions.

Grayscale is the process of making the R, G, and B components of a color equal in value. The value range of R, G, and B is 0–255, so the grayscale image can only represent 256 colors.

There are three main methods of grayscale processing:

Maximum method: Make the value of the R, G, and B components equal to the largest of the 3 values; namely,

$$R = G = B = \max(R, G, B). \tag{3}$$

The maximum method results in a very bright grayscale image.

Average method: Make the value of R, G, B components equal to the average of the three; that is,

$$R = G = B = \frac{(R + G + B)}{3}. \tag{4}$$

The averaging method produces a softer grayscale image.

Weighted average method: Assign different values to R, G, B components according to importance or other indicators, and make a weighted average of the three values; namely,

$$R = G = B = \frac{(W_R R + W_G G + W_B B)}{3}. \tag{5}$$

Among them, W_R, W_G, and W_B are the weights of R, G, and B components, respectively. W_R, W_G, and W_B take different values; the weighted average method forms different grayscale images. Experiments and theoretical derivations prove that $W_R = 0.30$, $W_G = 0.59$, and$W_G = 0.11$; that is,

$$R = G = B = V_{\text{gray}} = 0.3R + 0.59G + 0.11B. \tag{6}$$

The most reasonable grayscale image can be obtained.

According to the target requirements of image processing, it is necessary to turn the image into an image with only two gray levels; that is, the image is binarized. Let the gray value range of the image $f(x, y)$ be in $[(a, b]$, and the binarization threshold is set to $T(a \leq Tsb)$; then, the general formula for binarization is

$$g(x.y) = \begin{cases} 1 = f(x, y) \geq T, \\ 0 = f(x, y) \leq T. \end{cases} \tag{7}$$

$g(x, y)$ is a binary image; usually, we use 1 to represent the object (black area) and use 0 to represent the background area (white area). There are many ways to choose the threshold T; it determines the quality of the binary image. According to the selection method of the threshold T, there are many methods for image binarization, such as mode method and threshold method. For example, the pattern method is that when the grayscale histogram has bimodality, the grayscale of the object and the background, generally, they are near the two peaks, so the center point of the valley can be taken as the threshold; this method is called the mode method. However, in reality, the grayscale histogram is not very smooth, and there will be local minima generated by some small bumps, which will cause great inconvenience to automatic judgment [23]. The simpler method is to first smooth the grayscale histogram and then select the value or take the selected grayscale as the center to examine the two points of k; use these two points to judge the point of the selected gray value, whether it is a maximum or minimum point. Such a processing method will generate some noise, but it will not have a great impact on judgment.

According to the pointer to the image, the image data are taken out for processing, and the process is shown in Figure 10.

The binarized image formed after the image is segmented, according to the author's needs, set the color value of the target area as 255, the color value of the background area is 0, and its center point is the center of mass of the target; the calculation method is

$$S(x, y) = \begin{cases} 1, \\ 0. \end{cases} \tag{8}$$

Then, determine the position of the centroid of the hand:

$$\begin{aligned} x &= \frac{\sum_{i=1}^{N} \sum_{j=1}^{M} S(i, j) \times i}{\sum_{i=1}^{N} \sum_{j=1}^{M} S(i, j)}, \\ y &= \frac{\sum_{i=1}^{N} \sum_{j=1}^{M} S(i, j) \times j}{\sum_{i=1}^{N} \sum_{j=1}^{M} S(i, j)}. \end{aligned} \tag{9}$$

Among them, i and j are the number of pixels in the row and the number of pixels in the column of the determined hand area, respectively.

As shown in the figure, d is the distance of the target image from the camera, h is the side height of the target under vision, H is the height of the target image, D is the distance from the actual scene plane to the center of the camera, f is the focal distance of the camera, so the distance d of the target image from the camera can be reflected by the following formula, the distance between the target and the camera: the focal distance = the height of the side of the target: the height of the target image, as shown in the following formula.

$$d : f = h : H. \tag{10}$$

According to the above formula, we can calculate $d = f * h/H$. In the formula, we can measure h, and we can also obtain H according to the information of the target image segmented by the collection, we also calculate the value f of the focal distance, the calculation method of the author's camera focal distance f; what is used is to set the angle of view of the camera to 16 to get the image as shown in Figure 11; according to the triangle shown in Figure 11, the focal distance is calculated to be 2579 using the formula $f = 384/\tan 8$. According to the actual fixed camera height, the image resolution is $768 * 576$.

Among them, the kinematic relationship of each virtual hand joint and other parts, it can be explained by mathematical formula, since the mathematical models of the

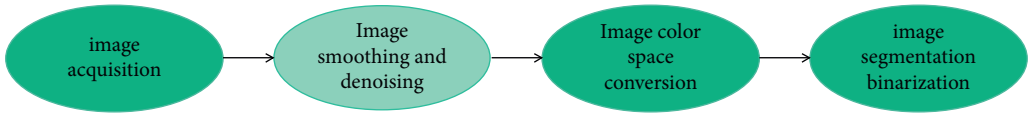

Figure 10: Schematic diagram of image processing.

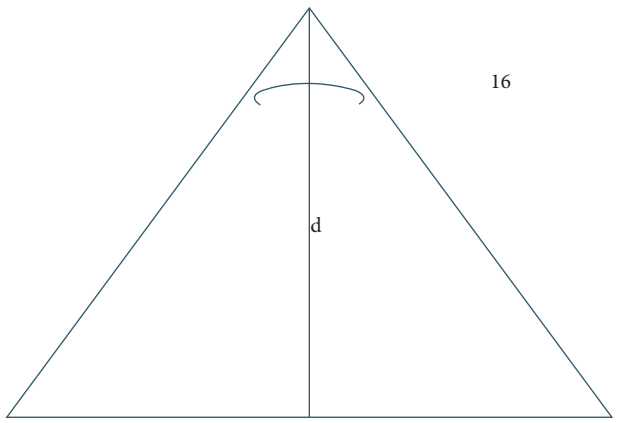

Figure 11: The focal length of the camera.

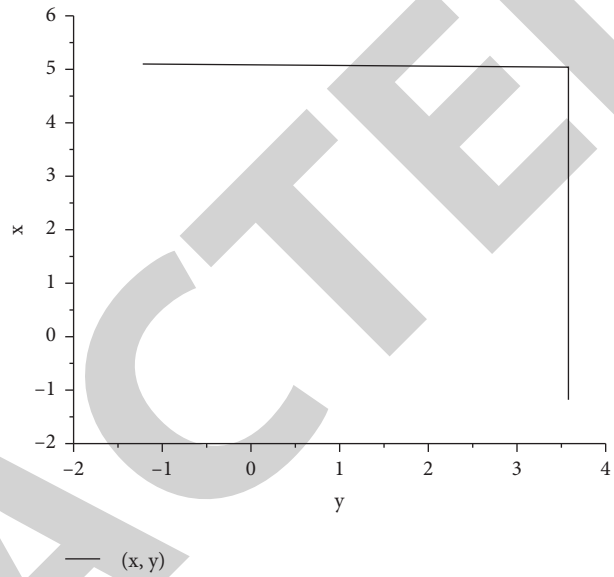

Figure 12: Schematic diagram of two-dimensional coordinate system.

movements of the thumb, index finger, middle finger, ring finger, and little finger are similar, the author only explains the wrist joint, and the base coordinates defined on the wrist joint are ($X0$, $Y0$, $Z0$); its $X0$-axis points along the forearm to the metacarpal bone corresponding to the index finger. The $Z0$-axis is parallel to the rotation axis of the wrist joint, and the $Y0$-axis is defined according to the right-hand rule. Define the wrist joint coordinate system WR on the carpal bone as (XWR, YR, ZWR), where m is the rotation angle of the wrist joint around the XWR axis, when $\varphi = 0^{\circ}$, the palm and the forearm are in a straight line, and the base coordinate system coincides with the wrist coordinate system. From this, the homogeneous transformation matrix from the wrist joint coordinate WR to the base coordinate can be derived:

$$m^{0}R = \begin{bmatrix} \cos(\varphi R) & -\min(\varphi) & 0 & 0 \\ \min(\varphi) & \cos(\varphi) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. \quad (11)$$

The pixel coordinates of the visual image and the distance information to the virtual hand, information mapping of states in the 3D world, is the coordinate point information and distance information of the image, converted to the virtual world coordinate system according to the coordinate transformation. According to the knowledge of the previous section, points (x, y) are all pixel coordinates, which are the coordinate points that reflect the two-dimensional array image collected into the memory, is a two-dimensional coordinate point, as shown in Figure 12 is the coordinate system of the image coordinate.

Introduce visual target tracking into virtual software platform, the specific work of its introduction is briefly introduced, and a theoretical analysis is made on the image location and the distance and depth reflection. And according to the six set gestures, the feature values are given, as a fixed gesture template; therefore, through the recognition of the set virtual gesture, the corresponding piano key pronunciation is realized, which achieves the purpose of the research work in this paper [24].

5. Conclusion

According to what the author wants to achieve is to use a monocular CCD camera to take pictures of the target, the collected image is sent to the computer for processing, and the feature information of the object is obtained by using the principle of camera imaging, providing information for the position and depth of virtual objects. Therefore, the author first realized the construction of image acquisition and processing hardware; on the basis of the development kit provided by the image acquisition card, the image acquisition is realized by using VC++ programming, and preprocessing and image segmentation of the collected images, the characteristic information of the image is obtained, and the color plane tracking is realized. Visual acquisition and image processing is introduced into the virtual reality development platform, and the integration with the original system data information is realized. The scene reflects the status information of the data glove. The virtual piano has 14 piano keys; for the implementation of piano performance, it is each piano key; once the piano key is greater than the set value, just call m_Wave.Load() to make a sound. According

to the CWave class in the object-oriented MFC class library under VC++, create an object m_Wave of class CWave; then according to the m_Wave.Load () function of the CWave class, the connection of the sound is realized. This work involves visual images and virtual reality technology and involves a lot of knowledge content. The research time and the level of knowledge acquired are limited, only for basic knowledge and visual applications under the virtual reality system, make tentative learning and exploration, so there are some deficiencies in the realization of the work of this paper. Because the camera used is often unstable, the captured image will be discolored and disturbed by noise; it has a bad influence on the image processing work. Because the image plane segmentation adopted by the author is relatively simple background, it needs to be improved for complex background. In addition, there are still inherent deficiencies in the image feature information of monocular vision; it is faced with the occlusion problem when the three-dimensional object rotates. Since the author is in the process of mapping the image feature information to the virtual scene, the target image distance reflection information under monocular vision is calculated according to the image pixels, so the depth reflection in the virtual scene can only take a similar value, and the accuracy is not high.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

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Research Article

Environmental Landscape Modeling Design Based on Smart City Public Facilities

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At present, the development of cities faces many problems of integration and coordination of practical operation and management. Smart cities will change the existing urban management model to a new management level and will bring about changes in many aspects. With the acceleration of urbanization, people will pay more attention to improving the living environment and living standards. Landscape is an important part of people's living environment. The research of landscape modeling design is of great significance to improve people's living environment. The purpose of this study is to study the modeling design of the environmental landscape of public facilities in smart cities. It improves the quality of residents' living environment and the sense of belonging to the city by optimizing the landscape shape. This study firstly describes the point, line, surface, body, and color elements that constitute the landscape modeling and lists the corresponding vivid cases for design reference. Then, this study uses the virtual reality method and BIM technology to conduct a detailed analysis and research on the construction of landscape image and the dynamic visual characteristics of human eyes. Then, this study conducts a field investigation and research with the preference of the community vegetation as the investigation target and collects the residents' satisfaction with the vegetation design. Experimental data show that more than 80% of residents prefer carefully designed and tailored plant combinations with regular arrangements. Then, based on these experimental results, this study proposes a targeted improvement plan for the landscape modeling design of the community. Through the research on the environmental landscape modeling design of public facilities based on virtual technology and BIM technology, it can enhance the interactivity of landscape experience, reduce design costs, and optimize landscape modeling design. It makes the landscape environment truly serve to improve the quality of life of residents.

1. Introduction

With the leap and development of new urbanization construction, the environmental landscape industry has also encountered new development opportunities. At the same time, people's living standards are constantly improving, and people's concepts are also changing with the development of the times. Therefore, people pay more attention to improving the living environment and living conditions. In the development and construction of the city, the landscape art of the public facility environment is an important part of building a smart city. As the vitality and arteries of urban development, public facilities are one of the places where people interact more frequently in their daily lives. Through the rendering of the landscape environment, the viewer can establish an emotional resonance with the landscape and even the city. It makes the viewers feel a strong sense of belonging and identity and feel the warmth from the city. But at present, the urban landscape design is still far from meeting people's needs for improving the urban environment. People urgently need a public facility landscape environment that can enhance viewing pleasure and living happiness from all senses. Therefore, it is an inevitable popular development trend to create excellent landscape modeling based on smart cities.

Virtual reality is not only a presentation medium but also a design tool, which produces a human-friendly multidimensional information space in a visual form, which provides favorable support for people to create and experience virtual worlds. Due to the real-time three-dimensional space

performance capability, human-computer interactive operating environment and the immersive feeling brought by virtual reality technology, it has played a pivotal role in the simulation and training in the aerospace field. The environmental landscape design exists to improve the living standard of the residents, and it provides the residents with a landscape of a comfortable living environment. An excellent urban environment landscape design can become a city's business card and logo. It can not only enhance the character and charm of the city but also promote the development of local tourism, thereby enhancing the city's influence and regional popularity. Through the design of the environmental landscape, a bridge of emotional communication between the city and the viewer can be constructed. While presenting strong local cultural characteristics, it can also arouse the audience's resonance and enhance the audience's pleasure and sense of belonging. The urban environmental landscape design is of great significance to the construction of a modern city, the inheritance of spiritual culture, the continuation of history, and the protection of the ecological environment. Therefore, the environmental landscape design of urban public facilities is crucial to the development of the city.

Once the real landscape is formed, the designer cannot easily change it, but the virtual landscape designer can change it at will. Therefore, before formulating a plan, designers can present the design plan through virtual reality technology and then improve the plan according to the information fed back by the virtual image. The innovations of this study are as follows: (1) this study uses virtual reality technology to optimize the landscape experience. It breaks the limitation of traditional landscape experience and makes landscape design more interesting. (2) This study uses BIM technology for cost analysis and dynamic visual analysis. Its multiangle research is to study the multiangle of its landscape modeling design. (3) This study takes the constituent elements of the landscape as the starting point of the research and designs the landscape modeling design scheme suitable for the target area through the analysis of the elements.

2. Related Work

Many scholars have paid attention to the research on the environmental landscape modeling design of urban public facilities. Shan discussed and researched how to construct a three-dimensional urban landscape. He introduced the role, significance, and development prospects of the three-dimensional urban landscape dynamic simulation technology, combined with the application possibility and development direction of GIS. He gave an application example of dynamic simulation of three-dimensional urban landscape [1]. Liu combined salt culture with landscape design for sports and leisure tourism. He analyzed the elements of salt culture in the modern sports and leisure tourism landscape and listed the application examples of salt culture in landscape design. He clarified how to spread salt culture through the sports and leisure tourism landscape [2]. Young and Vosloo identified the role of landscape design in communicating multiculturalism and significance in places of remembrance. Using the case study of memorial site Isivivane, he surveyed and measured visitors' experiences and perceptions of Isivivane. Based on the results of the quantitative questionnaire, he analyzed it with the theory of phenomenological explanation and landscape narrative [3]. Kurtaslan et al. investigated the water requirements of plants used in the Selcuk campus, irrigation methods of green spaces, mulching, and plant species used and made recommendations for ecologically sustainable landscapes [4]. Dnmez used correlation analysis to determine the relationship between landscape design work and brand image in the preferences of tourists in the accommodation industry. The results show that as the role of individual regional regulations in tourists' purchasing preferences increases, so do brand awareness, brand image, quality perception, and brand trust [5]. However, most of these studies lack sufficient data to support, and the individual differences in the investigation are large, which can easily lead to the bias of the research results.

Virtual reality and BIM technology can be used in the design of landscape modeling. Diao et al. analyzed the application of virtual reality and simulation technology in 3D urban landscape environment design. He also studied in detail the contribution of virtual reality technology to major landscape activities such as landscape experience, project site selection, and landscape composition [6]. Li and Hou use virtual reality technology to build a virtual roaming system of rural landscape. He aimed to provide a rural landscape experience with strong authenticity, good user experience, and vivid image [7]. Dong and Gao discussed the application of BIM technology in landscape design to help the future development of BIM technology application. He used BIM technology to analyze landscape site selection, landscape construction costs, landscape layout paths, etc. [8]. Borkowski and Wyszomirski introduced the application of BIM in landscape architecture construction engineering, pointed out the problems existing in landscape architecture engineering design, and optimized the design of landscape shape through landscape modeling technology [9]. These methods provide technical and data support for the optimization of landscape design, but their complexity is relatively high, and they are more troublesome to operate.

3. Ways to Improve Landscape Modeling

3.1. Elements of Landscape Modeling Design. Point, line, surface, body, and color are the design elements of landscape modeling. In these design elements, the point represents the collection of landscape in space and the line represents the aggregation of the movement of multiple points with the characteristics of length and orientation. A surface represents a two-dimensional surface formed by the aggregation of multiple lines with length, width, and orientation characteristics. A body represents a three-dimensional cube composed of multiple faces with length, width, depth, orientation, form, and spatial characteristics. The schematic diagram of the elements is shown in Figure 1.

3.1.1. O'clock. The point is the most concise and basic shape in the modeling design elements. Points have the characteristics of concentrating sight lines and representing the spatial location of the landscape [10]. In urban public facility environments, fragmented landscapes are often grouped together and presented as attractions. Its specific manifestations are vegetation and flowers, rockery lakes, amusement facilities, pavilions, and towers.

(1) Create a Landscape Mood. When designing landscape modeling, it is necessary to clarify the role of "points" in the design, and make full use of the highly aggregated characteristics of points [11]. The shape and orientation of the points appearing in the space are easy to attract people's attention and become the focus of attention. Therefore, the characteristics of "points" can be flexibly used in the design, so that they can play a better role in the overall landscape layout. The following three aspects can be mainly considered: (1) it emphasizes the use of "point" elements at the endpoints of the overall landscape, emphasizing the focus of the overall layout. It focuses the eye on the focal point of the landscape. (2) It uses the change of topography to configure the landscape elements of "points" on the highest or lowest terrain. (3) It arranges the landscape elements in the center of the site, making it the center of sight.

(2) Highlight Rhythm and Rhythm. The way the points are scattered and gathered can form a line or plane, and when two points are in different positions, it will give people a different psychological feeling [12]. As a visual appreciation, it also has a clear sense of rhythm, which effectively increases the interest of viewing, as shown in Figure 2. A variety of different layouts and combinations have formed a regular and orderly form, showing a different charm and specific artistic conception.

3.1.2. Line. In general, lines can be divided into straight lines and curves. Straight lines have obvious directionality and are the most basic techniques in landscape modeling design, which are suitable for use in various scenes. The curve has a strong sense of flow, and it can be used as a supplement to the design of scenic spots to produce very good visual effects, as shown in Figure 3.

(1) Straight Line Framing. Straight line is the most commonly used expression method in landscape modeling design. Straight lines give people a sense of stability and solemnity, which are usually applied to the pavement of pavement, the construction of water features, the outline of monuments, and the design of guardrails. Using straight lines to frame the landscape creates a clear sense of boundaries, allowing each landscape to be isolated. It makes the picture appear orderly, neat, and harmonious.

(2) Curve Composition. Curves are usually used in landscape design in supplementary form. The basic look and feel of curves are soft, flexible, and vivid. It is not as rigid as a straight line, and it can often show a lively, flowing, and vital atmosphere [13]. Therefore, it often appears in the design of classical gardens. Curves can imitate the rolling feeling of mountains and rivers. It is often used in the modeling design of arch bridges, rockeries, and flower beds. Moreover, the curve can soften the texture of the picture, making the picture more relaxed, free, and impactful.

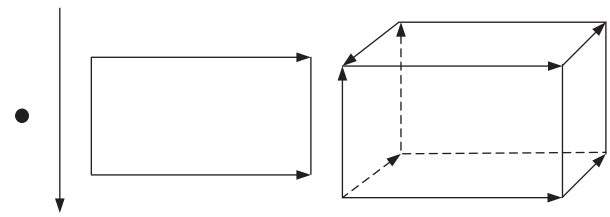

Figure 1: Design elements: points, lines, surfaces, and volumes.

3.1.3. Surface and Body. Surfaces and volumes are forms composed of points and lines. In the design of landscape modeling, the trimming of plants, the layout of flowers, the appearance design of fountains, sculptures, buildings, etc., all have face and body techniques. Symmetrical and irregular composition techniques can also be used in the design, which can make the overall picture appear neat and bold, giving people a harmonious and orderly viewing effect.

3.1.4. Color. Color can bring fresh life to a landscape. It is the most infectious design factor [14]. Landscapes with different tones can arouse different emotions in viewers, and bright colors can make people feel happy and refreshed. Dark tones can make people feel depressed and solemn. The use and collocation of colors should be in line with the theme of the design venue, and the leisure and entertainment venues can enrich the collocation of colors. It allows the viewer to relax. For some solemn occasions such as memorial sites, the performance of colors should be weakened and a quiet and solemn atmosphere should be created. At the same time, the use of color can also be designed according to the preferences of the target group. The children's playground can be decorated with warm and bright colors. The elderly activity center can use more calm, low-saturation colors to meet the psychological needs of the elderly.

3.2. Landscape Modeling Design Method Based on Virtual Reality Technology. In contemporary society, various fields have a certain degree of dabbling in virtual reality technology, such as virtual scene construction in the film and television industry, virtual scene experience in the game animation industry, and mechanical virtual manufacturing in the industrial field. Thanks to the development of digitization and computers, human beings have made the most of aesthetic art using modern science and technology [15]. Vision is the most intuitive way for the brain to receive external information. It applies virtual reality technology to urban landscape design. It can transform the audience from passive recipients to interactive participants, making the landscape just like a dazzling array of commodities for the audience to choose from.

Figure 2: The vergence of points.

Figure 3: Landscape design of straight lines and curves.

The development of science and technology has promoted the development of society and economy. As the basic driving force of development, science and technology have promoted the progress of productivity, and people's living standards have gradually improved. Subsequently, it will pay more attention to the promotion of social culture and economic prosperity, and people's way of life has also been changed [16, 17]. As science and technology become more and more common in people's production and life, people's thinking and concepts have gradually changed. People begin to pursue new things and pursue spiritual satisfaction. Improving the quality of life has become the focus of attention. Therefore, under the promotion of many parties, the design and creation of urban environmental landscape can be generated and developed. Figure 4 shows a deduction diagram of technological development and landscape creation.

3.2.1. Spatial Thinking of Environmental Landscape Design. Landscape design often starts with space creation [18]. Taking matter, time, and space as the three basic elements of space experience, the understanding of the space world can be reconstructed by applying the changes of matter, time, and space caused by virtual reality technology. In previous cognition, time was defined as linear and irreversible, and space was defined as forbidden and enclosed. Matter is defined as tangible and perceptible. But with the development of virtual reality technology, the real space where people live and the nonreal virtual space are often intertwined and infiltrated. This has greatly broadened people's cognitive scope, the traditional cognitive dimension has also undergone subversive changes, and the cognitive space has expanded into 8 quadrants, as shown in Figure 5. The super time, super space, and nonmaterial are a kind of transcendence based on the original cognition. Just like being in a virtual scene, it will give people a feeling that the space is wider, the time passes faster, and the objects in the field of vision are richer. But in fact, it only occupies a small space in the real scene. This is just a cognitive illusion caused by psychological effects. Based on this concept of space, the virtual space that transmits huge information and energy is integrated into the space constructed by reality, and space is no longer a pure reality enclosed by matter [19]. The designer dynamically displays the spatial structure by embedding the space with virtual functions into the actual landscape space and flexibly changes the spatial order, thereby extending new spatial forms and functions.

Table 1 lists the new classification of space under the virtual reality field of view. The material composed of objective objects is the real space, and the real space is the space for people to live in real life. The virtual space is often not limited by the objective world, and it is the space that people often touch through imagination [20]. Augmented reality space mainly enhances the reality experience by enhancing people's senses. Augmented virtual spaces are the opposite, enhancing virtual experiences through the properties of physical entities and the virtual elements contained within them. The purpose of physical virtual space is to bring people's spirit and senses into

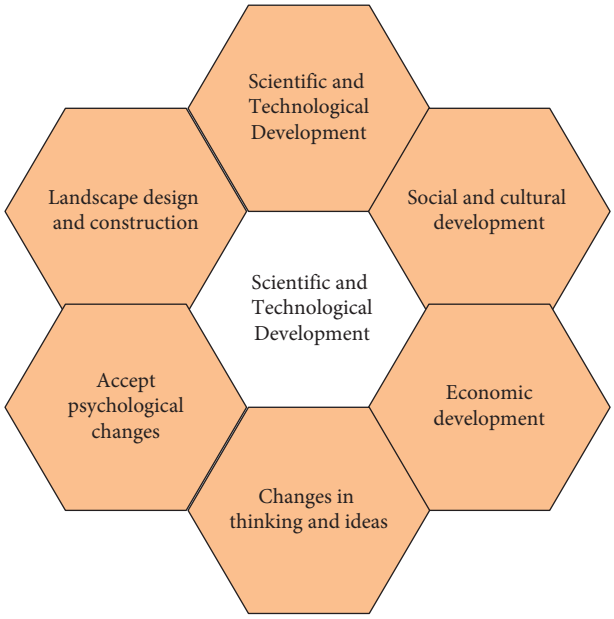

Figure 4: Deduction relationship between technological development and landscape creation.

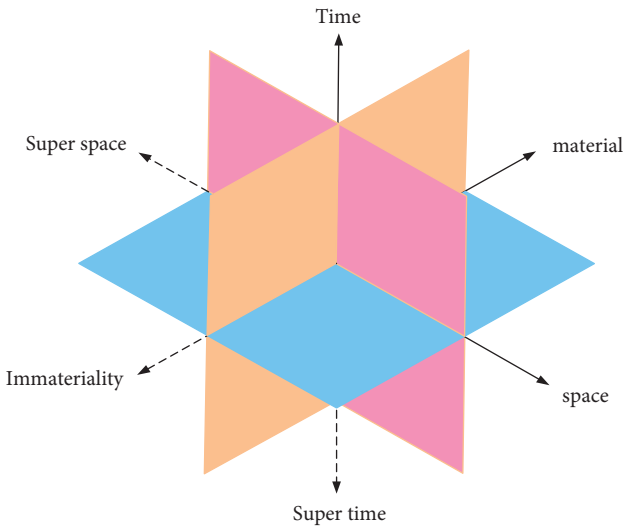

Figure 5: Multiple spaces of virtual reality.

Table 1: New forms of space extended by virtual reality.

Serial number	Time variable	Spatial variable	Material variable	Spatial classification	Spatial property
Group 1	Time Super time	Space Super space	Material Immateriality	Real space Virtual space	Realism Virtuality
Group 2	Time Super time	Space Super space	Material Immateriality	Augmented reality space Enhance virtual space	
Group 3	Time Super time	Space Super space	Material Immateriality	Physical virtual space Alternative real space	Coexistence of virtuality and reality
Group 4	Time Super time	Space Super space	Material Immateriality	Mirror virtual space Distort real space	

virtual scenes through virtual objects. It constantly proves its existence in reality and improves the real experience. Alternative reality space is based on the real space, incorporating virtual elements to enhance the virtual experience. Mirrored virtual space is to simulate the real world in real time and enhance the virtual experience, while distorted reality space is based on physical space and real objects, combined with virtual scenes to enhance reality.

3.2.2. The Modes of Virtual and Reality Complement Each Other. With the advancement and development of science and technology, more and more new garden construction technologies and new materials have been applied to garden landscape design, which can not only improve the effect of garden landscape design but also effectively promote the development of my country's garden landscape industry. The landscape modeling design under the concept of virtual reality includes not only the objective style of the physical world but also the virtual style based on the network, and the mixed style of the coexistence of virtual and reality [21]. On the sensory level, it is the actual object that people can hear, see, smell, touch, and perceive. From a spiritual point of view, it also includes the artistic conception formed by the integration of landscape and people's thinking and feelings. With the development of intelligent technology and digital film and television, the traditional stereotyped landscape modeling can no longer meet people's viewing needs. Landscape modeling design is changing in the direction of innovation and diversification. The landscape modeling design modes integrated with virtual reality are as follows:

(1) *Embedded Mode.* It applies high-tech interactive equipment to landscape design and uses digital holographic images, sensors, simulation, and other technologies to embed the landscape morphological structure. It strengthens people's senses and experiences in multiple directions and modes. The "embedded mode" retains the realistic spatial characteristics of the landscape and does not change the entire morphological attributes of the original landscape, but enriches the presentation of the original landscape modeling. It adds interest and enriches the connotation of landscape modeling.

(2) *Expansion Mode.* If the site is limited, the original landscape cannot adopt the embedded mode, and the traditional landscape presentation method can be expanded. It allows new styles such as traditional landscape styles and virtual landscapes to coexist in parallel. The expansion mode greatly improves the linear and spatial constraints of traditional landscape styles. It expands the landscape to any place and is a powerful complement and improvement to the traditional landscape style.

(3) *Progressive Mode.* This mode combines the features of embedded mode and extended mode. It combines traditional landscape styles with new styles guided by new technologies. In the process of people's landscape experience, the two styles are progressive and transformed into each other. The boundary between the traditional landscape style and the new landscape style is completely blurred, which forms a new landscape style, that is, the virtual reality landscape form, as shown in Figure 6.

3.3. Dynamic Visual Characteristics Based on BIM Technology. Vision is the key to landscape modeling design. As the most direct tool for humans to perceive the external world, eyes can not only identify external things but also judge features such as color, shape, and location [22]. Vision has the difference between active and passive. Active vision means that people choose what they want to see, while passive vision means that people cannot decide what to see. In landscape design, the initiative of vision is mainly to reduce the visual fatigue of viewers and improve the pleasure of viewing. The human eye is constantly moving, and people can form a dynamic visual picture in their minds when viewing the landscape. Therefore, in the design of environmental landscape modeling of urban public facilities, the dynamic nature of vision is taken into consideration. It can effectively enhance the viewing ability and make the viewer impress the landscape environment.

3.3.1. Plane View. Motion trajectory is the path of the object motion. It also refers to the spatial characteristics of the action consisting of the route that a certain part of the body travels from the starting position to the end. Supposing Q is a point of the movement trajectory of the near sight line, the coordinates are (E_Q, F_Q), and U is the viewer's gaze point (E_U, F_U). QU is the collimation axis, L is a point of the motion trajectory of the distant sight, and the dynamic field of view characteristic takes the length of QL to obtain the following equation:

$$\begin{cases} E_U = E_Q - QU\ \cos\alpha, \\ F_U = F_U + QU\ \sin\alpha, \end{cases}$$

$$\begin{cases} E_L = E_U + UL\ \sin\beta, \\ F_L = F_U + UL\ \cos\beta, \end{cases} \tag{1}$$

namely,

$$\begin{aligned} E_U^2 + F_U^2 &= \left(E_Q - QU\ \cos\alpha\right)^2 + \left(F_U + QU\ \sin\alpha\right)^2 \\ &= K^2 + QU^2, \\ E_L^2 + F_L^2 &= \left(E_U + UL\sin\beta\right)^2 + \left(F_U + UL\ \cos\beta\right) \\ &= K^2 + UL^2 + 2UL. \end{aligned} \tag{2}$$

When the lengths of QL and UL are fixed, L is an arc.

3.3.2. Longitudinal View. When a viewer is climbing a sloped curved plane such as a hillside or an arch bridge, there is a certain height difference between the viewer's viewpoint and the gaze point. When climbing up, the viewing angle is looking up, and when going down, the viewing angle is looking down. If the viewing angle is different, the impression of the scenery will be very different. When the viewing angle is looking up, the field of view is wider, the landscape should be relatively high, and the viewer may not notice the relatively short landscape plants. The field of view is framed by the sky. However, if the elevation angle is too large, there will be a greater sense of pressure. When the viewing angle is looking down, the landscape is based on the ground, with the ground as the background, and the viewer can see all the landscape, but if the depression angle is too

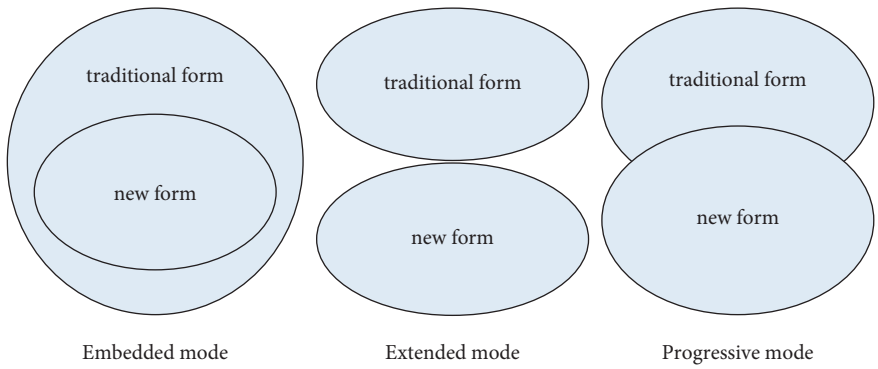

Figure 6: Presentation mode of landscape modeling.

large, it will be scary. Therefore, it is very necessary to reasonably select the height of the slope surface landscape.

Lambda expression is a new feature provided in JAVA8, and it supports JAVA and can also perform simple "functional programming." It is an anonymous function. Supposing K is a point of the line-of-sight movement trajectory, the coordinates are (E_K, F_K), and G is the viewer's gaze point (E_G, F_G). Dynamic field of view mainly refers to the range of moving objects that can be seen. Dynamic visual field measurement is a method of detecting the junction point between the invisible area and the visible area by moving a stimulus intensity optotype from the periphery of a visual field to the visible area. KG is the collimation axis, P is a point of the motion trajectory of the near sight line, V is a point of the motion trajectory of the distant sight line, the dynamic visual field characteristic is taken as the length of KP and KV, and we get

$$\begin{cases} E_G = E_K + KG\cos\lambda, \\ F_G = F_K + KG\sin\lambda, \end{cases}$$

$$\begin{cases} E_P = E_K + KP\cos\theta, \\ F_P = F_K - KP\sin\theta, \end{cases} \tag{3}$$

Getting the general equation for a vertical curve is as follows:

$$f(x) = \frac{1}{2v}x^2 + sx. \tag{4}$$

Slope of any point on a vertical curve is as follows:

$$s_n = \frac{x}{v} + s. \tag{5}$$

The radius of any point O on a vertical curve is as follows:

$$r = v\left(h + s^2\right)^{3/2}. \tag{6}$$

where s is a constant between s_1, s_2, and s_1; s_2 is a small value, so s^2 can be omitted; $s \approx v$, $v = H/J$, and H is the length of the vertical curve; J is the gradient difference, $J = s_1 - s_2$.

The slope of KG is as follows:

$$v_{KG} = \frac{E_K}{v} + s, \ \tan\lambda = v_{AB}. \tag{7}$$

Traditional graphic design can no longer meet people's visual needs. Graphic design based on visual thinking improves the way of information presentation, improves the visual effect and sensibility of works, and makes it easier to grasp people's psychology. When the viewer goes from the straight slope section to the vertical curve section, the tangent angle gradually changes from s_1 to 0, and after passing the highest point of the slope, it gradually increases from 0 to s_1. The value of v_{KG} is between s_1 and s_2, and if the angle between the near viewpoint and the slope is θ, the trajectories of G and P can be expressed as follows:

$$\begin{aligned} E_G^2 + F_G^2 &= \left(E_K + KG\cos\lambda\right)^2 + \left(F_K + KG\sin\lambda\right)^2 \\ &= E_K^2 + F_K^2 + KG^2 + 2KG\left(\frac{\cos\lambda}{2} + \frac{\sin\lambda}{2}\right), \\ E_G^2 + F_G^2 &\approx r_k + KG^2 + 2KG, \\ E_P^2 + F_P^2 &= \left(E_K + KP\cos\theta\right)^2 + \left(F_K - KP\sin\theta\right)^2 \\ &= E_K^2 + F_K^2 + KP^2 + 2KP\left(\frac{\cos\theta}{2} - \frac{\sin\theta}{2}\right), \\ E_P^2 + F_P^2 &= \frac{r_k + KP^2 + 4KP}{\sqrt{2}\cos\left(\theta/2 + 45^\circ\right)}. \end{aligned} \tag{8}$$

This results in a GP approximation circle.

3.3.3. Concave Surface Field of View. When walking on a road with low-lying terrain, assuming that M is a point on the trajectory of the sight line, the coordinates are (E_M, F_M), N is the viewer's gaze point (E_N, F_N), and MN is the collimation axis. D is a point of the motion trajectory of the near sight line, W is a point of the motion trajectory of the distant sight line, the dynamic field of view characteristics are the lengths of MD and MW, and we get

$$\begin{cases} E_N = E_M + MN\ \cos\mu, \\ F_N = F_M - MN\ \sin\mu, \end{cases}$$

$$\begin{cases} E_D = E_M + MD\ \cos\ \omega, \\ F_D = F_M + MN\ \sin\omega, \end{cases}$$

$$E_N^2 + F_N^2 = (E_M + MN\ \cos\mu)^2 + (F_M + MN\ \sin\mu)^2 = E_M^2 + F_M^2 + MN^2 + 2MN\left(\frac{\cos\mu}{2} + \frac{\sin\mu}{2}\right), \tag{9}$$

$$E_N^2 + F_N^2 \approx r_M + MN^2 + 2MN,$$

$$E_D^2 + F_D^2 = (E_M + MD\ \cos\ \omega)^2 + (F_M + MD\ \sin\ \omega)^2 = E_M^2 + F_M^2 + MD^2 + 2MD\left(\frac{\cos\omega}{2} + \frac{\sin\omega}{2}\right),$$

$$E_D^2 + F_D^2 = \frac{r_M + MD^2 + 4MD}{\sqrt{2}\cos(\omega/2 + 45^\circ)},$$

where ND is similar to a circle, because MD and MW have the same length, so the viewer's line of sight on the convex and concave surfaces is the same.

In summary, it can apply the line-of-sight analysis to the design of landscape modeling to determine the height of the landscape and the location of the display. Its reasonable planning and layout landscape can create a comfortable urban living environment.

4. Experiments and Improving Landscape Modeling

4.1. Elemental of Landscape Modeling Design

4.1.1. Line-of-Sight Analysis. The elements of a place can be divided into four types: space, ecology, function, and culture [23]. The landscape modeling analysis of the design elements in the place is first to describe the place with images and qualitative methods. It is then quantified, quantified, analyzed, and refined. It uses the most intuitive diagrams and text. It enables designers to easily grasp site information and better arrange site landscape.

All landscapes are reflected through landscape elements, and the landscape design materials and contents include topography, vegetation, water bodies, and paving and landscape sketches. Among them, topography is the design basis, and the rest are design elements. Line-of-sight analysis is an indispensable consideration in landscape modeling design. The analysis of the line of sight can get the visibility of the landscape, which is convenient for the designer to make a better overall planning and design. Affected by the terrain, sometimes, the landscape cannot be presented well, so it is necessary to analyze and design the location of the landscape. Location is positioning, and it can not only express the direction and position of the landscape but also reflect the internal connection between different landscapes in the site. Topography is the basic element that constitutes a site. Most of the landscape designs are based on natural resources. Analyzing topography is helpful to grasp the overall spatial characteristics of the target planning site, as shown in Figure 7.

As shown in Figure 7, through the line-of-sight analysis, people can get the best sight and sight distance of the site, help plan or adjust the functional partition, and guide the planning of the tour route or tour guide line.

4.1.2. Cost Analysis. Comprehensive cost analysis is the basic method of cost distance calculation. After each factor is dimensionless, it needs to be integrated into a unified evaluation system, and superimposed and evaluated. The richer the hierarchy of costs, the more paths there are to choose from.

This study uses 32 grades as the maximum grade to evaluate the comprehensive cost, compared with 9 grades and 12 grades. Compared with the longitudinal slope of the highway, the road selection in the urban public facility landscape environment can be slightly relaxed, but even this is not suitable for landscape construction on a slope of more than 30 degrees. Therefore, in this study, a 32-level unequal interval value is added for comparison. The importance of the unequal cut-off value is to classify the slopes suitable for construction in detail, thus enriching the classification comparison.

As can be seen from Figure 8, different colors represent different classifications, that is, different cost classification levels. The path selection direction of the 9-level equivalence discontinuity is similar to that of the 18-level equivalence discontinuity, and the results of the 32-level equivalence discontinuity and the 32-level unequal discontinuity are roughly the same. Among them, the first half of the 9-based path moves along the valley with a small inclination angle, and the second half of the path basically rises in a straight line to the end. The path of the 18-level dividing line advances along a stable ridge, and the overall slope presents a tortuous upward trend. The first half of the 32-level equally divided discontinuous value selection path is a long, very gentle slope, and the middle part and the second half rise with a relatively slow slope. The upper half of the 32-level unequal discontinuous value selection path is also a long and gentle slope, and the middle and second half of the path rise straight up at a smaller angle.

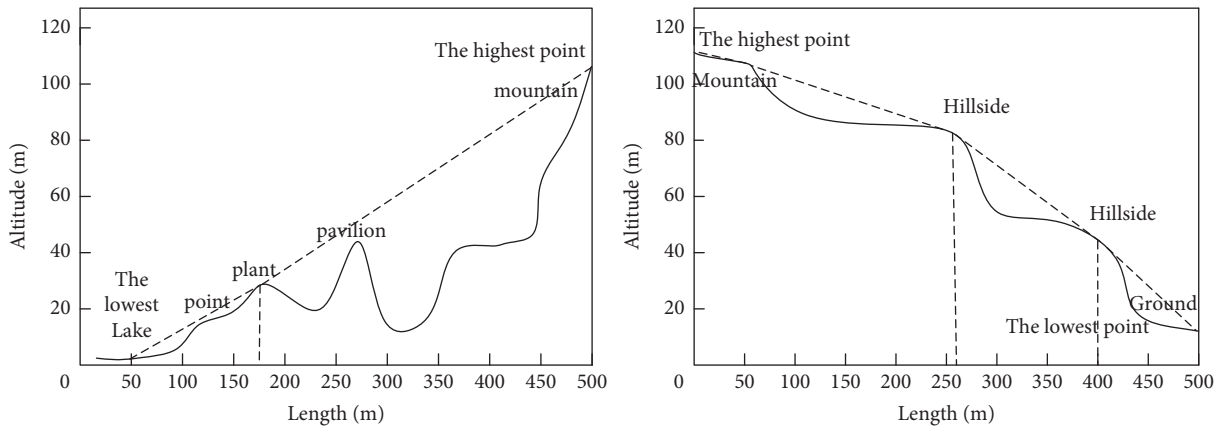

Figure 7: Schematic diagram of the sight range of landscape space.

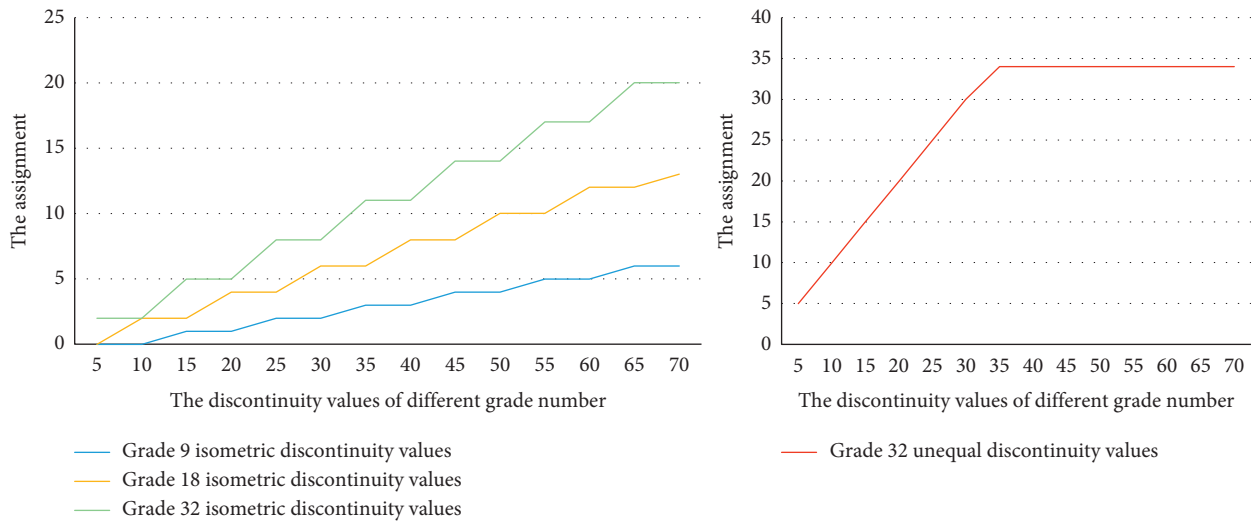

Figure 8: Corresponding relationship between different levels of equally divided discontinuous values and assignments.

The value attribute of the cost is reflected in the assignment, usually the area with a smaller slope has a lower cost. Sometimes, there is a problem when designing, that is, the cost assignment of two similar slopes differs by only 1 degree. However, during the calculation, the route selection only passes through one area and bypasses the other area, which causes the area with lower slope to be more expensive. Therefore, it is necessary to widen the gap of "cost" between each level. It uses the exponentiation method, increasing the level assignment. It is agreed that the area tends to be less sloped when calculating the line selection, as shown in Figure 9.

The path selected without power assignment is an area with sparse contour lines in the first half, and basically an area with a large inclination angle with dense contour lines in the second half. The selection path of the 1/2e power assignment is a slope with a gentle angle. The power-of-2 assignment chooses a tortuous, circuitous path. The rationale for the choice is that the slopes with higher inclinations result in a more winding and circuitous path than the landscaping cost of a straight path. This result is more suitable for the modeling design of the environmental landscape of urban public facilities.

It can be concluded that the cost map of adding power assignment more comprehensively and intuitively reflects the cost status of the landscape path design of the target site. Adjusting route selection through cost management helps avoid ecologically sensitive areas. It makes landscape design more scientific and rational. The path selected by the power-of-2 assignment effectively avoids areas with large inclination angles and dense contour lines. It optimizes the path better, and it is more in line with creating a high-quality urban landscape.

4.2. Landscape Modeling Design Based on Virtual Reality

4.2.1. Constructing New Logic. Logic is the abstract thinking that people generate when they recognize things, and it is a mode of analysis of things. Constructing a new logic of landscape modeling does not mean that landscape modeling must conform to traditional logic but starts with logical thinking. It explores new thinking modes and design schemes, and it obtains more novel and optimized landscape modeling.

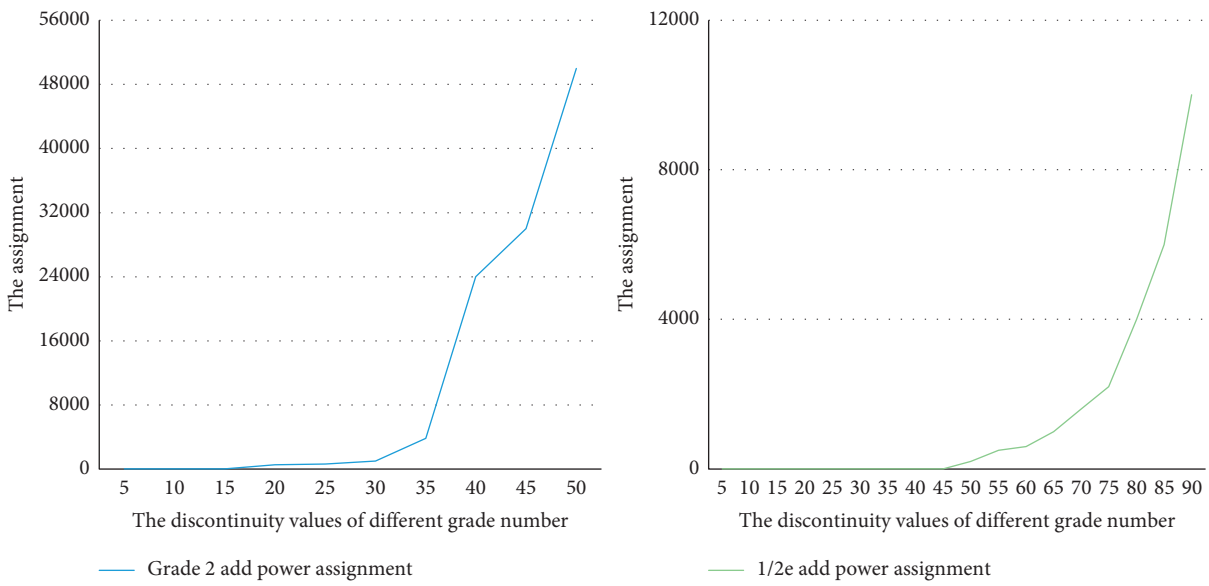

Figure 9: Correspondence between different levels of equally divided discontinuous values and assignments under the guidance of the exponentiation method.

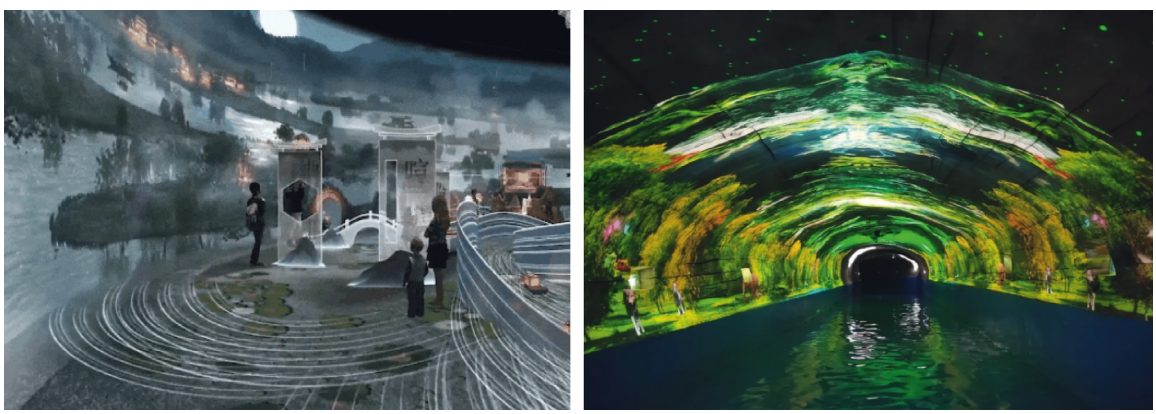

Figure 10: Immersive landscape experience.

The result of landscape modeling design is not only simple appearance modeling but also should be combined with the realization of functions, and the design should be carried out in multiple directions and angles. Landscape modeling should be based on dynamic thinking, which can dynamically deduce landscape elements by establishing mathematical models. It processes the design, and it continuously optimizes to get the best design solution.

4.2.2. Mobilize the Five Senses. The traditional landscape perception is largely accomplished by vision, and the viewer can understand the whole picture of the landscape only by looking at it with the eyes. This is prone to lack of interactivity and experience, and viewers cannot establish a unique emotional connection with the landscape. Virtual reality technology can break this limitation. With the help of some instruments, viewers can experience any landscape they want to experience anywhere. These landscapes can be based on reality-enhancing experiences, or they can be completely imagined. Designers can place some special equipment or QR codes in certain locations to experience different landscape presentation methods through virtual reality technology. It can also set up an experience area, which uses holographic projection to project the virtual landscape with lights, and the viewer can shuttle on the light and shadow trail by himself. At the same time, it can also interact with the landscape, making the landscape lively. Furthermore, it can set up virtual levels, and viewers are integrated into the virtual landscape environment through task challenges. It can receive gift rewards for completing tasks, which not only enriches the interactive mode but also adds interest. As shown in Figure 10, in this mode of landscape modeling design, virtual technology creates a vivid and immersive interactive landscape experience for viewers.

4.2.3. Create a New Image. Imagery is an experience based on landscape modeling. The generation of intention is similar to the lyrical technique of borrowing objects, which is

often used in art appreciation. The landscape modeling design under the guidance of virtual reality technology includes nonreal virtual elements. When designing landscape modeling, designers often integrate their own thinking into the design and express their emotions through works. Therefore, creating a new image of landscape modeling based on the viewpoint of virtual reality means that designers use virtual reality technology to place their thoughts and emotions on real materials and express them in the form of landscapes. It establishes a mutual connection through the sensory interaction with the viewer, thereby arousing the viewer's resonance and thinking process. Figure 11 shows the new image construction process of landscape modeling.

As listed in Table 2, the urban landscape is composed of multiple image elements, and the interaction between the traditional landscape and the viewer is limited. The intention is usually relatively single and fixed, which is easy to make the viewer feel boring. Under the interactive experience of virtual reality, people in different moods act their emotions on interactive devices. The equipment then feeds back the information to the set landscape modeling program, so that the landscape modeling changes with the viewer's mood changes. In this mode, the landscape can resonate with the viewer to the greatest extent possible, immersing the viewer in a unique landscape experience.

4.3. Investigation and Preferences of Landscape Modeling

4.3.1. Field Investigation. Taking the plant landscape as an example, this study conducts a questionnaire survey on the preference of plant landscape modeling among the residents of Meijingdongfang Community, Chaoyang District, Beijing. A total of 300 valid questionnaires were obtained in this study, and among these respondents, residents under the age of 25 accounted for 5%. About 32% of residents are 25–50 years old, 46% are 50–65 years old, and 17% are 65+ years old. The occupations of the respondents include civil servants, employees of public institutions, employees of enterprises, students, retirees, teachers, self-employed persons, and freelancers. For the convenience of statistics, the occupations of the respondents are collectively referred to as the following major types: government employees, public institution employees, enterprise employees, self-employed households, freelancers, students, and retirees. Among them, 5% are government employees, 10% are public institutions, 24% are enterprise employees, 7% are self-employed, 16% are freelancers, 9% are students, and 29% are retirees. Among the respondents, 54% were male and 46% were female, and the age structure was relatively average. The composition of the respondents is listed in Table 3.

The survey results of landscape modeling preference show that residents have a higher overall preference for community landscape. In terms of vegetation, residents prefer arbor plants, and the flora should have clear boundaries, preferably pruning. In terms of community landmarks, residents prefer human statues or well-designed and pruned-shaped plants and have a low preference for signs of iron plates or iron gates. In a specific plant landscape, a single plant community is more favored by residents than a variety of mixed plant communities, and the regular arrangement of plant planting rules is better than the disorderly arrangement rules. At the same time, the preference for all planted broad-leaved forest landscapes was higher than that of coniferous and broad-leaved forests or other mixed planting landscapes. In terms of the combination of vegetation, residents prefer the combination of trees and lawns, and they have a lower preference for a single slope with more vegetation. The specific survey results are shown in Figure 12.

4.3.2. Improvement Strategy

(1) Forming Regional Landscape Features. Due to the different natural conditions in different regions, the distribution of plants is correspondingly regional. Different regions have different landscapes, such as large tropical rainforests, temperate broad-leaved forests, and boreal coniferous forests. Different landscapes have their own unique scenes. Beijing is located in a temperate monsoon climate, the vegetation type is mostly warm temperate deciduous broad-leaved, and the winter is dry. There is plenty of sunshine in summer, which is suitable for planting weeping willows, cherry blossoms, other plants, and roses, wisterias, and other flowers.

(a) *Vegetation Size*. Like many other types of space design, the size of plants is actually relative. Even medium-sized trees will appear tall compared to cover plants and dwarf shrubs, regardless of the type of plant that people see and feel. In terms of plant selection, different combinations of plants can be used to form different spatial perspectives to decorate the space. The canopy and trunk of large trees can limit the scope of the space. Planting large trees at the entrance and exit of the area can not only highlight the position of the gate but also create a solemn visual sense. The combination of small trees and large trees can complete the enclosure or interconnect the space to complete the space, which can be widely decorated in all aspects of the space. Different low plants have their own unique colors and textures, which often constitute different ground landscapes. It has very good effects for viewing and resting. Figure 13 shows the framing effects of different vegetation sizes.

(b) *Vegetation Style*. When the style of plants forms a landscape space, although the size of the plant cannot act as a space skeleton, it can form different space types and enclosure qualities. Umbrella plants have wide branches and leaves to emphasize the top plane of the space, which can be planted on both sides of the road to shade the sun or in recreational areas to rest under the trees. The spherical plants are soft in shape and moderate in size, which can enhance the softness and fullness of the space. It is used to highlight key landscapes and create characteristic landscape shapes with good

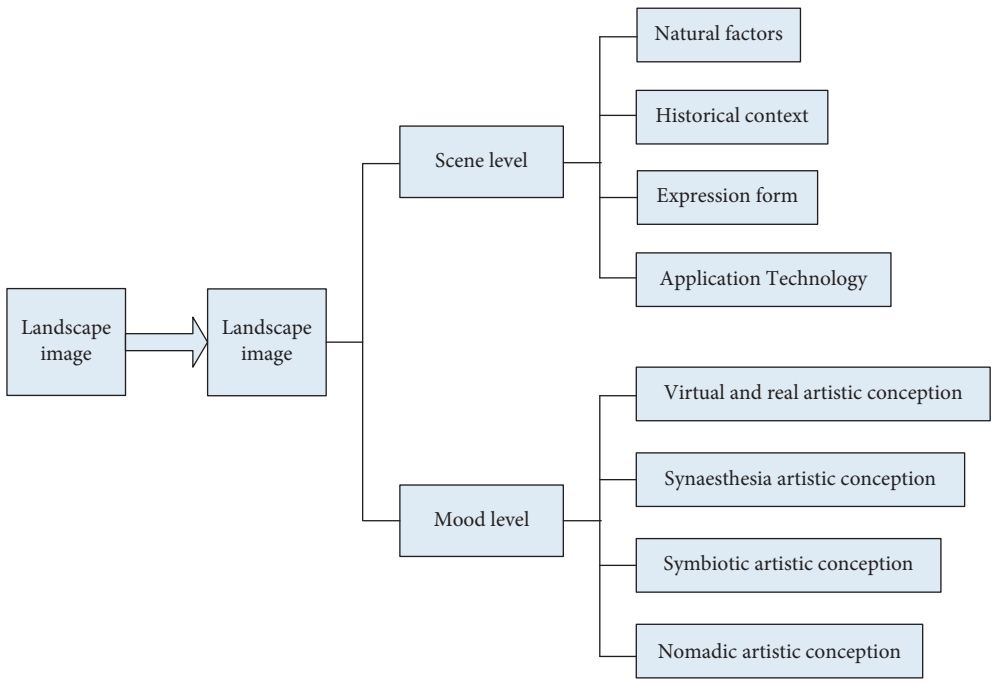

Figure 11: The new image construction process of landscape modeling.

Table 2: Composition of urban landscape image elements.

Urban landscape image			
Natural elements		Humanistic elements	
Intangible element	Tangible element	Physical and chemical elements	Nonmaterialized elements
Air temperature, wind direction, precipitation, humidity; sunshine, etc.	Geographical location, terrain, landform, lake, vegetation, etc.	Urban structure, street, buildings, public utilities, historic sites, etc.	Public awareness, mental structure, custom, language, rules and regulations, etc.

Table 3: Composition of respondents to the questionnaire.

Gender						
Male			Female			
54%			46%			
Age						
Below 25	25–50		50–65		More than 65	
5%	32%		46%		17%	
Profession						
Government workers	Employees of public institutions	Enterprise staff	Individual proprietor	Freelance	Student	Retiree
5%	10%	24%	7%	16%	9%	29%

results. Conical and tower-shaped plants are mostly used to coordinate the space structure and can be used for road guidance and space decoration. The dangling plants play an important role in guiding the space and connecting the ground landscape. The use of pendant plants can better create an atmosphere and artistic conception, which makes the overall picture vivid as if it has a sense of story. Figure 14 shows the framing effects of different vegetation styles.

(c) *Vegetation Color*. The color of plants will not directly affect the structure and type of the space, but it will affect the atmosphere and emotional resonance of the space, thereby optimizing the enclosure quality of the space. Plants of different colors are matched together to form a strong contrast or a soft sense of coordination, which greatly enriches the layered texture and visual

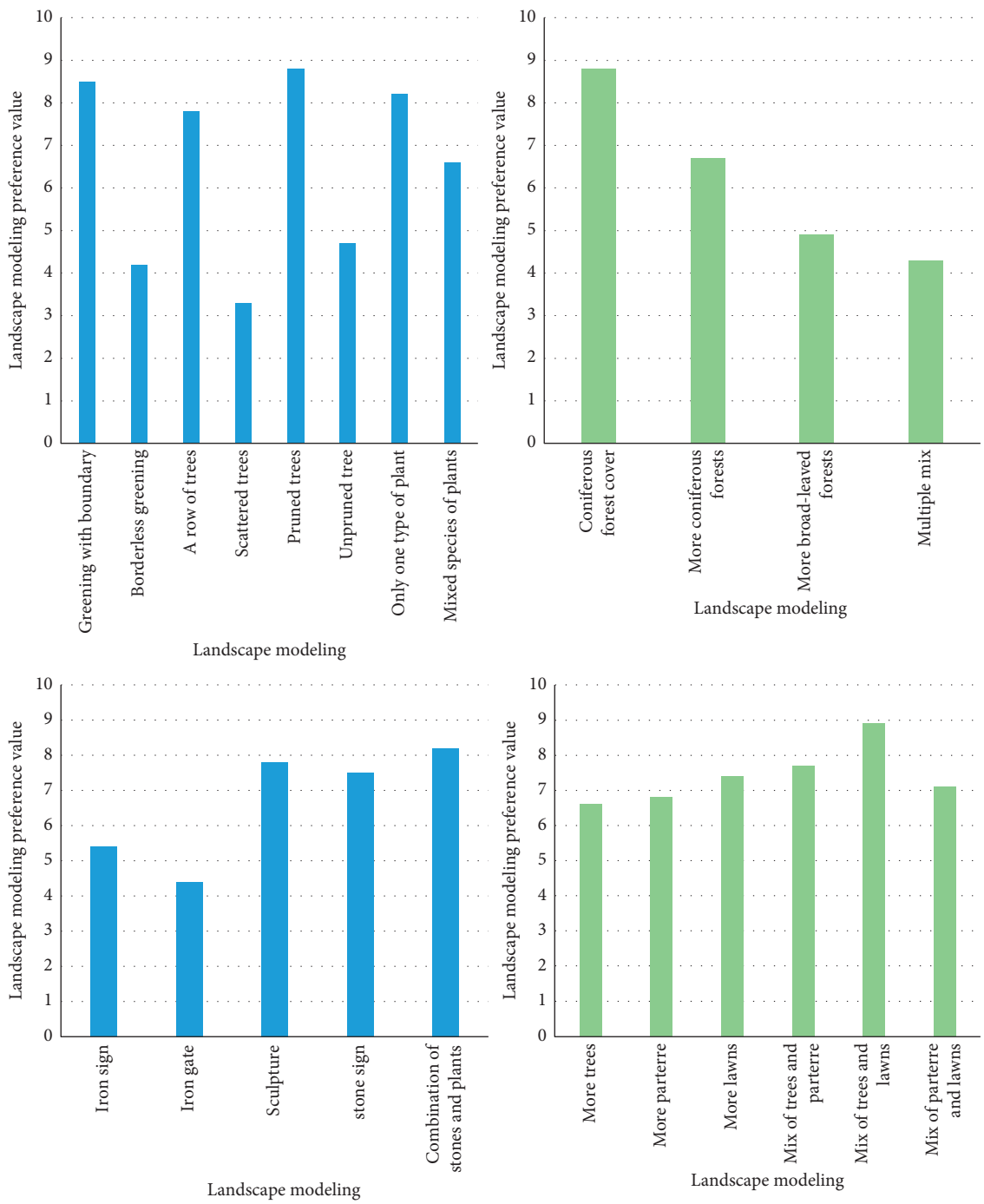

Figure 12: Survey results of respondents' landscape preference.

effect of the space. It enhances the diversity and coordination of landscape space. Plants in dark tones can be used around buildings with classic features to make the space look calm and storytelling. In addition, it also creates a melancholy atmosphere to a certain extent, highlighting the focus and character of the building. Mid-tone plants are often used as a medium to moderate and adjust, which can play a good role in the transition of different landscapes. Plants with bright tones can cause a strong visual impact, and their bright and brisk colors give people the visual sense of expanding the space. It can arrange bright-toned plants in the center of the area or beside the landmark building, which attracts the sight and impresses the viewer. At the same time, the incidental fruits and branches of plants are also an important part of the color matching of the space. When designing a landscape design, a variety of color combinations can

Figure 13: The composition effect of different vegetation sizes.

Figure 14: The composition effect of different vegetation styles.

be considered. It enhances and enriches the texture of the space. Figure 15 shows the composition effect of different vegetation colors.

(2) Clever Use of Plants for Contrast. The soft lines of plants are a natural texture unique to nature. In urban landscape design, the characteristics of this plant can be used to soften the sharpness of artificial building lines and create a friendly atmosphere. The composition relationship of plants should be comprehensively considered in the design. Generally speaking, plant species with tall stems, thick branches, and well-developed crowns should be selected around buildings with a solemn appearance and a wide field of view. Around buildings with smaller size and beautiful shapes, small, light, and dense plant species should be selected. For example, brightly colored low-to-medium plants and flowers are used to decorate near statues, fountains, and small pavilions with a single color, or hedges are used as a background. It emphasizes the texture of building materials through the strong contrast of colors and spatial organization, enhances the atmosphere, and deepens the viewer's impression of the landscape. The combination of plants and rocks in the space can outline the undulating lines and space structure, showing the interest of nature. The combination of plants and water can form a beautiful landscape and enhance the texture and story of the picture. Generally speaking, the staggered distribution of low bushes and tall bushes should be used, and the good growth of the bushes can highlight the beauty of the waters and mountains.

Common contrast methods are as follows: tall trees should be used to highlight the solemn atmosphere around memorial halls, ancient buildings, or gates. Brightly colored plants are used to enhance the visual impression around the iconic building. Hedges, bushes, and lawns are used as backgrounds around the sculptures and small fountains to enhance the texture of the picture. Figure 16 shows the framing effect of plants.

5. Discussion

This study is devoted to the research on the modeling design of the environmental landscape of urban public facilities. This study not only expounds and analyzes the elements and construction methods of landscape modeling design but also conducts investigation and research on the field. The landscape design is optimized through residents' preference for landscape modeling, which transforms the living environment of the community.

Figure 15: The composition effect of different vegetation colors.

Figure 16: The composition effect of plants.

This study analyzes the five elements that make up the landscape, point, line, surface, body, and color and lists the design cases that can be used in reality, which can be used for design reference. In this study, virtual reality technology and BIM technology are used in the optimization of landscape modeling and dynamic visual analysis. Compared with other methods, these two methods can better increase the viewer's sense of experience and interaction. It gives the viewer an immersive and wonderful experience. The last is the questionnaire survey and analysis stage. This study takes the modeling design of vegetation landscape as an example to collect the preference of the residents of the community for landscape modeling, which is used as a case reference for improving the landscape modeling design.

Through the analysis of this case, it shows that virtual reality technology can improve the way the landscape is presented. It enhances the interactivity and interest of the landscape experience, making the presentation of the landscape more lively. BIM technology plays an important role in dynamic visual analysis and cost analysis. It is beneficial to save the design cost and optimize the design scheme.

6. Conclusion

Through the analysis of this study, the following conclusions are drawn: (1) virtual reality technology plays an important role in the optimization of the five senses of landscape experience. The traditional landscape experience is too monotonous, but the landscape design under the guidance of virtual reality technology enriches the mode of landscape experience and enhances the interest of viewing and the interactivity of experience. (2) The cost map of power assignment can intuitively reflect the cost status of the landscape path design of the target site. It picks the best path through cost management, which helps avoid ecologically sensitive areas. It makes landscape design more scientific and rational. (3) Most of the landscape design is based on natural resources. This study analyzes the topography of the design space and helps to grasp the overall characteristics of the space. It is reasonable and effective for landscape modeling design. (4) Landscape modeling design should be considered from multiple perspectives, and the modeling elements should be refined. The design according to local conditions conforms to the characteristics of the place and

the landscape shape of the target group. (5) The urban landscape modeling design should be more researched among residents. According to the feedback of the residents, the layout and shape of the landscape are adjusted so that the landscape environment can serve to improve the quality of life of the residents. (6) This study has a certain contribution to the research on the environmental landscape modeling design of urban public facilities, but it also has some shortcomings. How to carry out the landscape modeling design while ensuring the stability of the landscape security pattern is an area that needs to be studied in the future.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Research Article

Meta-Analytical Approach to the Impact of Corpus-Driven Teaching on Foreign Language Acquisition

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Corpus linguistics is an emerging discipline in contemporary linguistics. Corpus refers to a large number of real used languages, which are collected, classified, stored, coded, or marked by computer to form a huge electronic resource library for users to learn or conduct research. Nowadays, corpus is gradually applied to English teaching, but corpus is mostly used in undergraduate teaching, and it is still in its infancy in higher vocational English teaching. Starting from this realistic background, in this work, a meta-analysis was conducted to analyze corpus-driven instruction on foreign language acquisition. The introduction of meta-analysis and the related introduction of chaotic communication system were carried out, and the hardware architecture of the system was designed. In the experiment, the error corpus was collected and sorted out and used as a sample. The comparative experiment method was adopted, which meant that two or more experimental groups were set up, and the relationship between various factors and experimental objects was explored through the comparative analysis of the results. Experimental results showed that judging from the average correct rate, the correct rate of the questionnaires for international students generally increased with the level of the international students. It also showed from another aspect that the higher the level of international students, the less the impact of the English translation of words on their acquisition process. The subject of meta-analysis of the impact of corpus-driven teaching on foreign language acquisition has been well completed.

1. Introduction

China's higher vocational education is still in its infancy, and has a certain distance from the current social, economic, and technological development. Compared with the United States, Germany, the United Kingdom, and other countries, the gap is even more obvious. However, due to the importance, ubiquity, and high frequency of use of English, front-line English teachers in higher professional universities need to think deeply about the teaching of advanced professional English. English teaching faces a complex new international form. Higher vocational education requires that the talents cultivated are three-dimensional and compound. Students should not only understand theory but also be able to practice. Students should not only be able to master English, but also be able to communicate in English. In recent years, due to the expansion of college enrollment and the course entrance examinations of higher vocational colleges, the admission level of students is uneven, and many new situations have followed, such as aversion to learning and poor foundation.

In the decades since the middle of the last century, corpora have developed rapidly at home and abroad. The corpus has three characteristics: 1. The corpus stores the language materials that have actually appeared in the actual use of the language, so the example sentence database should not usually be regarded as a corpus; 2. The corpus is the basic resource for carrying language knowledge, but it is not equal to language knowledge; 3. Real corpus needs to be processed (analyzed and processed) before it can become a useful resource. Some people use it to collect data; others directly use the corpus as their research direction. Corpus linguistics is an application-based discipline. Without application, the corpus has no source and development motivation. English teaching is an important field of corpus application. In fact, the application of corpus in English teaching has been

regarded as an important research direction of corpus by many foreign scholars. In such an international environment, under the new form of domestic education reform, the application of research subjects in higher vocational English teaching reform has been put on the agenda. The innovations of this paper are: (1) The introduction of chaotic communication system, which is an important theoretical concept in corpus research. (2) The moderating effect of relevant factors on deep acting and foreign language learning intention is analyzed. (3) CMA 3.0 professional software is used to process and analyze the data. The software can directly import, calculate, and output data, with convenient operation and powerful functions. The meta-analysis method of corpus-driven teaching adopted in this paper is more intelligent, and a system can also be produced in the later stage to digitize the impact of foreign language learning, which is convenient for teaching and learning.

2. Related Work

Corpus linguistics is a new discipline in contemporary linguistics. Alex et al. studied text awareness using DocuScope. For students' written decision-making, Alex et al. believed that using corpus-driven tools could better improve the work efficiency. But this research content did not cause much repercussion [1]. Boettger et al. extended Orr's work by providing an overview of ongoing activities on statistical driven solutions in TPC research. A quick metadata search on Technical and Professional Communication (TPC) journals and conference proceedings found that a growing number of essays related to common terminology in digital technology were published. However, the TPC field was just a beginning to embrace the power of a data-driven approach [2]. Chareonkul used a corpora-driven methodology to study the schema-means screen of the present perfect tense using a corpus of English. These meanings were discovered with unique co-occurrence grid [3]. Lackov provided a frequency list of the studied words in a text corpus and classified them morphologically. The main research interests focused on the collocation and coherence of frequently occurring words [4].

Language is the bridge of human communication. Singh and Seet research focused on whether early learning of different languages affected long-term English acquisition. In this study, the effect of foreign language nursing on the final acquisition of English and on the memory traces of Hokkien people was investigated, the knowledge of English phonetics, semantics, and grammar in the Hokkien group and the pure English group were compared. The memory of Hokkien tones, phonology, and vocabulary was also compared between the two groups. However, Chinese and English are essentially agglutinative and isolating languages, and the significance of such research is not particularly obvious [5]. Manegre examined whether foreign language accession was achieved by exchanging message when students enrolled in web authoring assignments in English as a common language. It also examines whether students with high-level language skills related to foreign languages share this information with their peers throughout the writing process [6]. Bao and Liu conducted a study to investigate the impact of the emotional component of L2 learning on linguistic teaching and learning. Bao and Liu believed that emotional factors had positive and negative effects on foreign language teaching and were a crucial factor in language learning [7].

3. Meta-Analytical Approach to the Impact of Foreign Language Acquisition

3.1. Meta-Analytical Method. Meta-analysis is a method that uses quantitative methods to synthesize previous empirical studies for quantitative literature review [8]. Its application types mainly include experimental research, related research, mortality, and recurrence rate issues. In the past, it was widely used in the medical field, and then gradually applied to the field of psychology and management. It is a better method to integrate previous research and conduct literature review, and its results are more convincing than single research and ordinary literature review [9].

Generally speaking, the operation process of meta-analysis is complicated, but the repeatability is high [10]. Therefore, the operation of meta-analysis needs to be strict according to the standard process. Even if there are less than 10 documents that meet the standards, the meta-analysis can be carried out. The overview is more convincing. However, meta-analysis is not an actual study after all [11], but an integration of previous studies. Therefore, the applicability of the study results may also consider the influence of factors such as study design and study participants. For example, the results of cross-sectional studies may be different from those of the follow-up studies. Therefore, whether the cross-sectional research results can be directly applied to follow-up research also needs to be verified by empirical research [12].

In this study, CMA 3.0 professional software was used for data processing and analysis. The software can directly import, calculate, and output data, with convenient operation and powerful functions. The resulting effect size in this study is the correlation coefficient r, which refers to either the individual correlation coefficient or the processed average correlation coefficient. When the meta-analysis software calculates relevant statistics such as r, 95% confidence level, $p$value, and reports other statistical results of the meta-analysis, it only needs to input the correlation coefficient and sample size of each study. Through meta-analysis, this paper integrated the research results of the relationship between corpus-driven teaching and foreign language acquisition, and discussed the moderating effects of sample characteristics and scales on the two.

3.2. Algorithm Optimization. The bounded optimized issue is formulated as formula (1):

$$\begin{aligned} Q:\ \min_{x} F(x) &= (f_m(x)), \\ \text{s.p. } g_j(x_1) &\geq a_j, \\ h_k(x) &= b_k, \\ x &\in X \subset R. \end{aligned} \tag{1}$$

Total number of settlements in the destination dimension that satisfy the constraints are known as a viable solution.

The uncertain mathematical methods are as follows.

The multiobjective optimization problems with constrained intervals are shown as the formulas (2)–(5):

$$Q\colon \min_{a} F(a,q) = (f_m(a,q)). \tag{2}$$

Defining X,

$$\text{s.p. } g_j(x_1,u) \geq a_j = \left[a_j, \overline{a_j}\right]. \tag{3}$$

Defining x,

$$h_m(x,v) \geq b_m = \left[b_m, \overline{b_m}\right]. \tag{4}$$

Defining x_1,

$$x \in X \subset R^q. \tag{5}$$

Defining u,

$$u \subset R^p. \tag{6}$$

Furthermore,

$$\begin{aligned} f_1(x) &= \min_v f_1(x,v), \\ \overline{f_2(x)} &= \max_v f_1(x,v), \\ g_2(x) &= \min_v g_2(x,v), \\ \overline{g_2(x)} &= \max_v g_v(x,v), \\ h_3(x) &= \min_v h_3(x,v), \\ \overline{h_3(x)} &= \max_v h_3(x,v). \end{aligned} \tag{7}$$

Taylor expansion at u. Taylor expansion is an important content in mathematical analysis, and it is also an indispensable mathematical tool for studying function limit and estimation error. It embodies the essence of calculus "approximation method" and has unique advantages in approximate calculation. Using Taylor expansion can transform nonlinear problems into linear problems with high accuracy, so it has important applications in all aspects of calculus.

$$\min_x F(x,u) = \left(f_1(x), \overline{f_1(x)}\right). \tag{8}$$

Processed:

$$f_i(x) = f_i(x,u^c) - \sum_{i=1}^{p} \left| \frac{\partial f_i(x,u^c)}{\partial u_l} \right| u_l^r. \tag{9}$$

The same with the constraint function is applied:

$$g_j(x,u) = \left[g_j(x), \overline{g_j(x)}\right], \tag{10}$$

where:

$$\begin{aligned} \overline{p_j(x)} &= p_j(x,u^c) + \sum_{i=1}^{p} \left| \frac{\partial p_j(x,u^c)}{\partial u_l} \right| u_l^r, \\ j_k(x) &= j_k(x,u^c) - \sum_{i=1}^{p} \left| \frac{\partial j_k(x,u^c)}{\partial u_l} \right| u_l^r. \end{aligned} \tag{11}$$

The use of Taylor series expansions can reduce the calculation effort effectively [13]. The time-frequency method is analyzed below.

In the context of conversions, there are

$$p(t,f) = M_1(f) + M_2(f) + 2R[mnM_{12}(f)]. \tag{12}$$

The signature $x(t)$ is

$$D(f) = \int_{-\infty}^{+\infty} h\left(t + \frac{\tau}{2}\right) h^*\left(t - \frac{\tau}{2}\right) \exp(-j2\pi f\tau) \mathrm{d}\tau. \tag{13}$$

Since the window function is not included in the formula, there are few restrictions between the two parameters.

If

$$h(1) = h_1(1) + h_2(1). \tag{14}$$

So,

$$\begin{aligned} D(f) &= D_1(f) + D_2(f) + 2\mathrm{Re}\{D_{12}(f)\}, \\ D_{12}(f) &= \int_{-\infty}^{+\infty} h_1\left(T + \frac{\tau}{2}\right) h_2^*\left(T - \frac{\tau}{2}\right) \exp(-j2\pi f\tau) \mathrm{d}\tau. \end{aligned} \tag{15}$$

3.3. System Flow. To make the system complete the necessary hardware conform to access the script demands of multifaceted number collection and machining and data mining operations in the electronic text library [14], the hardware architecture of the system was designed [15, 16]. Therefore, in order to complete the support of the above overall hardware design and realize the corresponding computer capability, there is a need to choose a suitable microprocessor as the core part of the computing equipment of the passive communication system [17]. In order to ensure that an extensive data that has been gleaned can be uploaded to the cloud in time, the computer edge system must have high data performance to prevent a huge quantity of data gathered by connecting extreme devices and the cloud. Finally, for specific scenarios can be used, various data processing and analysis algorithms must provide a variable software environment for edge devices so that users can develop or transplant programs separately [18]. The system framework is shown in Figure 1.

3.4. Corpus Paid Platform. Along with the advancement of the community, to meet the special research purposes of some researchers, the society's demand for small corpora for special purposes is increasing. The construction of such a more targeted and relatively small-scale corpus will become a research hotspot in the academic world. In fact, the rapid growth of PC skills is constantly integrated into people's

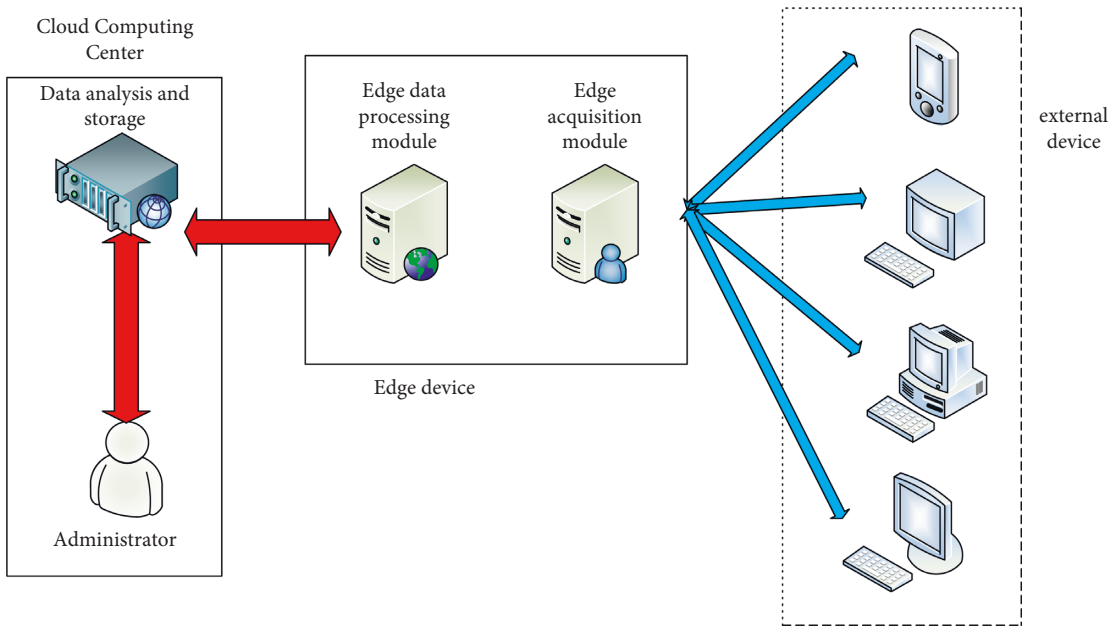

Figure 1: System framework diagram.

lives, coupled with the existing research results of corpus nationally and internationally and the extensive attention to corpus construction all over the world. Especially in the era of big data, people are more and more dependent on data processing and processing [19]. At present, corpus is widely used in the field of linguistics. It is a new means of modern language research. The corpus is used in language teaching, dialect research, dictionary compilation, phonetics, vocabulary, grammar, and other language problems. It also shows that the corpus research method is a new research method and has played an important role in language research. These make the construction and research of corpus become a new direction of research by many scholars [20]. The schematic model of the corpus platform is illustrated in Figure 2.

4. Meta-Analytical Experiment on the Impact of Foreign Language Acquisition

The basic framework of the experiment is as follows: firstly, the error corpus is collected and organized, then the correlation experiment of different trait scales and acquisition levels is carried out, and finally the simulation analysis of the algorithm performance is carried out.

4.1. Collection and Arrangement of Biased Corpus. The experiment collected a sample of 120 international students from three foreign language classes in a certain institution, which were divided into elementary, intermediate, and advanced classes according to their grades. In the composition data collected in this paper, it is considered that Germany and Austria use German as the official language. In theory, the native language of candidates in these two countries should be German. The current HSK dynamic corpus divides errors into: omission due to lack of components, addition due to redundant components, substitution due to improper usage, and wrong order due to wrong word order. This paper will also take the above method here as a classification method by biased performance.

Verbs can be divided into monosyllabic verbs, disyllabic verbs, and polysyllabic verbs according to their syllable characteristics. A syllable contains a vowel phoneme, called a monosyllabic word, such as a, at, hi, meet, and three. According to the syllable characteristics, the collected verb errors can be clearly divided in form. The error distribution is shown in Table 1.

It can be seen from the above table that a total of 129 cases of verb errors can be classified according to syllable characteristics. Among them, substitution errors occur most frequently in disyllabic verbs, with 53 cases, while omission errors occur in monosyllabic verbs with a relatively high probability. There are 20 cases of omission, the addition errors are relatively few, and the monosyllabic verbs are more than the two-syllable verbs.

Verbs can be divided into mental activity verbs, directional verbs, relational verbs, auxiliary verbs, etc., according to their semantic characteristics. This article divides them according to the specific errors shown in the corpus. Therefore, only 42 cases of errors can be classified from the following verb types, as shown in Figure 3.

Among the 42 cases of errors classified according to semantic features, only the substitution errors appeared in the verbs of mental activity, and the substitution errors of these types of verbs were the largest in the verbs of the mental activity; the errors of the tendency verbs were generally less, errors are the main ones; there were more omission errors of relative verbs, but they were similar to addition errors; auxiliary verbs were dominated by addition errors, and auxiliary verbs had the largest proportion of addition errors in these types of verbs.

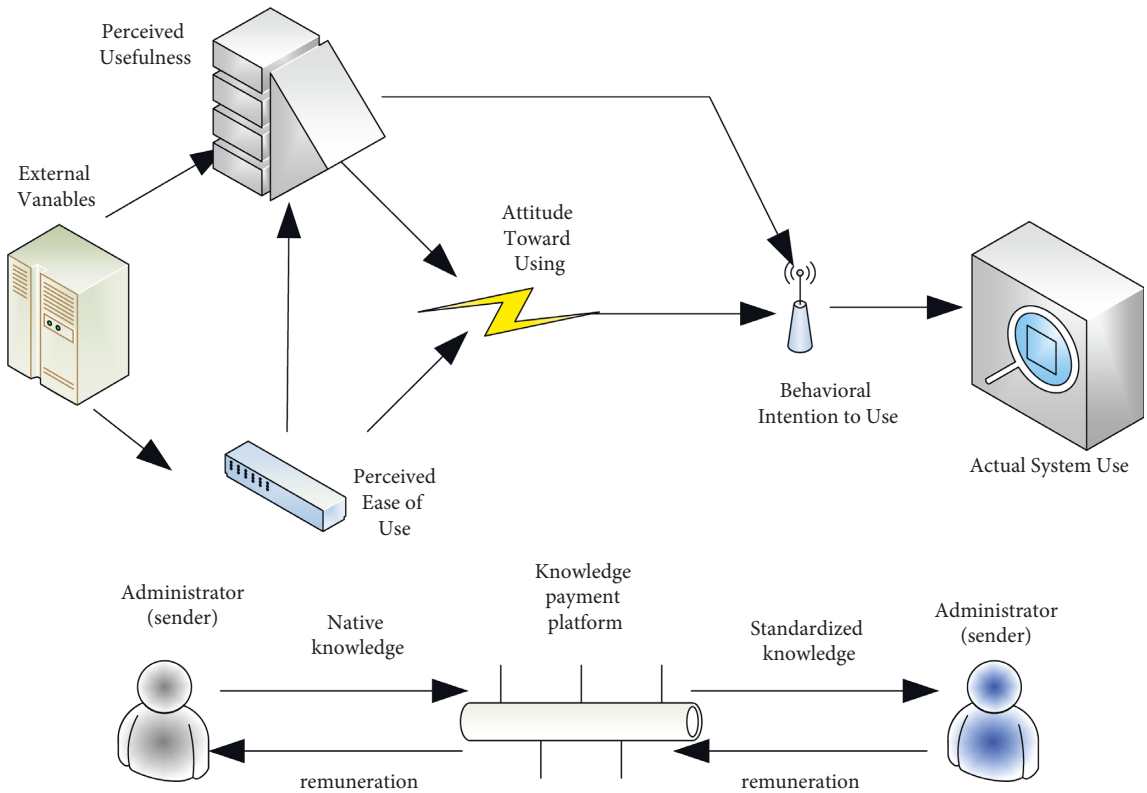

Figure 2: Model diagram of the corpus payment platform.

Table 1: Deviated verbs - by syllable feature.

	Replace	Add	Omission	Total
Monosyllabic - verb	13	14	20	47
Disyllabic - verb	53	5	8	66
Polysyllabic - verb	3	—	—	3
Monosyllabic and disyllabic mixing	13	—	—	13
Total	82	19	28	129

Statistical analysis was carried out on the questionnaire results of the elementary, intermediate, and advanced classes by using excel sheet, and it made the correct number of questions and the correct rate of the questionnaire, statistics of the results of each student's questionnaire. There were four data items in the analysis results: mean, variance, standard deviation, and coefficient of variation. The first three data were calculated by using the corresponding functions in excel, and the coefficient of variation was the result obtained by dividing the standard deviation by the mean. The relevant statistics are as follows.

Figure 4 is the data results of the elementary class, the intermediate class, and the advanced class.

The comparison between the beginner class and the advanced class is shown in Figure 5.

Judging from the average correct rate, the correct rate of the questionnaires for international students generally increased with the level of the international students. It also showed from another aspect that the higher the level of international students, the less the impact of the English translation of words on their acquisition process.

4.2. Correlation between Different Trait Scales and Acquired Levels in the Experiment. By analyzing the data, the correlation coefficients between different trait scales and acquired levels are obtained, as shown in Table 2.

The data in the table has shown that in the study using NEO-PI-R, the coefficients of trait scale and acquisition level were 0298, 0.331, 0.330, −0.073, and 0.203, respectively. Among them, the relationship between R9 of rough memory and acquisition level was −0.073, which was a low negative correlation. The rest of the items were positively correlated. It is shown that the trait scale has a good predictive effect on the level of language acquisition.

Due to the heterogeneity of the studies, a sensitivity analysis on different trait scales and acquisition levels was then conducted and compared according to the number of effect model literature. In the fixed effect model and the random effect model, different analysis results were obtained by using different effect models to process the data. The random effect model is a generalization of the classic linear model, that is, the regression coefficient of the original (fixed effect model) is regarded as a random variable, which is generally assumed to be from a normal distribution, as shown in Table 3.

Among them, the correlation coefficients between R6 and the acquired level were 0.275 and 2.78, the correlation coefficients between R7 and the acquired level were 0.286 and 2.87, and the correlation coefficients between R8 and the acquired level were 0.275 and 3.87, respectively. The correlation coefficients between R9 and the acquired level were −0.045 and 0.2, respectively, and the correlation coefficients

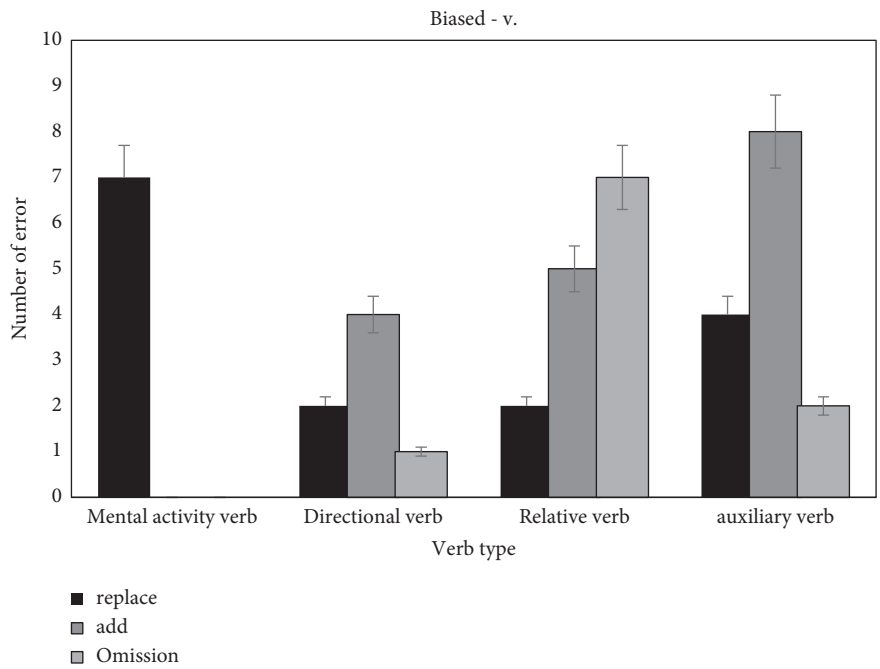

Figure 3: Deviating verbs - by semantic feature.

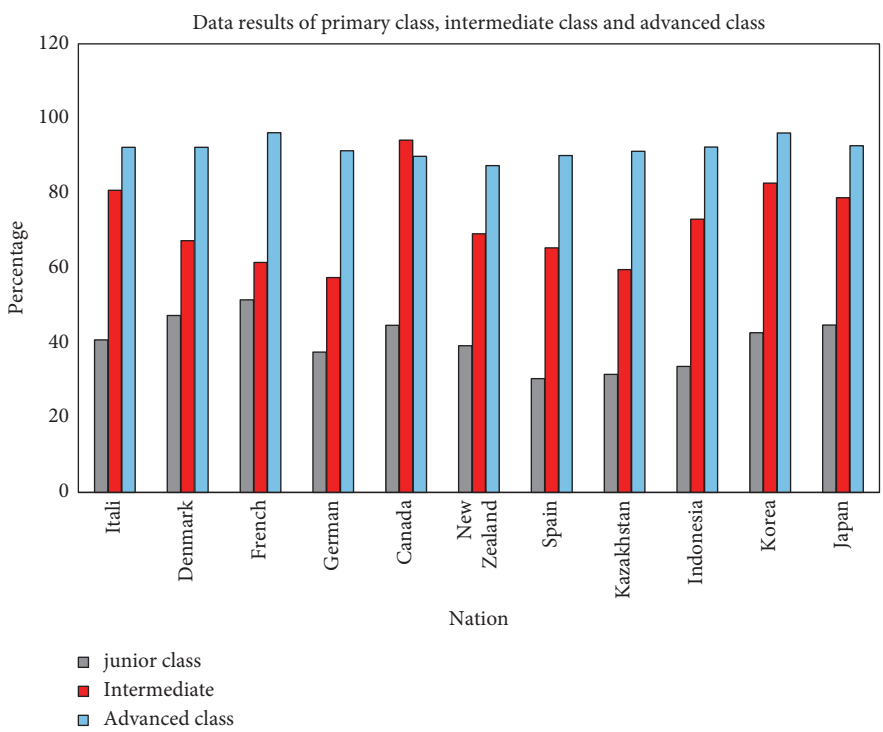

Figure 4: Data results for beginner, intermediate, and advanced classes.

between R10 and the acquired level were 0.196 and 2.50, respectively. The *p*values were not very different. It is worth mentioning that the random effect model of R9 shows a negative correlation of −0.045, because the rough memory method can master a large number of language vocabulary in a short time, but it will be quickly forgotten along with the memory curve without review. It can be seen that the difference between the results of the fixed-effect model and the random effects model is very large, and the random effects model is better in terms of accuracy. However, due to the heterogeneity of effect sizes in this study, the random effect model should be used to test the overall effect, and the random effect model should also be used when testing the moderating effect.

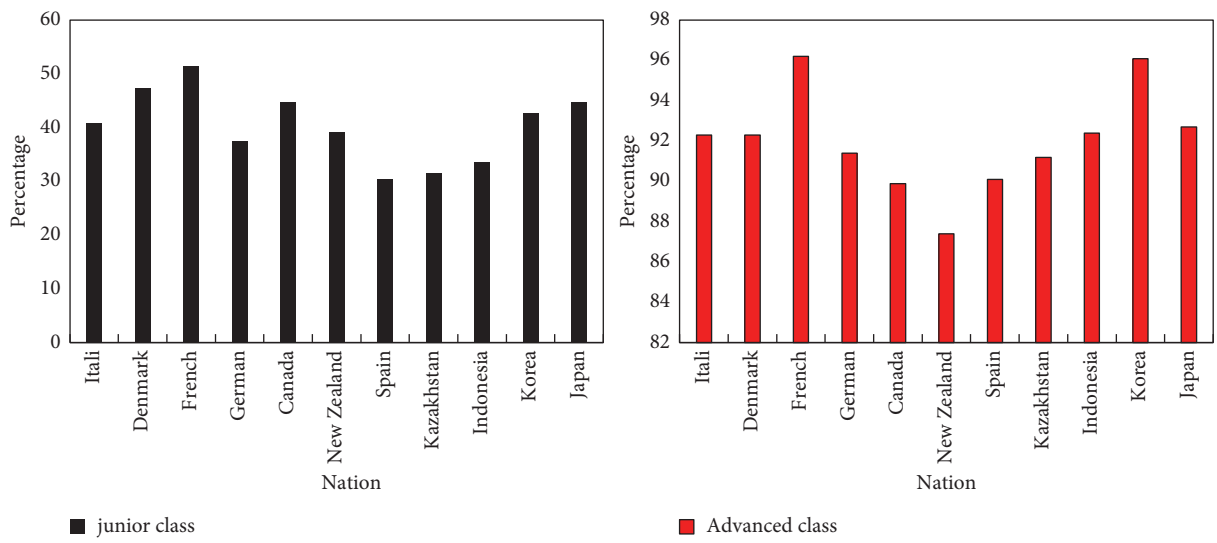

Figure 5: Comparison of beginner class and advanced class.

Table 2: Correlation coefficients between different trait scales and acquired levels.

Model	Q between groups	NEO-PI-R	16PF	Other
R6	4.979	0.298	0.101	0.215
R7	23.316***	0.331	0.402	0.215
R8	87.663***	0.330	0.042	0.186
R9	5.043	−0.073	0.059	0.103
R10	7.131***	0.203	0.029	0.258

Table 3: Comparison of results for different effect models.

Model	Effect value	
	Random effect model	Fixed effect model
R6	0.275	2.87 _ _
R7	0.286	2.87 _ _
R8	0.275	3.87 _ _
R9	−0.045	0.2 _ _
R10	0.196	2.0 _ _

Sensitivity analyses were performed using the cut-and-fill method to ensure the rigour of the results of this study as shown in Table 4.

The data analysis was carried out again, and the conclusions were as shown in the above table, and there was no significant difference. Sensitivity analysis showed that the correlation coefficient did not change substantially after trimming out asymmetric small sample studies, so the data analysis results were robust.

Table 5 is the results of the influence and moderating effect of related factors on language acquisition. The moderating effects of the proportion of male subjects, language learning intention, and deep-playing strategy scales on the relationship between the two were, respectively, verified. The result is as follows.

Through the adjustment analysis of the measurement tools of deep acting strategies, and it was found that different deep-playing strategies measurement scales had no significant moderating effects on the relationship between deep-playing and foreign language learning intentions (QB = 4.740, $p > 0.05$), assuming that H42 was not verified. Different deep-playing strategies measurement scales had no obvious moderating effect on the proportion of male subjects and foreign language learning intention. (QB = 2.6 4 1, $p > 0.05$), assuming that H 2 2 was not verified.

4.3. Simulation of Algorithm Performance. There were two cases where the primary user uses the transmit power level with the same probability and the primary user uses the transmit power level with different probabilities. The false detection probability performance of the proposed spectrum sensing algorithm was given, and the detection performance based on soft combining and several detection algorithms based on hard combining were compared. Figure 6 shows the performance comparison of spectrum sensing algorithms under different combining methods when the primary user uses each energy level with equal probability. Since this problem is generally modeled by graph theory, its core idea is to optimally allocate the set of sensing channels to satisfy the constraint relationship of the competition graph (also known as the interference graph) between nodes.

It can be seen from the figure that the effect of the algorithm using soft merging is relatively stable. The soft combining method essentially uses the channel state information of different users to weight the received signal energy, highlighting the weight of the detection samples provided by users with good channel conditions in the total samples, while other hard combining methods cannot fully utilize the channel state information of the user. On the other hand, the soft merging method can reduce the error generated by the hard merging method when the information is discretized after merging (such as the round-up operation after the mean value merging).

In general scenarios, the performance of the algorithm configured by the primary user using each transmit power with different probabilities is shown in Figure 7.

Table 4: Sensitivity analysis.

Model	Effect value			
	Random effect model		Fixed effect model	
Before and after subtraction and supplement	Before reduction and supplement	Subtraction and supplement hou	Before reduction and supplement	Subtraction and supplement hou
R6	0.275	0.309	0.287	0.319
R7	0.286	0.215	0.287	0.218
R8	0.275	0.269	0.387	0.299
R9	−0.045	−0.085	0.002	−0.069
R10	0.196	0.203	0.250	0.220

Table 5: Analysis of the moderating effect of related factors on deep acting and foreign language learning intention.

Adjustment variable	Homogeneous assays			Name category	Independent sample	N	Effect value and confidence interval			Two-tailed test	
	Between Q group	df	p				Point estimation	Lower limit	Upper limit	Z value	p value
Proportion of male subjects	41.156	4	0.000	1	3	790	−0.177	−0.248	−0.104	−4.697	<0.001
				2	8	2533	−0.493	−0.659	−0.281	−4.213	<0.001
				3	3	801	−0.505	−0.578	−0.425	−10.572	<0.001
				4	3	909	−0.060	−0.320	0.208	−0.437	>0.05
				X	4	1541	−0.192	−0.401	0.036	−1.651	>0.05
	16.852	4	0.002	TQ	5	1203	−0.536	−0.712	−0.296	−3.996	<0.001
Cognitive structure of turnover scale				TQ&IQ	6	1580	−0.366	−0.618	−0.045	−2.221	<0.05
				TQ&IS	4	1818	−0.350	−0.451	−0.240	−5.940	<0.001
				TQ,IQ&IS	5	1599	−0.103	−0.214	−0.011	−1.778	>0.05
				X	1	595	−0.200	−0.276	−0.122	−4.933	<0.001
Emotional labor strategy scale	4.740	3	0.192	D	4	1191	−0.508	−0.757	−0.131	−2.565	<0.05
				G	9	3147	−0.396	−0.542	−0.226	−4.352	<0.001
				W	4	1107	−0.263	−0.419	−0.091	−2.965	<0.05
				X	4	1350	−0.108	−0.372	0.172	−0.753	>0.05

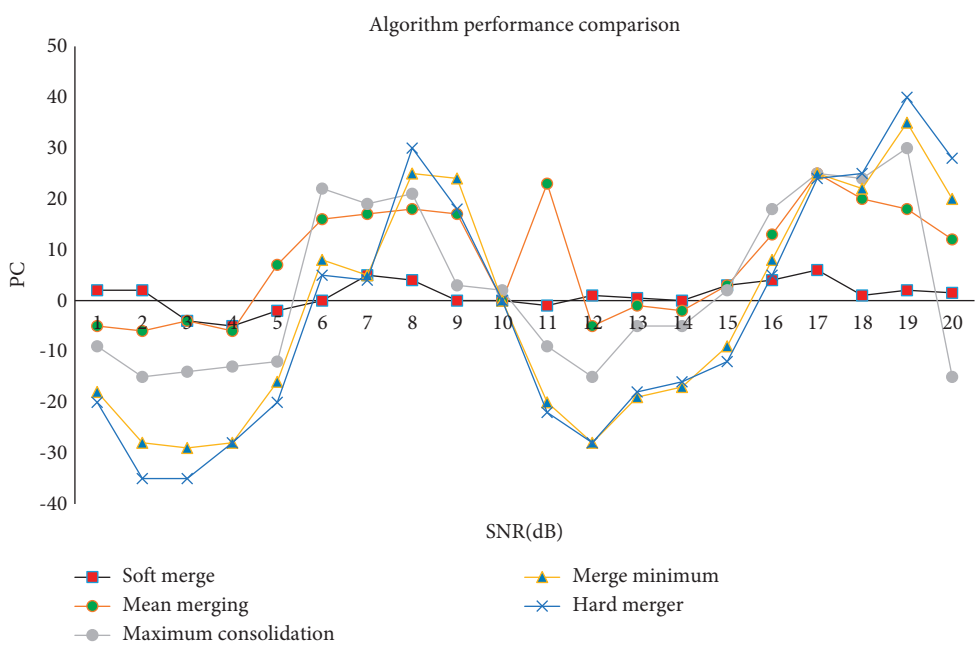

Figure 6: Performance comparison of spectrum sensing algorithms under different combining methods when the primary user uses each energy level with equal probability.

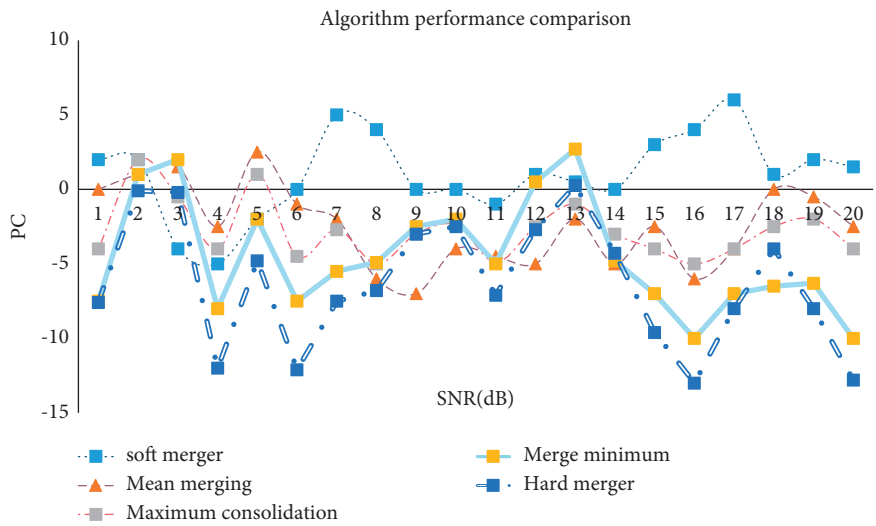

Figure 7: The performance of the algorithm configured by the primary user using each transmit power with different probabilities in a general scenario.

It can be seen from the figure that the curves in Figures 6 and 7 have similar trends, but the performance of Figure 7 is better in terms of false detection probability, mainly because when the primary user is idle, the detection of this user for the secondary scene and the primary user using other transmissions, the power level is more precise. However, the algorithm based on maximum merging in Figures 6 and 7 are slightly better than the algorithm based on minimum merging, mainly because the proposed algorithm adopts energy detection.

The rotated component matrix is as shown in Figure 8.

It can be seen from the figure that both components 1 and 4 reach the maximum value of over 1000, while the maximum value of components 3, 6, and 10 is only about 900, but it is relatively stable.

Descriptive statistics of each variable for the algorithm system used in this paper are shown in Figure 9.

As shown in the figure, the standard deviation and variance are high, while the kurtosis is low and relatively stable, which meets the research needs.

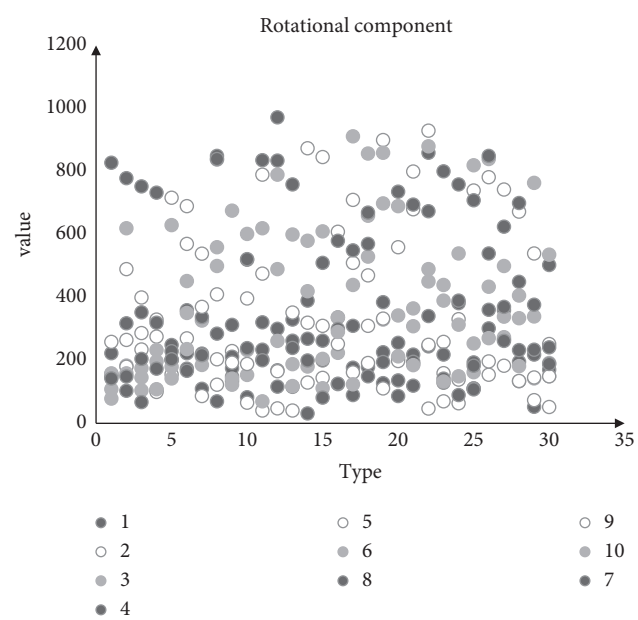

Figure 8: Rotated component matrix scatter plot.

5. Discussion

5.1. Validity Details. Effectiveness measurement is mainly used to test whether the samples' precision can effectively represent the association between different covariates. In general, the greater the validity of a test, the better the results will accurately capture the level of acceptance of the data being measured. In this paper, we will examine two aspects of effectiveness: construct validity and content validity. Contextual legitimacy has been called use legitimacy or peculiar validity. Whether the key demographic data in the interrogation questionnaire cover all the aspects that the researches want to study should be analyzed. Usually, the scores of the single subject are used to capture all the pertinent elements of the subject's overall score. If the relevant factor is not statistically valid, it indicates that the interpretive force of the element is low and should be removed. Since most of the underlying covariates for this paper are referenced, it cites the most developed measure, incorporating both expert evaluation and in-depth user interaction, to produce the final scale through analytic analysis, which in this case is effective.

5.2. Intelligent Spectrum Access Technology in Passive Communication and Computing. By applying mobile edge computing technology and sinking computing power to mobile edge nodes, localized computing services can be provided for users, which greatly reduce the communication delays, relieves central computing pressure, and significantly increases network robustness. In addition, third-party application integration can be provided, providing unlimited

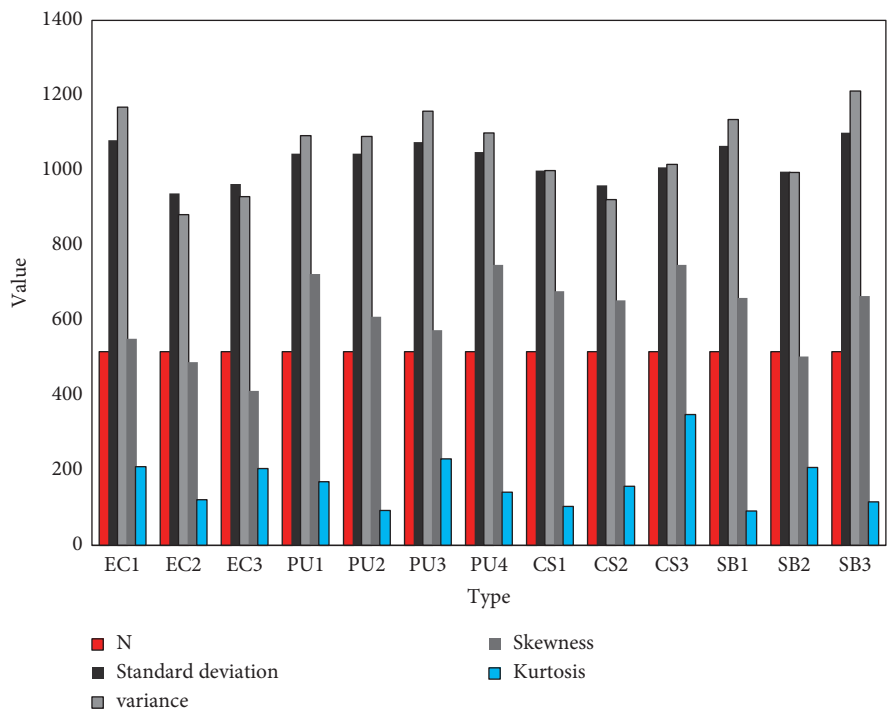

Figure 9: Descriptive statistics for each variable.

possibilities for service innovation at the mobile edge portal. In mobile edge computing systems, computing offload scheduling is undoubtedly the most critical issue affecting system performance, and it has received extensive attention recently. Modern scholars chose to offload computing tasks to minimize the average energy, and proposed a delay optimization algorithm for single-user MEC systems using Markov decision process. The trade-off between energy and delay of single-user MEC systems was analyzed. Then, the results were extended to a multi-user system. And based on game theory, a distributed computing offloading algorithm is proposed, which is then applied in multi-cellular MEC using continuous convex approximation to jointly optimize communication and computing resources. However, the above existing work assumes that the MEC server has sufficiently powerful computing power, and the offloaded computing tasks are executed immediately upon reaching the server. In practice, the number of offload tasks can be quite large when multiple users are considered. Therefore, these tasks cannot be completed by MEC controller in a brief period of time, especially when considering the system delay performance, and the queuing delay cannot be ignored. On the other hand, most existing works are based on data queues for random resource allocation.

Some scholars only operate on user data queues or computing task queues. However, a queue cannot reflect the two characteristics of data, namely, storage size and calculation size. Furthermore, since these queue lengths belong to state-dependent controlled random sequences, most of the existing work on latency performance does not analyze the steady-state distribution of state-dependent queues, and there is no known closed-form steady-state distribution. Limited storage space and computing power make analysis more complex. Therefore, the theoretical research on the mobile edge computing system is still not deep enough, and the performance of this complex network needs to be further studied and optimized.

6. Conclusions

Foreign language studies is an indispensable discipline and a useful tool for enhancing national influence and opening to the outside world. Under such a guiding theory and background significance, this paper selected the results of the questionnaires for the elementary, intermediate, and advanced classes for statistical analysis, and made the correct number of questions and the correct rate of the questionnaire, statistics of the results of each student's questionnaire. The error corpus was collected and organized, and the correlation coefficients of different trait scales and acquisition levels were listed. Results, comparison, and sensitivity analysis of different effect models were carried out. Finally, the simulation analysis of the performance of the algorithm was carried out, and the curves of the soft merging, hard merging, mean merging, maximum merging, and minimum merging algorithms under different test conditions were compared. The experimental results showed that the effect of the algorithm using soft merging was relatively stable. When the primary user was idle, the detection of the secondary scene by this user was more accurate than that of the primary user using other transmit power levels. The subject of meta-analysis of the impact of corpus on foreign language acquisition has been well completed. Subsequent research should expand the sample size of students in elementary,

intermediate, and advanced classes, and take into account the differences between the students' native language and the language they are learning, so that the research results are more reliable.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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Research Article

Risk Assessment of Operator's Big Data Internet of Things Credit Financial Management Based on Machine Learning

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Credit risk evaluation innovation is of incredible importance to monetary establishments. AI innovation can fundamentally work on the precision and versatility of credit risk evaluation. This paper aims to study the risk assessment of operator big data Internet of Things credit financial management based on machine learning. It proposes machine learning-related algorithms, including the introduction of logistic model and decision tree model, as well as related concepts of credit financial management risk. This paper proposes that big data can be better used to reduce financial risk management problems and proposes specific actions based on the actual situation of the company. This paper selects company A for financial risk management evaluation through case analysis and compares it with three major e-commerce companies. The experimental results show that the earnings per share of company A is between −0.99 and 0. Company A is still in a state of loss in recent years, and there are certain debt risks, operational risks, and capital risks.

1. Introduction

Today's society is an information society. With the rapid development of science and technology, network applications are increasingly deepened. The global economy tends to develop in an integrated manner, and international exchanges are increasingly close. Network information has greatly changed the living environment of human beings. Great changes have taken place in social concepts, production methods, and social division of labor. People are in an era of unprecedented information explosion. It is undoubtedly of vital significance to carry out information extraction and knowledge mining in these massive pieces of information to obtain the required information. Web of Things endeavors with enormous information volumes are likewise confronted with a lot of data, for example, information stream, data stream, capital stream, and so on. Simultaneously, contest among administrators is turning out to be increasingly extreme [1, 2].

Monetary gambling the executives is the center of big business monetary administration. The degree of monetary gamble of an endeavor is a pointer to quantify the working state of a venture. Corporate financial risks often include management, creditors, and debtors. In the time of huge information, ventures should lay out center intensity and further develop monetary administration level to adapt to the vulnerability in the cutthroat climate. Through the analysis of the financial risk management mode and status quo of large-data Internet of Thing enterprises, this paper points out the risk management opportunities and challenges faced by enterprises in the era of big data. It uses a large amount of financial data to construct financial risk prevention measures for e-commerce enterprises to meet the needs of large-data enterprises in the e-commerce era and provide reference financial risk management for other enterprises.

The innovation of this paper lies in the application of machine learning to operators' big data Internet of Things

credit financial management risk assessment, which is innovative and practical.

2. Related Work

With the approach of the period of large information, executives focus harder on their monetary gamble. Monetary gamble is especially vital to the endurance and improvement of an undertaking. Yang and Luo embraced a superior AdaBoost-SVM calculation to order the security and chance of shared loaning stages [3]. Lam and Siwingwa adopted an exploratory approach combining qualitative and quantitative. The aim is to identify the risk factors that lead to project cost overruns during the construction phase and to establish a reliable method for estimating unforeseen costs [4]. Nolde and Zhou reviewed the extreme value analysis method and its application in financial risk assessment [5]. Risk assessment in the Mukhlis and Damayanti study used the analytic hierarchy process to examine and reduce expert inconsistency [6]. The downside of these studies, however, is the inaccuracy of monitoring financial risk.

With the improvement of science and innovation, artificial intelligent innovation has entered into all parts of individuals' lives, and that is just the beginning and more researchers are concentrating on it. Buczak and Guven depicted an engaged writing survey of artificial intelligence (ML) and information mining (DM) techniques supporting organization examination for interruption discovery [7]. The purpose of Voyant et al. was to outline methods for predicting solar radiation using machine learning methods [8]. Zhou et al. presented the ML structure on large information to direct the conversation of its chances and difficulties. The system is ML-driven and follows the preprocessing, learning, and assessment stages [9]. The motivation behind Kavakiotis et al.'s study was to methodologically survey the utilization of AI, information mining strategies, and apparatuses in the field of diabetes research. Different AI calculations are utilized [10]. However, the shortcomings of these studies are that the model construction is not scientific and reasonable enough.

3. Machine Learning-Related Algorithms

3.1. Machine Learning and Credit Risk Assessment

3.1.1. Concepts Related to Machine Learning. The definition of machine learning has many forms, the more classic is "the behavior of computer to use experience to improve the performance of the system." Artificial intelligent calculations plan to find designs independently from a class of obscure information and afterward utilize this example to arrange the excess information or anticipate the following approaching information ahead of time [11, 12]. Accordingly, the reason for AI is to plan calculations that permit PCs to learn independently, subsequently understanding the utilization of man-made consciousness. The exploration of AI depends on the hypotheses of human learning system like physiology and mental science. It lays out a learning model or mental model by reenacting the human growing experience, concentrates on broad learning calculations and behaviors hypothetical investigation, and lays out task-situated learning models. Practice has proved that machine learning has played an important practical value in many application field, including data mining, speech recognition, image recognition, bioinformatics, and computational finance.

In recent years, artificial intelligence has become more and more popular. Many companies are more or less involved in artificial intelligence; otherwise, they will be regarded as not keeping up with the trend of the times. Furthermore, artificial intelligence in light of huge information has become exceptionally well known, on the grounds that it can understand the expectation of information and give assurance and premise to decision-production through the estimation of large information and the mining of stowed away information.

Machine learning can be viewed as a predictive technique. It learns rules from historical data and makes predictions on new data, and what it actually learns is a function. For the input to give the corresponding output, it can be divided into two applications: regression and classification, as shown in Figure 1 [13]. The learning process is essential to search for a function in the function space that can better fit the original data set and has a good generalization ability.

3.1.2. Machine Learning Algorithm Theory. A credit card scoring model is essentially a classification model within a machine learning algorithm. The following will bring the introduction of logistic regression, decision tree, and two model algorithms.

(1) Logistic Model. The calculated model is primarily used to look at the association between free factors and discrete ward factors [14, 15]. Subordinate variables are generally straightout factors as "0-1.". In this investigation, the basic assessment content is private credit risk evaluation. The dependent variable B is a twofold element with values 0 and 1, independently. $B = 1$ addresses clients with default conduct, and $y = 0$ addresses clients without default records.

Suppose there are m-dimensional independent variables in the logistic model, denoted by $(A_1, A_2, A_3, \cdots, A_m)$. The dependent variable is whether the user has default behavior, which is represented by 0 and 1. After AI, the classifier of the strategic model will get the weight coefficient $(\alpha_1, \alpha_2, \cdots, \alpha_m)$ of a bunch of free factors, where x increments with the increment of M. The outcome is obtained by the direct weighting of the arrangement of loads and the example information:

$$\chi = \alpha_1 A_1 + \alpha_2 A_2 + \alpha_3 A_3 + \cdots + \alpha_m A_m. \quad (1)$$

Logistic is basically a discriminative model in light of contingent likelihood. Thus, the sigmoid capacity is presented here as the discriminant work [16]. The sigmoid capacity is

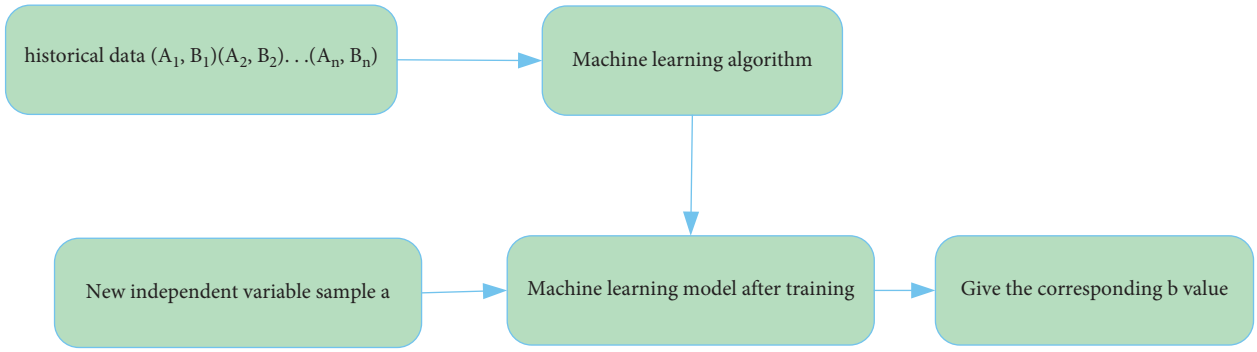

Figure 1: Schematic diagram of the machine learning process.

$$g(A) = \frac{1}{\left(1 + e^{-A}\right)}. \tag{2}$$

The larger the A, the larger the sigmoid; the smaller the A, the smaller the sigmoid. Figure 2 shows that the results are obtained by calculation, and 0.5 is used as a dividing point. If the result $A > 0.5$, it belongs to the positive class with the class value of 1, and if $A < 0.5$, it belongs to the negative class with the class value of 0. It puts the above fitting result as follows:

$$A = \alpha_1 A_1 + \alpha_2 A_2 + \alpha_3 A_3 + \cdots + \alpha_m A_m. \tag{3}$$

It is fed into the sigmoid function, which in turn gets a value from 0 to 1. In the actual credit approval classification, classification is performed by setting a threshold. Thus, the strategic relapse model can likewise be viewed as a likelihood assessment or, at least, the assessment of the default likelihood of the client [17].

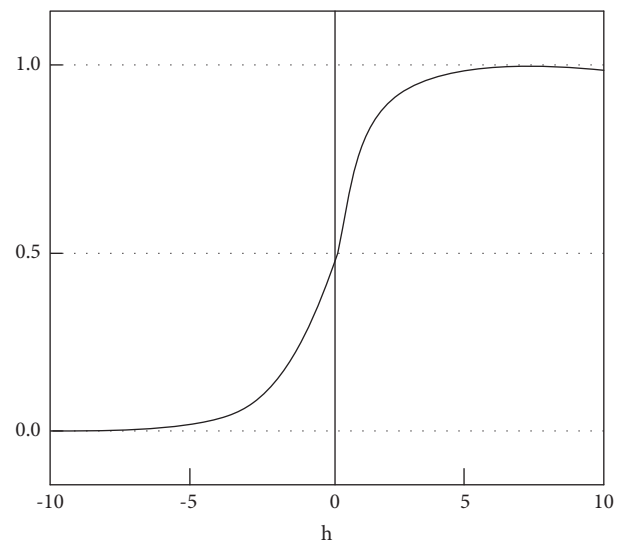

Figure 2: Sigmoid function.

(2) Decision Tree

(a) Decision tree-related concepts

Choice tree is a tree structure: a trait tree is built from the properties of each example in the preparation set. It is built start to finish. The leaf hubs of the tree are the classes utilized for characterization, the nonleaf hubs are feature ascribes, and the parts of the tree are choice circumstances. Decision tree is a graphical strategy, which is a somewhat instinctive characterization and relapse technique [18]. The classification decision tree model classifies the instances in a descriptive way, which is represented as a tree structure diagram. It can be seen from Figure 3 that what this decision tree does is to decide whether to meet the blind date. At each node, classification is done by a feature. Judging by age first, one category is less than or equal to 30, another category is greater than 30, and then the category less than or equal to 30 is classified according to the appearance. A complete decision tree is constructed until it is finally indivisible.

Determining branching criteria is undoubtedly the top priority in the decision tree grouping process. A complete decision tree model must determine the branching criteria. There are many types of branching criteria, and the information entropy gain method is a more commonly used one. According to the definition of physics [19], there are various energies in the surrounding space. And, entropy represents their distribution in space. The size of the entropy value is proportional to the uniformity of the energy distribution. A system reaches the highest entropy value when its energy system is uniformly distributed. Formula (4) is the calculation formula of entropy:

$$S(R_u) = -\log_2 q(R_u). \tag{4}$$

Information entropy can be understood as a mathematical expectation, which represents the mean value of the uncertain probability before the information is sent by the information source, which represents the expectation and is defined as a priori entropy:

$$Ent(R) = -\sum Q(R_u)\log_2 q(R_u). \tag{5}$$

If the probability distribution of the known signal R is Q(R) and the received signal, $J = j_v$, the probability distribution of the signal is $Q(R|j_v)$. From this,

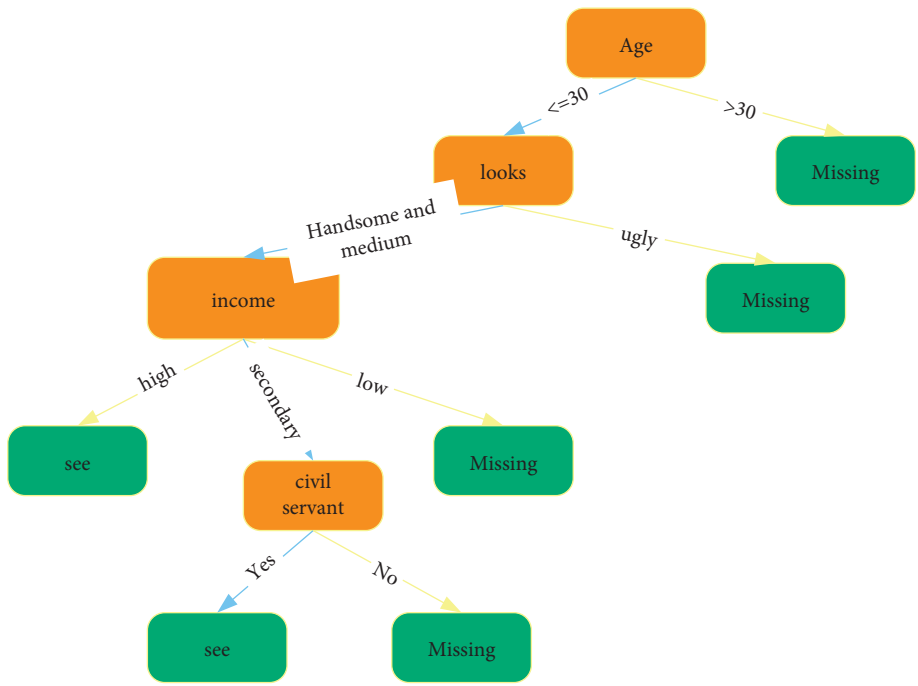

Figure 3: Decision tree model.

the mean value of the uncertainty probability of the signal source is obtained:

$$Ent\left(R \mid j_v\right)\log_2\frac{1}{q\left(r_u \mid j_v\right)} = \sum Q\left(r_u \mid j_v\right)\log_2\, q\left(r_u \mid j_v\right). \tag{6}$$

This formula is called a posteriori entropy, and it expresses the mean value of the uncertainty probability of the signal U after the signal v has been received. Since the signal v is a random variable, the resulting expected posterior entropy is

$$\mathrm{Ent}\left(R \mid J\right) = \sum_v Q\left(j_v\right)\sum_v q\left(r_u \mid j_v\right)\log_2\, q\left(r_u \mid j_v\right). \tag{7}$$

The size of the degree to which information eliminates random uncertainty is measured by the information gain:

$$\mathrm{Gains}\left(R, J\right) = \mathrm{Ent}\left(R\right) - \mathrm{Ent}\left(R \mid J\right). \tag{8}$$

In addition, common classification criteria are information gain:

$$\mathrm{Gains}\left(R, J\right) = \frac{\mathrm{Gains}\left(R, J\right)}{\mathrm{Ent}\left(J\right)}. \tag{9}$$

The Gini index is calculated as follows:

$$\mathrm{Gin}\left(P\right) = 1 - \sum_u^n q_u^2. \tag{10}$$

The upside of the choice tree calculation is that it can give clear choice rules and can be changed into a progression of if else rationale that is simple for people to comprehend. The drawback is that it can make decisions in view of the connection between a solitary trait and the forecast target. At the point when there are mind boggling connections between certain qualities, it is frequently challenging to precisely display the forecast target. Furthermore, it is not difficult to create overfitting, which is additionally a significant imperfection of this calculation.

(b) A typical decision tree algorithm—ID3 algorithm

The decision tree is derived from ID3 calculation, the optimal feature center is obtained through the calculation of information entropy, and then a differential decision tree is constructed [20].

ID3 calculation is the center calculation of choice tree. In the event that a likelihood circulation $(K_1, K_2, \cdots K_n)$ is given, how much data conveyed by that appropriation is known as the entropy of the likelihood dispersion. The complete entropy of the framework is

$$I\left(K_1, K_2, \cdots, K_n\right) = -\sum_{i=1}^n K_i \log_2 K_i. \tag{11}$$

Given a preparation set Q, the quantity of test focuses is indicated as $|Q|$. In the event that there are t various classes $B_i\,(i = 1, 2, \cdots, k)$, the example point in class B_i is $|Q_i|$. Utilizing $|Q_i|/Q$ to appraise the likelihood that any example has a place with B_i, then

$$I\left(\frac{\left|Q_1\right|}{Q}, \frac{\left|Q_2\right|}{Q}, \cdots, \frac{\left|Q_k\right|}{Q}\right) - \sum_{i=1}^k \frac{\left|Q_i\right|}{Q}\log_2\frac{\left|Q_i\right|}{Q}. \tag{12}$$

The entropy (anticipated data) of the subset separated by C is

$$E(C) = \sum_{i=1}^{k} \frac{|Q_{ij}| + |Q_{2j}| + \ldots + |Q_{kj}|}{|Q|} I\left(|Q_{1j}|, |Q_{2j}|, \ldots, |Q_{kj}|\right). \tag{13}$$

For a given subset D_j, the data entropy is

$$I\left(|Q_{1j}|, |Q_{2j}|, \ldots, |Q_{kj}|\right) = -\sum_{i=1}^{k} K_{ij} \log_2 K_{ij}. \tag{14}$$

Among them, $K_{ij} = |Q_{ij}|/Q$ is the likelihood that an example in Q_j has a place with A_i. The data gain of the entropy branch in property C is

$$\mathrm{IG}(C) = I\left(\frac{|Q_1|}{Q}, \frac{|Q_2|}{Q}, \ldots \frac{|Q_k|}{Q}\right) - E(C). \tag{15}$$

IG(C) is determined for each trait C while making a choice tree. The biggest is utilized as the test property of the preparation set Q. The fundamental issue of acquiring affiliation rules is the colossal measure of information to be investigated, so working on the proficiency of the algorithm is the most significant. If by some stroke of good luck one affiliation rule calculation is utilized and there are numerous information to be investigated, the execution season of the calculation will turn out to be extremely lengthy [21].

(c) Analysis of choice tree C4.5 calculation

The pruning strategy embraced by the C4.5 calculation in this assessment is skeptical stumble pruning. The C4.5 calculation apply to the following formula. A gauge of the misclassification rate is

$$G(t) = \frac{q(t)}{V(t)}. \tag{16}$$

The progression adjusted mistake rate is

$$G'(t) = \frac{q(t) + (1/2)}{V(t)}. \tag{17}$$

The misclassification rate of subtree T_t is

$$G(T_t) = \frac{\sum q(i)}{\sum V(i)}. \tag{18}$$

Among them, I takes each of the leaves of the subtree. The refreshed misclassification rate is then

$$G'(T_t) = \frac{\sum (q(i) + (1/2))}{\sum V(i)}. \tag{19}$$

Then,

$$G'(T_t) = \frac{\sum \left(q(i) + \left(V_{T_i}/2\right)\right)}{\sum V(i)}. \tag{20}$$

The standard deviation is determined as follows:

$$SE[u'(T_i)] = \sqrt{\frac{u'(T_t) * (V(t) - u'(T_i))}{V(t)}}. \tag{21}$$

Among them, for the node, there are

$$u'(t) = q(t) + \frac{1}{2}. \tag{22}$$

And, for subtrees, it has

$$u'(T_t) = \sum q(i) + \frac{V_{T_t}}{2}. \tag{23}$$

Consequently, in the event that the quantity of misclassifications in the wake of remedying levels is more noteworthy than the quantity of misclassifications subsequent to rectifying hubs, a strategy for it is proposed to prune levels. The benefit of this strategy is that a similar preparation set is utilized for tree development and pruning, and it is quick, requiring just a single output of every hub [22].

3.2. A Credit Risk Control Model Based on Operator Big Data

3.2.1. The Meaning of Credit Risk. Acknowledge risk, otherwise called default risk, alludes to the vulnerability of the wellbeing component of bank credit reserves. That is, the recipient cannot fulfill the commitment of reimbursing the head and premium, so the normal pay of the bank goes astray from the genuine pace of return. It is the principal kind of monetary gamble [23].

Credit risk arises for two reasons: macroeconomic activity and unique occasions that affect organizational activities. In this paper, it only analyzes the company's default risk through the company's financial statements and does not analyze the macro economy.

3.2.2. Characteristics of Credit Risk. The widespread existence of credit risk is an important factor in the current market economy. In this way, the purpose of assessing and monitoring credit risk is to grasp the quality of credit risk (Figure 4). The characteristics of credit risk are as follows: (1) asymmetry: the vacillation of market cost is fixated on its normal worth, for the most part focused on the two sides close to the mean worth. It tends to be approximated that the circulation of market risk pay is even, and essentially it very well may be utilized; (2) transitivity: credit risk is transitive, which leads to the accumulation of credit risk rather than zero-sum, and the credit risk of one party may spread to related parties, resulting in a total credit risk exponential

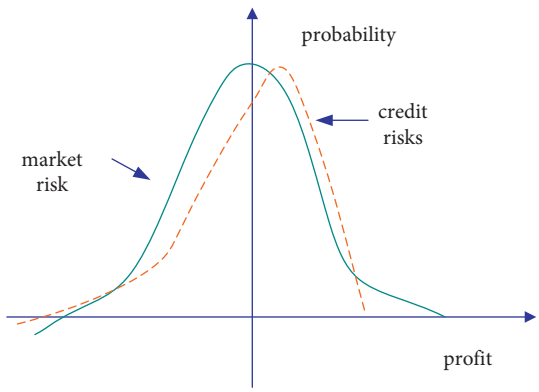

Figure 4: Credit risk distribution.

growth; (3) credit paradox phenomenon: in theory, when banks manage credit risk, they should use the idea of portfolio management to diversify and diversify investment, which is conducive to eliminating correlation and preventing credit risk concentration; (4) unsystematic: the risk management principle of diversifying and dispersing unsystematic risks is more suitable for credit risk management; (5) it is hard to gauge credit risk, and quantitative examination of credit risk is somewhat troublesome. The fundamental explanation is that perception data is scant and challenging to acquire.

It can be seen from Figure 4 that the distribution of credit risk is asymmetric, one end of the income distribution curve slopes to the lower left, and the probability density of extreme values in the loss area is larger than the corresponding normal distribution probability density curve, which is the so-called "thickness" "tail" problem. This characteristic is caused by the risk of loan default, that is, when the bank issues a loan, it is more likely to recover the loan and obtain the agreed income within the loan contract period, but once the loan violates the drug, the bank will have a relatively large risk, a loss of size (either the entire investment or most of it), which is much larger than the interest income. That is, the return on the loan is fixed and capped, and the bank cannot obtain the same proportion of the return from the business performance, that is, the expected return on the loan does not increase with the improvement of the business performance: on the contrary, the loss on the loan is variable and without a lower bound, expected losses on loans increase as business performance deteriorates.

3.2.3. Operator Credit Information System. A credit confirmation framework for administrators' extensive information includes an inspection subsystem, a rating subsystem, and a remote prepaid management subsystem. The validation subsystem recognizes client personalities and different authentication states and returns results in two configurations. The FICO assessment subsystem uses the wealth of the information provided by managers to plan a customer's credit scoring model. It also calculates the customer's credit score yield based on the model. The remote credit board subsystem processes the customer's early warning model and generates early warning data, as shown in Figure 5 [24].

A major information framework involves three issues: huge information storage, huge information censorship, and huge information management.

3.2.4. Credit Rating Model. The administrator's information mainly includes basic customer data, communication behavior, Internet behavior, customer assistance in appealing behavior, administrative use behavior, and different information, as shown in Figure 6.

Relational organizational information describes a customer's communication circle, texting friend network, and other relational connections. Conduct trademark information describes how customers communicate, the Internet, and behave differently. The credit risk evaluation issue is likewise a grouping issue. It is given a client record of loan repayment data set and expects to get familiar with an ideal capacity speculation. This capacity can fit the given preparation tests well and has the best speculation capacity. This issue is by and large the thing artificial intelligence is attempting to tackle. Artificial intelligent calculations have a decent capacity to manage nonlinear arrangement issues. The credit risk appraisal model in light of artificial intelligence can essentially work on the precision and versatility of credit risk evaluation. The data mining flow chart is shown in Figure 7.

4. Experiment of Enterprise Financial Risk Management System Based on Machine Learning Algorithm

With the advent of the era of big data, the aspects of identifying risks, managing risks, and evaluating risks in enterprise financial risk management need to keep pace with the time. Under the background, both the management and the executive layer need to strengthen risk awareness and use big data to improve the financial risk management capabilities of enterprises.

4.1. Debt Risk of Company A's Financial Risk Management. This paper selects company A for financial risk management assessment (data obtained from its financial statements). It compares the current ratio, quick ratio, and asset-liability ratio with the three major e-commerce companies (B, C, and D). Through the analysis of these 3 indicators, it aims to find out whether company A has certain solvency. Details are shown in Table 1.

In light of everything, the ongoing proportion (current assets/current liabilities) is 2 : 1, and the speedy proportion (fast assets/current liabilities) is 1 : 1. Expecting it falls underneath this worth, this demonstrates that the business needs liquidity of assets, lacks temporary solubility, and it is prone to bankruptcy, financial distress, and credit risk. From Tables 1 and 2, it can be seen that, during the period from 2013 to 2017, only the quick ratio in 2014 was above 1. The other 4-year quick ratios are all less than 1, and the current ratio is generally low. But for e-commerce companies, A's

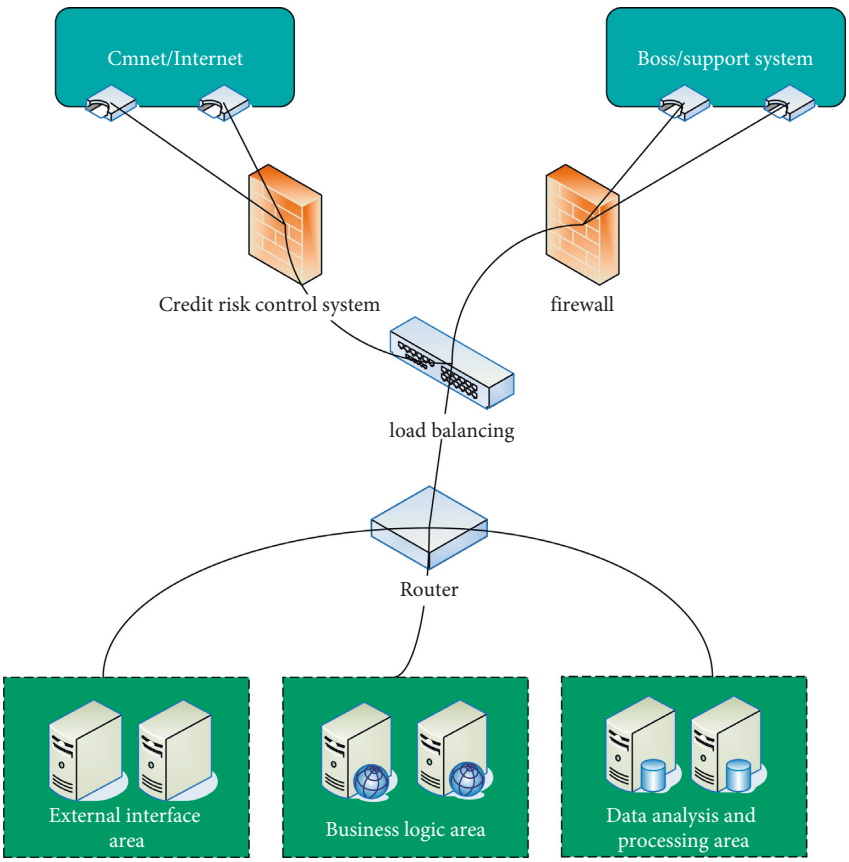

Figure 5: Deployment diagram of credit risk control system.

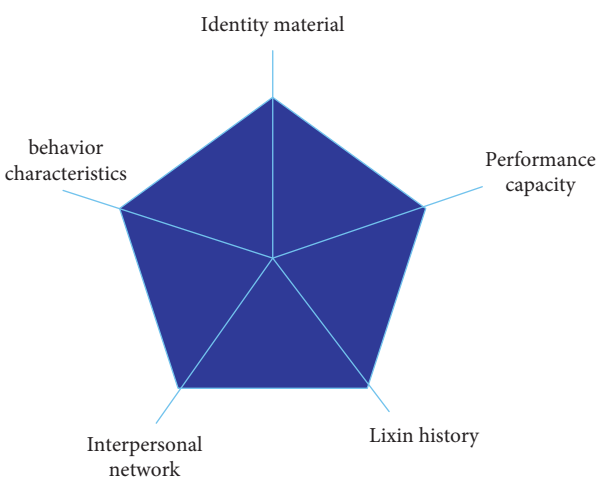

Figure 6: Dimensional classification of credit risk control models.

Figure 7: Data mining flowchart.

quick ratio and current ratio closely follow that of industry leader B, which is middle and upper in the industry. Because B is different from A in that it only provides a trading platform, so there is no need to worry about inventory issues. However, part of A's business is self-operated and requires a certain amount of warehousing and logistics costs.

It very well may be seen from Table 3 that the resource responsibility proportion is a critical marker to gauge the level of big business risk. In light of the resource risk proportion, the resource responsibility proportion of A is not hopeful in the business, and the value fluctuates between 40% and 75%. The asset-liability ratios of companies B, C, and D are far higher than those of A. It can be seen that the development trend of A's capital structure is not optimistic, with large fluctuations and certain debt risks.

Table 1: Current ratios of major e-commerce players.

Company	2013	2014	2015	2016	2017
A	1.33	1.70	1.22	1.01	0.98
B	1.81	3.60	2.56	1.94	1.94
C	1.06	2.10	1.25	0.88	1.05
D	1.24	1.31	1.02	1.06	1.37

Table 2: Quick ratios of major e-commerce players.

Company	2013	2014	2015	2016	2017
A	0.98	1.32	0.78	0.72	0.60
B	1.82	1.76	1.54	1.62	1.80
C	0.77	0.84	0.79	0.80	0.78
D	0.92	0.96	0.64	0.68	0.98

Table 3: Asset-liability ratios of major e-commerce companies.

Company	2013	2014	2015	2016	2017
A	0.66	0.43	0.65	0.77	0.75
B	0.85	0.64	0.80	0.88	0.69
C	0.77	0.82	0.82	0.79	0.81
D	0.79	0.86	0.79	0.79	0.64

4.2. Operational Risks of Company A's Financial Risk Management. By looking at the stock turnover proportions of the four significant Internet business organizations in Figure 8(a), it tends to be seen that the stock administration level of A in the beginning phase is top notch among online business organizations, far higher than that of web-based business organizations like B, C, and D. Be that as it may, A in the period of large information actually has some opportunity to get better in the computerized administration of stock. The return rate is a vital component influencing the resource of the executives of online business activities for Internet shopping. Since the return will unavoidably build the expense of the venture, these expenses include labor and material assets. Better yield rates additionally adversely affect the standing of the business and loss of clients, which thus adversely affects the presentation of business tasks.

From Figure 8(b), it can be seen that the overall trend of the accounts receivable turnover rate of e-commerce enterprises is decreasing year-by-year. A is in line with the industry trend, the realization of accounts receivable is slow, and the efficiency of operation management is not high. This reflects weakness in its core business. For e-commerce companies, working capital and inventory management capabilities are the focus of management. A has problems such as lax control over the management of funds, which indirectly indicates that it has certain operational risks.

From the perspective of earnings per share indicators, the earnings per share of A in the past five years have all been less than 0, which is the worst compared to the four selected e-commerce companies. According to the viewpoint of net resources per share, A's presentation is not hopeful. As should be visible from Figure 9, C's net resources per share are at a moderately significant level in the Internet business industry, a long way in front of different organizations. A's net resources per share are in the center and lower spans of the business, it shows that its profit creation ability is not high, and its defense ability is poor when external factors affect the operation of the enterprise, and there are sure dangers.

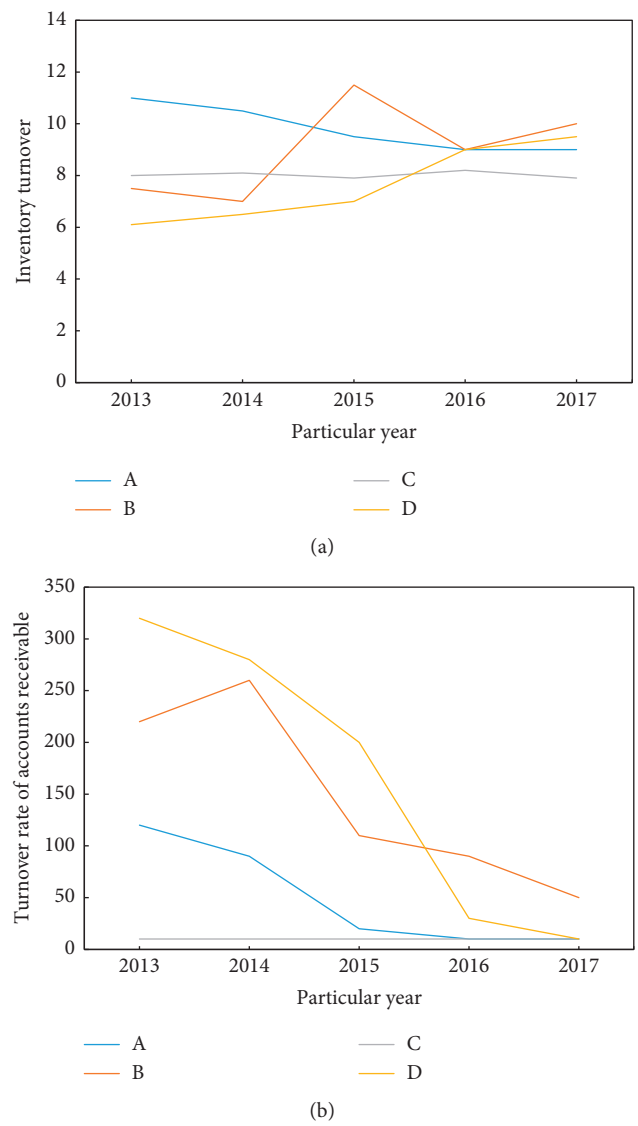

Figure 8: Comparison of inventory turnover ratio and accounts receivable turnover ratio with A in the same industry. (a) Comparison of inventory turnover ratio between A and the same industry. (b) Comparison of accounts receivable turnover ratio between A and the same industry.

Financial risk analysis summary, A is still in a state of loss in recent years. There are sure obligation gambles, functional dangers, and capital dangers. In the period of enormous information, the monetary gamble circumstance looked by A is not simply connected with A's own expense model, item structure, and monetary gamble the board framework, yet in addition to the effect of the outer climate. As of now, A has acquainted large information innovation with oversee corporate monetary dangers; however, the time is short and should be additionally moved along.

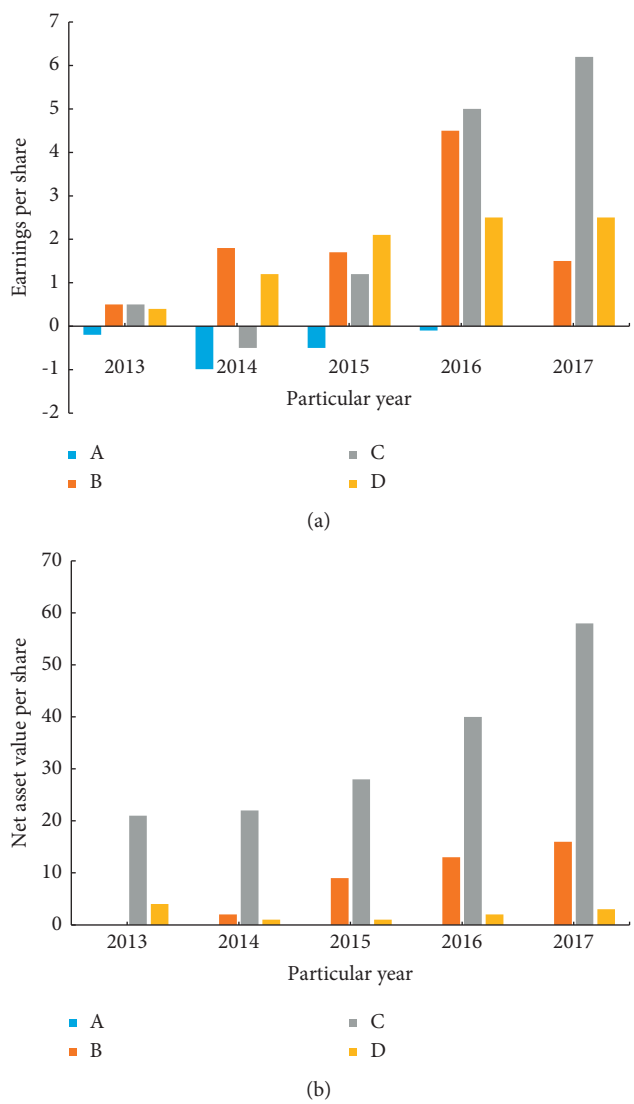

Figure 9: Comparison of industry earnings per share and net assets per share with A. (a) Comparison of earnings per share with peers. (b) Comparison of net assets per share with peers.

4.3. Financial Risk Early Warning Based on Big Data Platform. With the advent of the era of big data, the aspects of identifying risks, managing risks, and evaluating risks in enterprise financial risk management need to keep pace with the times. Under the background, both the management and the executive layer need to strengthen risk awareness and use big data to improve the financial risk management capabilities of enterprises.

On one hand, the big data platform can provide early warning of enterprise financial risks based on the financial early warning model, and on the other hand, it can also analyze some related risks.

For common financial risks of enterprises, the purpose of early warning can be achieved by establishing an early warning model as shown in Table 4 and using the data support provided by the big data platform.

The data support for early warning analysis of business risk indicators mainly includes market data, partner data, supplier data, and other external enterprise data and internal financial data, asset data, revenue data, transaction data, channel data, merchant data, and user data. The data support for the early warning analysis of capital risk indicators mainly includes the financial data, asset data, inventory turnover data, commodity data, and transaction data of the enterprise. The data support for the early warning analysis of debt risk indicators mainly includes data such as short-term loans (banks or individuals), bills payable, and special payables within the enterprise. The data support for the analysis of early warning indicators of fundraising investment projects mainly includes market data, partner data, investment project management data, and financial data.

5. Discussion

Financial risk analysis based on big data platform mainly includes the following aspects:

(1) Risk monitoring report/information disclosure

Risk monitoring report includes liquidity report, interest rate sensitivity report, and capital adequacy ratio report. Through the analysis of these reports, enterprises can better monitor the existence of risks and whether there are perfect measures to deal with the occurrence of risks. Big data can help enterprises in data acquisition and analysis and timely propose countermeasures through financial risk analysis.

(2) Market risk

The competition of e-commerce enterprises is very fierce, and there are a lot of market risks. Analysis of market risk based on big data technology can find out its market risk exposure value, liquidity management, and interest rate management. It enables enterprises to avoid some market risks in time and develop more healthily.

(3) Credit risk

Using big data technology can calculate the credit risk exposure value of enterprises, which cannot be done by traditional financial risk analysis. The calculation of this value can help enterprises to better control credit risks, including preloan control, inloan monitoring, and postloan analysis. It reduces the credit risk of the enterprise to a certain extent.

(4) Antifraud/antimoney laundering

Unlike traditional financial risk analysis, big data can unearth a large amount of financial data. This data can help companies define fraudulent transaction models and enable companies to establish early warnings of possible fraudulent transactions. In addition, the application of big data technology can also help companies analyze the distribution of fraudulent transactions, so that companies can improve their awareness of prevention in these areas and reduce their financial risks.

Table 4: Financial indicator requirements in the enterprise financial risk early warning model.

Classification	Alert category	Indicator name	Early warning area
Quantitative index	Operational risk early warning indicators	Profit margin of main business	Profit margin of main business income ≤5%
		Proportion of operating profit	Proportion of operating profit ≤50%
		Growth rate of main business income and	Main business income growth rate ≤30%
		Comparative analysis of growth rate of accounts receivable	Growth rate of main business income ≤0
		Turnover rate of accounts receivable	Growth rate of accounts receivable-growth rate of main business income ≥20%
		Return on net assets	Accounts receivable turnover rate ≤50% of the industry level
		Analysis of cash flow structure	Return on net assets ≤0
	Early warning index of capital risk	Asset liability ratio	Asset liability ratio ≥85%
		Current ratio	Current ratio ≤125%
		Quick ratio	Quick ratio ≤25%
		Inventory turnover	Inventory turnover times ≤50% of the industry level
	Debt risk early warning index	Profit cash ratio	Profit cash ratio ≤1
		Mandatory cash payment ratio	Mandatory cash payment ratio ≤1
		Current ratio	Current ratio ≤1.3
		Quick ratio	Quick ratio ≤L
		Asset liability ratio	Asset liability ratio ≥70%
		Interest earned multiple	Interest earned times $Q < 3.00$
	Early warning indicators of related party occupancy risk	Occupancy rate of asset related parties	Occupancy rate of related parties ≥5% (excluding current assets)
			Occupancy rate of asset related parties ≥40% (receivables are divisor)
		Income (cost) ratio of related businesses	Related business income (cost) Ratio ≥70%
	Early warning indicators of fundraising investment projects	Input output ratio	Input output ratio ≤ bank deposit interest rate level in the same period
		Completion rate of project investment schedule	Completion rate of project investment schedule ≤50%
	Early warning indicators of foreign investment risk	Long-term equity investment ratio	Long-term equity investment ratio ≥50%
		Return on investment	Return on investment ≤ return on net assets
Qualitative index		Major commitments	Failure to fulfill commitments
		Equity change	Changes in major shareholders and controlling shareholders
		Management changes	Suspected of corruption, fraud, smuggling, and other economic crimes; frequent changes
		Change of accounting firm	The reasons for the change are not disclosed in detail
		Mortgage guarantee matters	Guarantee for shareholders, no counterguarantee and other preventive measures
		Policy	Reform policies in finance and tax system

(5) Operational risk

Operational risk is the risk caused to the enterprise due to the operation error or intentional destruction of the financial staff of the enterprise. The use of big data technology can enhance the early warning mechanism of abnormal transactions, achieve post-supervision error inspection, strengthen the defense line of risk control, and ensure the normal operation of e-commerce enterprises.

6. Conclusions

It is common for companies to fall into financial distress due to poor financial risk management. Effectively managing and controlling financial risks can improve the efficiency of capital operations and the quality of management decisions. It is a powerful guarantee for the development of enterprises, especially in the face of the fierce competition of e-commerce enterprises. Through the analysis of the case of company A, it can be seen that the management of company A has a strong sense of risk. The annual report identified some potential risks, but detailed analysis also revealed flaws in financial risk management. Although company A has begun to use big data to manage and control financial risks, there is still discussion on how to use big data to improve the company's financial risk management.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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Research Article

Wisdom Homestay Tourism Recommendation Platform and Marketing Strategy Based on Multi-Information Fusion Sensor Network

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At present, China's tourism market is huge, and traditional hotel accommodation is not popular with young people, and homestays are just in line with young people's yearning. And most of the current push methods are determined by consumption on large platforms such as Ctrip, which not conforms to the recommendation method of homestays, so it aims at personalized marketing research for homestays. In this paper, the multi-information fusion sensor network is used to push B&B hotels in tourist areas to achieve B&B hotel marketing and maximize profits. Using the multi-information fusion sensor network to carry out personalized platform design, platform users can easily and quickly search for the homestay they want and can realize the automatic push function to achieve the rationality of marketing. The experimental results in this paper found that the average relative speedup increased from 1.9 to 17.7 for the execution of the scoring-oriented algorithm in the algorithm compared to a single computer. Performing the sort-oriented algorithm in the algorithm, the average relative speedup increased from 1.9 to 18.8. It can illustrate the effectiveness of the design system in this paper, and the software can carry out personalized marketing for homestays.

1. Introduction

In the current background, the country house industry is developing and growing, by reconfiguring the common houses in the rural social ecology. Reconstructing traditional culture with new life and new living thinking and creating building spaces and communities with multiple functions such as accommodation, entertainment, and leisure have become an important pawn in rural revitalization. The current level of informatization of the recommendation platform of the homestay industry is backward, resulting in a low accuracy rate of platform recommendation, resulting in insufficient user satisfaction.

Based on the experience of homestay consumption, this paper analyzes the development orientation, operation mode, implementation of differentiated strategies, consumption evaluation of homestays, and discusses and analyzes the problems faced in the operation process. Through the horizontal and vertical concept comparison with many homestays at home and abroad, and large-scale experiential

evaluation interviews and questionnaire analysis of consumer groups, the relevant factors affecting the homestay consumption experience are sorted out and summarized, so that homestay consumption can be rationally positioned. It provides theoretical and practical support for the improvement of the marketing strategy and operation mode of the homestay and provides a rational reference for the settlement of Ge Xianshan to other operating entities.

The main innovations of this paper are as follows: this paper proposes a multi-information fusion algorithm. The algorithm uses a single score to improve the accuracy of the recommendation. First, the unevaluated scores in a single score are estimated, and then they are converted into double scores as additional data for training and prediction. It is proved by experiments that the efficiency and accuracy are significantly improved.

2. Related Work

Information fusion technology is put forward in recent years when there is only one calculation method for various data calculations that is difficult and easy to solve, and there are many researches on it. Li et al. proposed a clustering integration algorithm based on evidence theory for the fusion process. The advantage of this algorithm was that the cluster structure information around an object was considered and its neighbors were used to describe it [1]. Miao et al. presented a new method to extract urban roads from very high resolution (VHR) optical satellite images using information-level fusion [2]. Prasath believed that digital image denoising schemes based on anisotropic partial differential equations (PDEs) were rapidly becoming an indispensable tool in computer vision problems. He proposed a fusion method for denoising images through this multiscale anisotropic diffusion [3]. This paper is based on the research of multi-information fusion sensor network, which will help the homestay tourism recommendation platform to move towards intelligence and informatization, so as to better complete the construction of related projects and lead the orderly and healthy development of the homestay tourism industry.

Homestays firstly emerged in European and American countries, mainly represented by British B&B. After that, most countries also use B&B to represent homestays, but due to cultural differences, some countries also used HomeStay, FamilyHotel, and other names to express homestays. Hong and Jung gave a multicriteria tensor model combining spatiotemporal information. The auxiliary information was classified by several features and applied to the model, so that the homestay could be recommended by combining various information [4]. Jain et al. held the opinion that there was a wealth of data related to consumer sentiment on online platforms, which may provide insight into how consumers provide feedback and how to use this feedback to predict recommendations using machine learning techniques. He designed a predictive recommendation method for predicting consumer recommendations in travel and tourism, especially in the case of airlines [5]. Wang aimed to establish an idea and framework for enhancing customer stickiness and improving the conversion efficiency of travel products from online to offline platforms through the application of personalized recommendation technology [6]. Through relevant research, it can be found that the performance of homestays is more related to the local economy and it is rarely involved in the development of the homestay industry. Therefore, for this reason, the research on the personalized recommendation system in this paper is necessary.

3. Multi-Information Fusion and Marketing Strategy

3.1. Homestay Tourism Marketing Strategy. The vigorous development of the tourism industry has brought the homestay tourism market into a new era of smart tourism, which has prompted the homestay tourism market to transform from a small industry to a large industry and from a traditional industry to a modern intelligent industry. The marketing of the homestay needs the help of social marketing. Social marketing aims to promote social change and development, and its specific content contains social concepts. And because of different forms and purposes, social marketing activities are divided into four stages, as shown in Figure 1 [7, 8].

3.1.1. Stages of Cognitive Change. Cognitive change is often seen as the initial stage of audience behavior change and it is also the most important stage. At this stage, social marketing activities are generally reflected in the popularization of new ideas, related knowledge education, the display of results of similar behaviors, and so on [9].

3.1.2. Stages of Behavior Change. The biggest difference between behavioral change and cognitive change is that the target audience needs to pay less to change their perceptions, so it is easier to achieve results. And its behavior change may need to pay a certain degree of economic cost, commuting cost, and time cost. It determines that the difficulty of behavioral change is much higher than that of simple cognitive change, and the implementation resistance of social marketing at this stage is relatively large. In order to promote short-term behavioral changes of target audiences, social marketing theory proposes that benefit compensation measures should be provided for target audiences. However, excessive use of coercive policies should also be avoided, so that the target audience makes behavioral changes voluntarily rather than coercively [10].

3.1.3. Stages of Habit Change. In marketing theory, behavior change refers to a relatively short-term behavior, while habit refers to a long-term fixed behavior. It means that the main goal of social marketing at this stage is to make the target audience maintain the behavior change method of the previous stage through corresponding means, and finally form a good behavioral habit. Among the four stages targeted by social marketing, the habit change stage is often regarded as the most difficult implementation stage, which

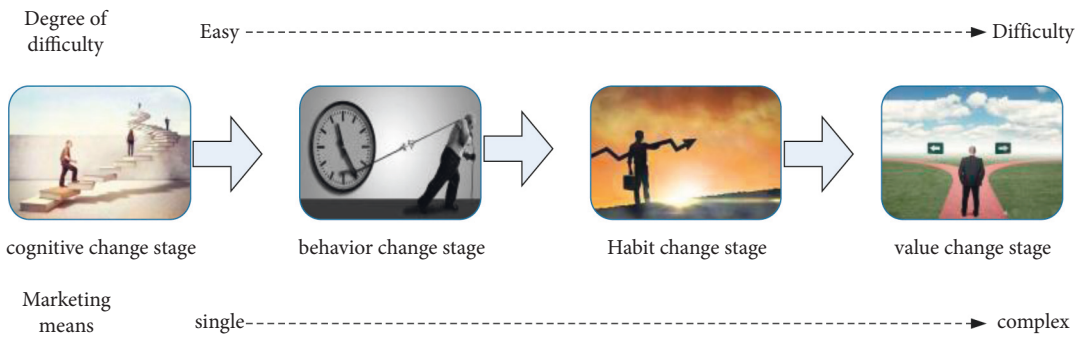

Figure 1: Social marketing activities.

not only requires the long-term investment of the marketing subject, but also puts forward higher requirements for the target audience. Behavior can be changed through some economic incentives, especially in rural societies. However, the change of habits may conflict with the folk customs that have persisted for thousands of years in the countryside. For this reason, social marketing applications in China, such as ecological environmental protection, community tobacco control, and other social movements have stagnated at this stage [11].

3.1.4. Stage of Value Change. Changes in values generally occur at the same time as the formation of habits. When social marketing promotes changes in the daily habits of target audiences, their values often change accordingly. Once the values of the target audience are changed again, their corresponding behaviors will not deviate from the established goals of social marketing even without corresponding strategic incentives. The main strategies that social marketing applies to this stage tend to be similar to those applied to the habit change stage. When the value of the target audience changes, it also means that the social interest goal pursued by social marketing is also achieved, that is, a certain social concept is truly accepted by the target audience [12].

Social marketing theory proposes a set of effective application tools to promote behavior change, as shown in Table 1.

The theoretical tools of social marketing are composed of five indicators: incentives, communication, norms, commitment, and convenience.

Table 1: Social marketing theoretical tools.

Theoretical tools	English abbreviation
Incentives	IS
Communication	CU
Norms	NS
Commitment	CT
Convenience	CE

3.2. Multisensor Information Fusion

3.2.1. Information Fusion Method. Compared with using a single sensor to collect data, multisensor information fusion data applies data from different sensors and other external information, which greatly reduces the randomness of the data, In this study, multiple sensor modules of the same type work synchronously, thereby constructing a multi-information fusion sensor network. Among them, the data output by the sensing modules will be input to the data fusion center at the same time, and the sensing modules are independent of each other and will not affect each other, thereby greatly improving the fault tolerance rate of the system. When a certain sensor data is abnormal, the multisensor fusion technology greatly reduces the overall performance impact of the system caused by the abnormal situation by reducing the weight of this data application. It is precisely because of this feature that multisensor information fusion has become a hot research topic at home and abroad, and the research has developed rapidly and has a mature system. Sensor fusion is generally divided into different fusion levels, namely data layer fusion, feature layer fusion, and decision layer fusion [13, 14].

Data Layer Fusion: direct fusion of raw sensor data. The input of the system is various types of sensor data, and different types of data are fused to extract more detailed information. The advantages of data layer fusion are strong versatility and high theoretical maturity. The disadvantages are large computational burden and poor real-time performance. The instability and uncertainty of the sensor data itself make the fault tolerance rate not very high. The block diagram of data layer fusion is shown in Figure 2(a).

Feature Layer Fusion is feature information fusion after analyzing and processing raw sensor information [15]. Compared with data layer fusion, some detailed information is discarded and relatively important information is retained to provide support for later decision-making and judgment. The advantage of feature layer fusion is that after feature extraction, the amount of data processing is reduced, thereby improving the real-time performance of system decision-making. The block diagram of feature layer fusion is shown in Figure 2(b).

Decision layer fusion: the decision layer fusion is based on preset strategies such as weights, products, and summations, so that the feature information of each modality can be kept intact. The main methods include AND-OR method, weighted majority voting method, Bayesian decision fusion method, and behavioral knowledge space method.

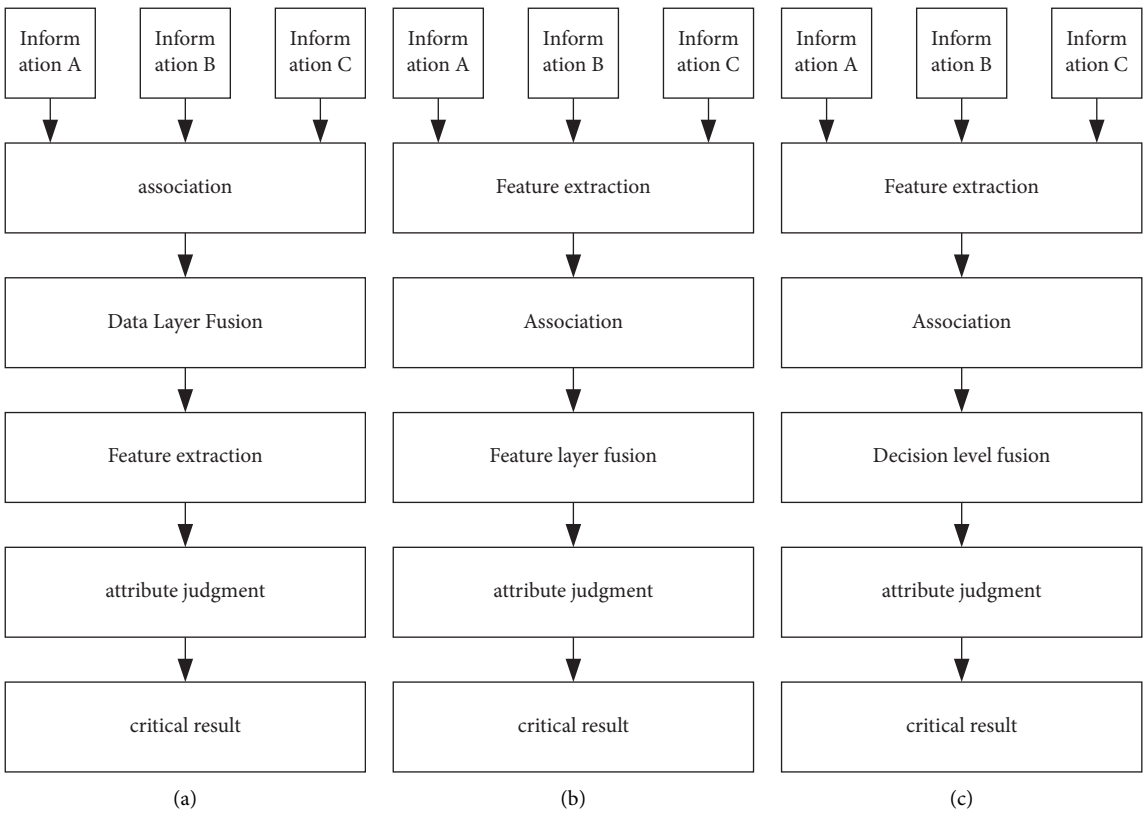

Figure 2: Multisensor information fusion. (a) Data layer fusion. (b) Feature layer fusion. (c) Decision layer fusion.

The three different levels of information fusion, data layer fusion, feature layer fusion, and decision layer fusion, have their own application backgrounds, advantages, and disadvantages. But no matter what level of information fusion, it is necessary to associate relevant information. In theory, data layer fusion provides more fine-grained information for final result determination by retaining a large amount of original data. As a result, the judgment of data layer fusion results has higher accuracy. The decision-making level fusion is less dependent on sensors, that is, sensor anomalies and other disturbances have less impact on it. Therefore, decision-level fusion has greater flexibility, stronger antijamming capability, and higher system fault tolerance [16].

3.2.2. The Structure of Information Fusion. The series structure means that the information of two sensors is fused once, and then the fusion result is fused with the information of the next sensor, and so on, until all sensor information is fused, as shown in Figure 3(a). The parallel structure fuses information only after receiving information from all sensors, as shown in Figure 3(b) [17, 18].

In the figure, C represents a single sensor, Y represents the fusion center, and S represents the fusion result.

3.2.3. Information Fusion Method. Sensor information fusion methods can be divided into the following categories: combination, comprehensive, fusion, and related. In this method, the choice of the user's current travel demand preference is added, that is, the user can choose the importance and degree of importance to certain features. Feature selection is the process of selecting some of the most effective features from the original features to reduce the dimension of the dataset, as shown in Figure 4.

Combination: it organizes multiple sensors into a whole. Comprehensive: it combines the parts and attributes of the analyzed object or phenomenon into a unified whole. Fusion: it combines many different types of sensors into one. Related: it refers to the degree of association between two variables.

3.3. Tourism Service Composition Method Based on Multi-objective Optimization (MO). The current tourism industry is an industry of integrated service management, including catering, shopping, accommodation, entertainment, transportation, leisure, and other services. These services constitute indicators of integrated service management. Therefore, this paper only considers the three factors of time (d), cost (p), and service quality (s) when designing the objective function [19–21]. Within the constraints of time, cost, and service quality proposed by the user, a service combination scheme integrating transportation (T), accommodation (H), and catering (R) is given. In order to make the best results, a layer of refinement is given under the transportation, accommodation and catering, and several related subattributes are given, respectively, and they will be

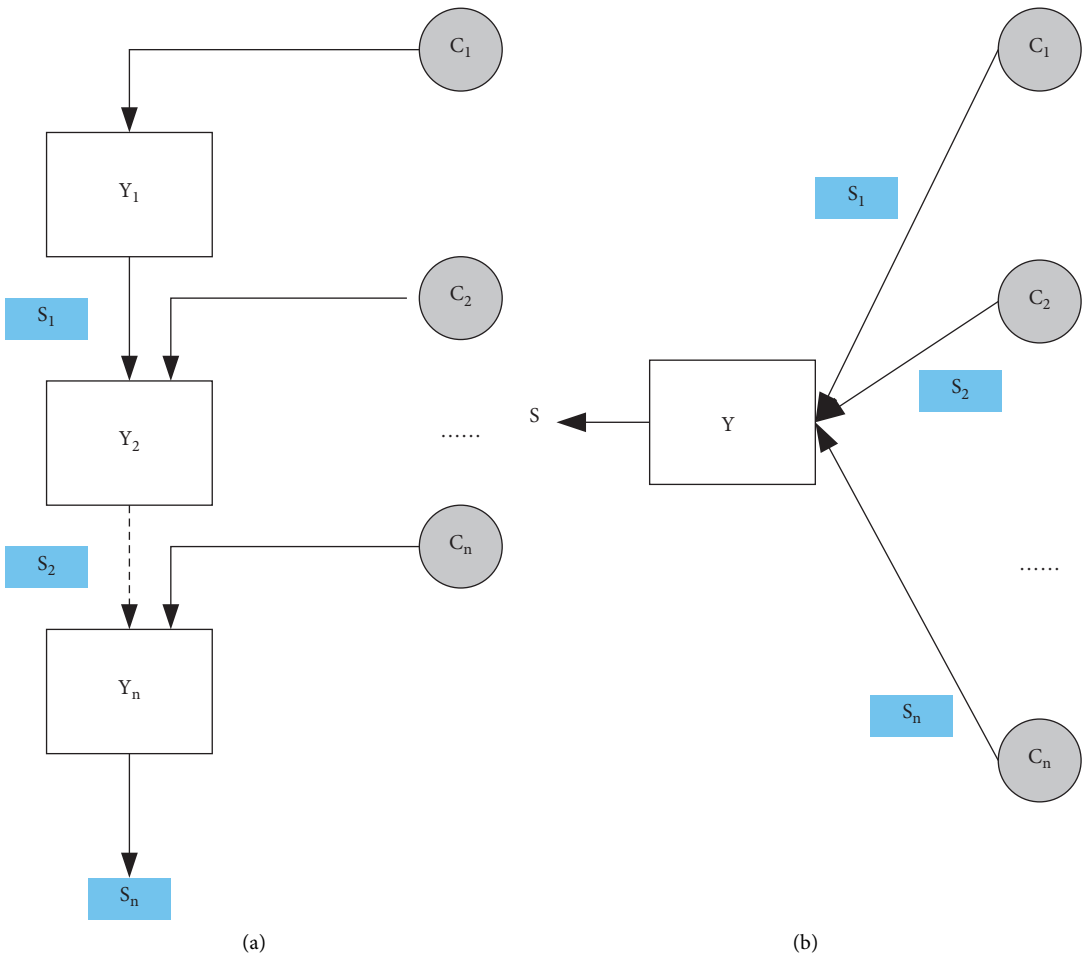

Figure 3: Information fusion structure. (a) Series structure. (b) Parallel structure.

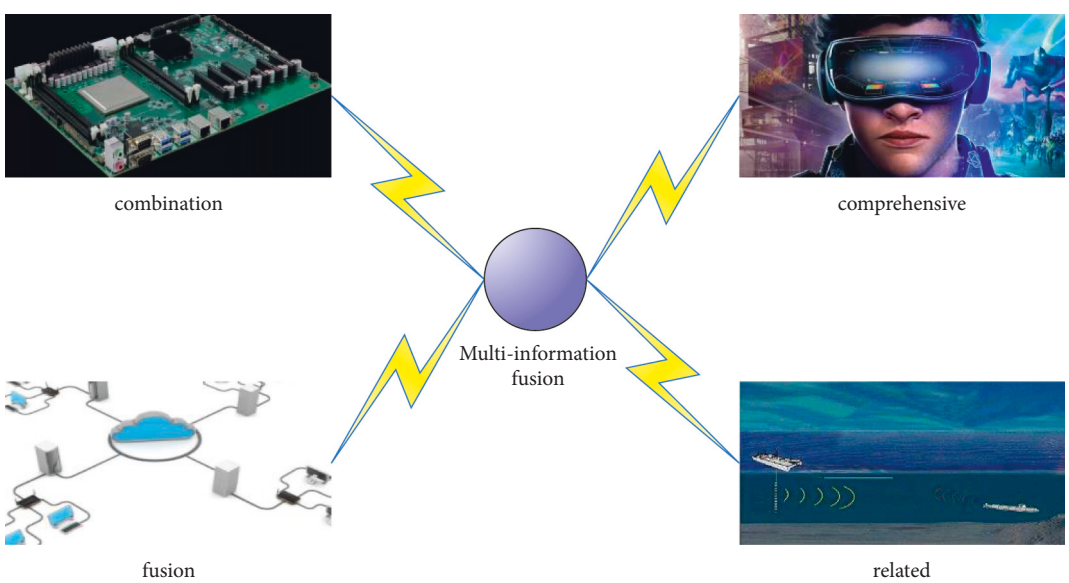

Figure 4: Sensor information fusion.

combined with the services, respectively. These properties will be more intuitively displayed through a table, as shown in Table 2.

To sum up, the optimal results that users hope to obtain are the shortest time, the lowest cost, and the best service quality. In this paper, the optimization method is used, under the constraints, some selectable variables are taken to the maximum value, so that the selected objective function can be optimal. For the sake of convenience, this paper defines a function for time d, cost p, and service quality s, respectively, as follows:

$$\begin{aligned} d &= f(x_1, x_2, \ldots, x_n), \\ p &= g(x_1, x_2, \ldots, x_n), \text{ and} \\ s &= h(x_1, x_2, \ldots, x_n). \end{aligned} \tag{1}$$

x_i ($i = 1, 2, \ldots, n$) is the parameter attribute of d, p, s. Therefore, its optimization objective is as follows:

(1) The time d is the shortest.

$$\begin{aligned} \text{Min}d &= \text{Min}(d_T + d_H + d_R), \\ d_T &= f(\text{CT}, \text{DT}), \\ d_H &= f(\text{DH}, \text{FH}, \text{LH}), \text{ and} \\ d_R &= f(\text{LR}, \text{CR}, \text{QR}). \end{aligned} \tag{2}$$

Here, d_T is the time spent by the user in transportation, d_H is the time spent by the user in accommodation, d_R is the time spent by the user in dining, and the attributes in the function f are shown in Table 2.

(2) The cost p is the lowest.

$$\begin{aligned} \text{Min}P &= \text{Min}(p_T + p_H + p_R), \\ p_T &= g(\text{CT}, \text{DT}), \\ p_H &= g(\text{DH}, \text{FH}, \text{LH}), \text{ and} \\ p_R &= g(\text{LR}, \text{CR}, \text{QR}). \end{aligned} \tag{3}$$

Here, P_T is the user's spending on transportation, P_H is the user's spending on accommodation, P_R is the user's spending on food, and the attributes in the function g are shown in Table 2.

The user's ultimate customized expression may be easily stated as a linear combination of the user's previous data and the personalized outcome achieved by the current preference decision, without losing generality. The fraction of the tailored demand produced by historical data mining in the final personalized expression varies according to differences in the user's previous data. The bigger the amount of a user's specific demands obtained through previous data mining, the more historical data a user possesses. The fraction of tailored demand determined by the current user's choice increases as the user's past data decreases.

Therefore, in this model, two variables w_d and w_c are introduced. w_d indicates the size of the weight obtained according to the historical data and w_c indicates the size of the weight obtained according to the data selected by the current user.

Table 2: Properties of the service.

Time, cost, quality of service		
Traffic (T)	Accommodation (H)	Dining (R)
Intercity transportation (CT)	Distance (DH)	Star rating (LR)
Downtown transit (DT)	Facilities (FH)	Is it clean (CR)
	Star (LH)	Food quality (QR)

The most crucial component of the algorithm is the calculation of w_d and w_c, and then the size of the weight w is calculated according to the size of the values of w_d and w_c. The value of w_c is determined by the user's current personalized needs to select a degree according to the attributes listed in Table 2, and the range is [0, 1]. According to the size of the w_d and w_c values, the calculation method of the weight w is as follows:

$$w = \alpha * w_d + (1 - \alpha) * w_c. \tag{4}$$

Here, w_d is the weight of variable d,w_c is the weight of variable c, andα represents the size of the proportion of w_d, its range is [0, 1], and its calculation method is as follows:

$$\alpha = \begin{cases} 0, 0 \le n < 3, \\ \dfrac{n}{n_{\max}}, 3 \le n < n_{\max}, \\ 1, n \ge n_{\max}, \end{cases} \tag{5}$$

where $n_{\max}$ refers to the maximum value of n.

4. Wisdom Homestay Travel Recommendation Platform

4.1. Introduction to Personalized Recommendation Algorithms. The recommendation algorithm is mainly composed of three modules: user data module, recommendation algorithm module, and recommendation result module. The system collects users' personal information data and behavior data, and after algorithm analysis, generates recommendation results and pushes them to users. A typical recommendation system architecture is shown in Figure 5.

Recommended systems analyze user preferences based on user data. Therefore, user data acquisition is the core of the system, and user data can be divided into explicit data and implicit data. Explicit data usually refers to the data that users actively submit in the system, such as personal registration information and comments submitted on the system. However, due to privacy issues, some users will provide false or incorrect information when registering personal information. In this way, the accuracy of the data will be reduced and modeling and analysis based on these data will lead to the later push effect not meeting expectations. The so-called "explicit data" is the data that can intuitively reflect the user's preference and the "implicit data" refers to the data that is not very intuitive to reflect the user's preference.

Figure 5: Basic architecture of recommendation system.

The smart homestay travel recommendation system helps to improve the accuracy of platform recommendation and improve user satisfaction. The system can quickly process complex data through multi-information fusion sensing technology and build it into an effective model. The overall construction method adopts the front-end and back-end separation mode and highly encapsulates its basic components, which can be imported by using the central library, which can reduce the bloat of the project and facilitate the strengthening of the linkage between the sensing modules. In addition, the system has strong security and protects the stability of services from multiple dimensions.

4.2. Demand for Wisdom Homestay Travel Recommendation Platform. The development of China's homestay industry has gone through a long period of time. Traditional hotels are simply unable to meet the passenger flow during peak tourist periods, especially near some well-known scenic spots, and homestays have become one of the supporting facilities for local tourist services. However, as far as the business model of the entire homestay is concerned, a completed industrial model has not yet been formed. Most of the homestay operators are scattered self-employed. The business concept is also relatively backward and the business channels are limited. During the peak period of tourism, tourists often have no room to rent near popular scenic spots, and the landlord's room appears to be vacant. The Internet has a lot of room to play in this direction. Tenants can book suitable housing online in advance according to their actual needs and travel plans. For landlords, their own listings can also be fully utilized. While making full use of idle social resources to promote social development, it also brings additional benefits to landlords. The design concept of the platform is mainly to provide suitable family housing for the vast number of traveling tourists. Tourists can choose whole rental or short-term rental according to their actual needs. Reliable plans can be provided in terms of technology and security. After a series of user demand research, the detailed needs of users in this aspect and the expected effect of the platform can be fully understood.

The main function of the homestay online reservation platform is to realize the function of users booking houses on the platform and landlords publishing houses on the platform. In order to realize that different users have different permissions, the platform starts from different role settings and sets two roles for the system, namely tenant and landlord. The functional structure is shown in Figure 6.

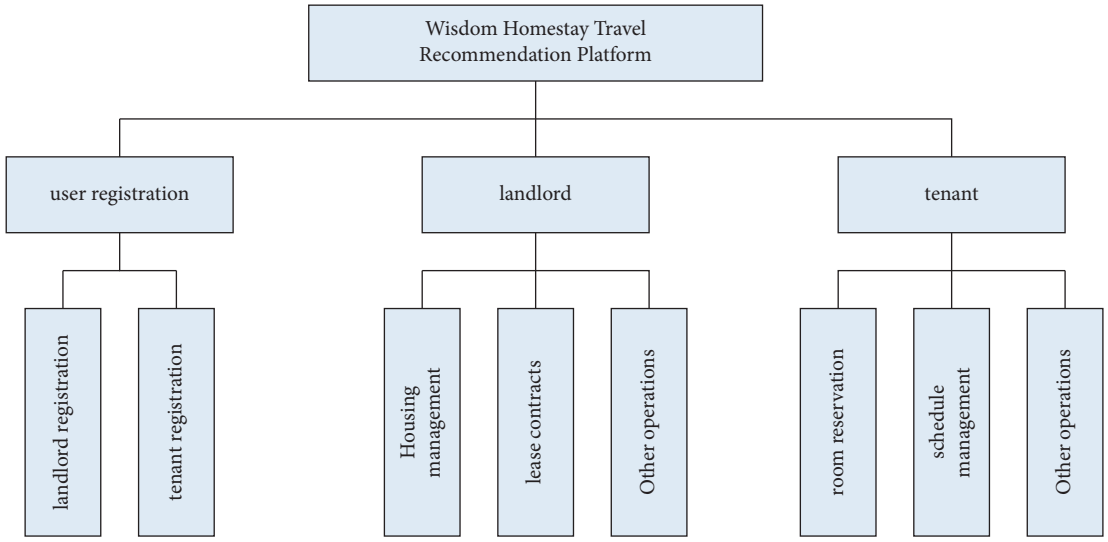

Figure 6: System functional architecture diagram.

4.3. Construction of Wisdom Homestay Tourism Recommendation System Platform. The construction environment of the wisdom homestay tourism recommendation system platform is shown in Table 3.

The personalized homestay online reservation platform is based on the traditional B/S structure. The client of this structure is mainly the browser, and the user can complete the access operation on the browser of his own computer. The system server of B/S structure consists of WEB server and database. The architecture of this platform is mainly designed with a three-tier B/S model, including presentation layer, business logic layer, and data layer, as shown in Figure 7(a).

The system is logically divided into front-end browser, back-end server, and database. The physical structure design of the system is shown in Figure 7(b).

The main function of the housing recommendation (personalized recommendation) module is to make personalized recommendations for the tenant's housing for reference when choosing housing, so that users can quickly find the housing that suits them. At the same time, it also increases the exposure of excellent properties as much as possible. The system divides the recommended objects into two categories: one is the new users who log in for the first time and the other is the old users of the platform. For different recommendation objects, different recommendation monitoring is adopted. The specific design is shown in Figure 8.

For users who log in for the first time, the system does not have basic user data information. At this time, the recommendation algorithm cannot recommend houses to them very well and the system can choose some popular houses to recommend. For the old users of the system, they have a certain data base. Based on their user information and historical data, the system can calculate and recommend properties suitable for them according to the collaborative filtering recommendation algorithm.

4.4. Performance of Wisdom Homestay Tourism Recommendation Platform. The performance test of the system mainly tests the security, response time, and compatibility of the system. The performance test is shown in Table 4.

In this section, this paper will evaluate the performance (that is, the execution time) of the algorithm through the distributed framework based on MapReduce on the Hadoop platform. This paper runs two implementations of D's algorithm, scoring-oriented and ranking-oriented. The dataset is ML-1M and uses different numbers of computers (1, 2, 4, 8, 16, and 32).

Figure 9 shows the execution times of the algorithms and their corresponding relative accelerations. It can be seen from the experimental results that for the algorithm in this paper, the distributed architecture based on MapReduce leads to a significant acceleration of the algorithm. The average relative speedup increases from 1.9 to 17.7 for the scoring-oriented execution of our algorithm compared to a single computer. Performing the sort-oriented algorithm in our algorithm, the average relative speedup increases from 1.9 to 18.8.

For sorting-oriented collaborative filtering, a widely used test method is the normalized discounted cumulative gain (NDCG) criterion, which is popular for evaluating sorted document results in information retrieval. In the background of collaborative filtering, product ratings specified by the user can naturally serve as a rank correlation judgment. Specifically, the NDCG metric evaluates the top n fixed products in a sorted list of products. Let U be the set of users and $r_{u,p}$ be the rating assigned by user u to the p-th product of the sorted product list in user u, the mean of the NDCG relative to the n-th position of all user U is defined as follows:

$$\mathrm{NDCG}_{\mathrm{avg}}@n = \frac{1}{|U|} \sum_{u \in U} Z_u \sum_{p=1}^{n} \frac{2^{r_{u,p}-1}}{\log(1+p)}. \tag{6}$$

Table 3: Development environment.

(1) Operating system	Windows 10 operating system.
(2) Server	Apache-tomcat, Gcoserver
(3) Database	PostgreSQL, PostGIS
(4) Development language	JAVA
(5) Compilation tools	Spring Boot
(6) Browser	Internet explorer, Google Chrome, 360 Browser, and Firefox

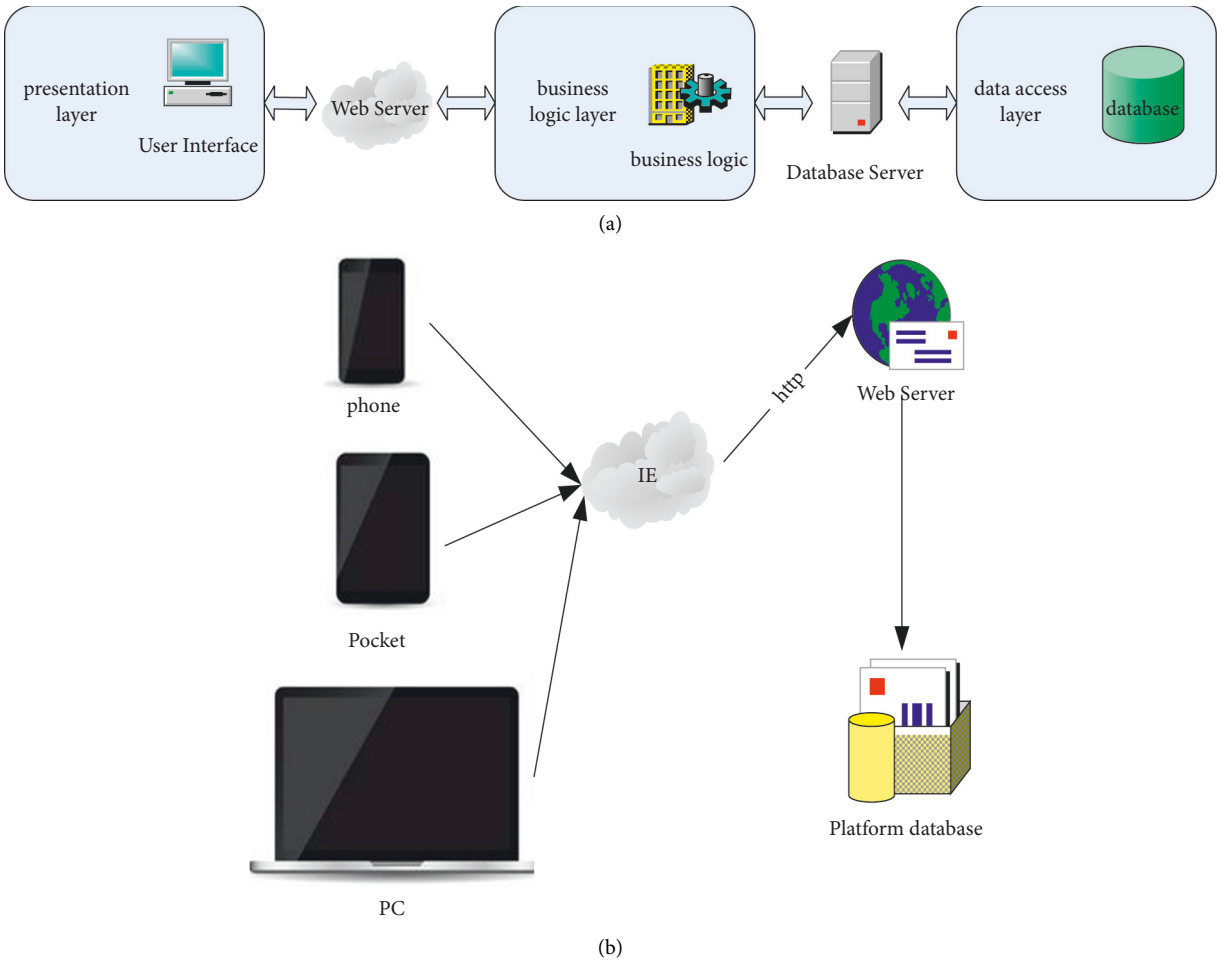

Figure 7: Overall design of wisdom homestay travel recommendation platform. (a) Three-tier architecture diagram of wisdom homestay travel recommendation platform. (b) Physical structure diagram of wisdom homestay travel recommendation platform.

The value of NDCG is in the range [0, 1] and its higher value means better sorting effect, NDCG is sensitive to the score of the highest ranked product. This is modeled by the discount factor $\log(1+p)$ of the position in the boosted ranking, which is a very desirable property for evaluating rankings in recommended systems. Because, like web searches, most users only look at the first few products on the recommended list, and the top products are more important than others.

Figure 10 shows the performance comparison under the NDCG metrics. It can be clearly seen from the figure that our algorithm outperforms all the compared algorithms. When the dataset is ML-100K, the performance of the algorithm in this paper is the best at NDCG@3–5. At NDCG@1–2, the performance fluctuates, but is much higher than the SVM

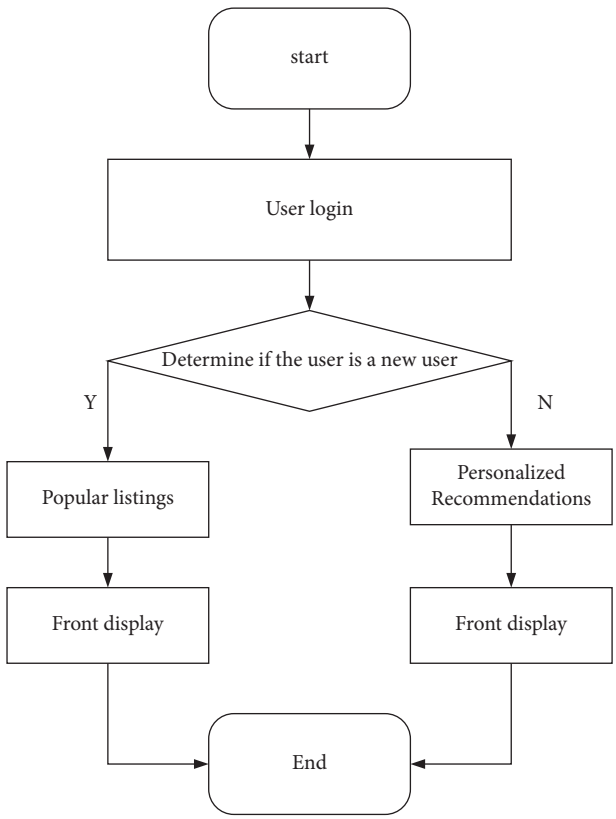

Figure 8: Listing recommendation (personalized recommendation) flowchart.

Table 4: System performance test.

Serial	Testing scenarios	Test steps	Test results
1	Safety	Log in to the system if the user is not registered	Pass
2	Response time	Record the time taken by the system to jump to the main interface of the system	Pass
3	Compatibility	Login and system functionality testing on different browsers	Pass

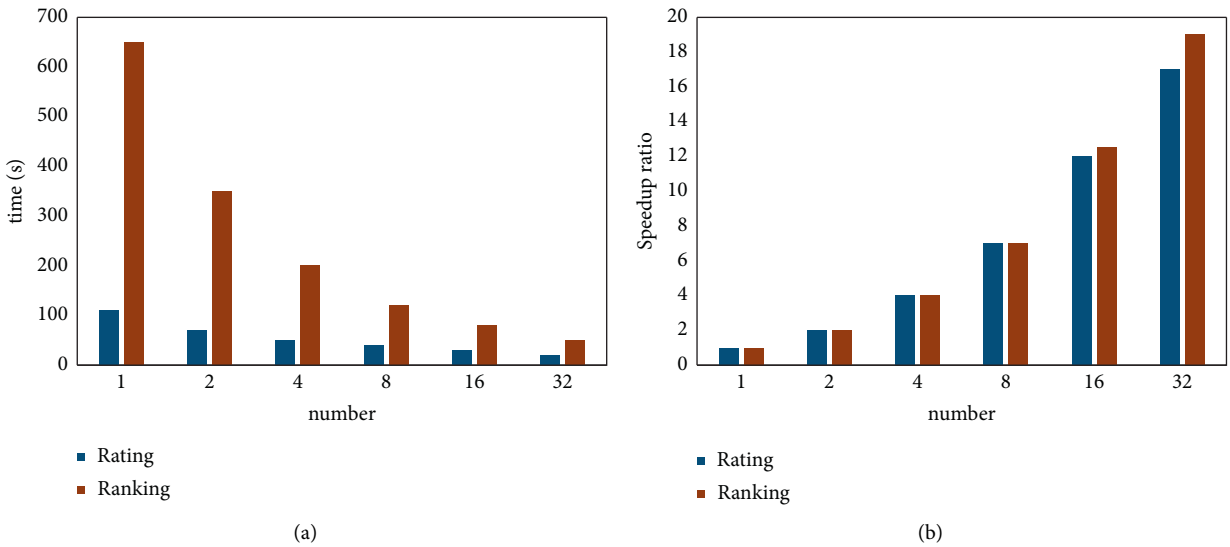

Figure 9: Comparison of system scoring and ranking performance. (a) Execution time relative to different numbers of computers. (b) Speedup relative to different numbers of computers.

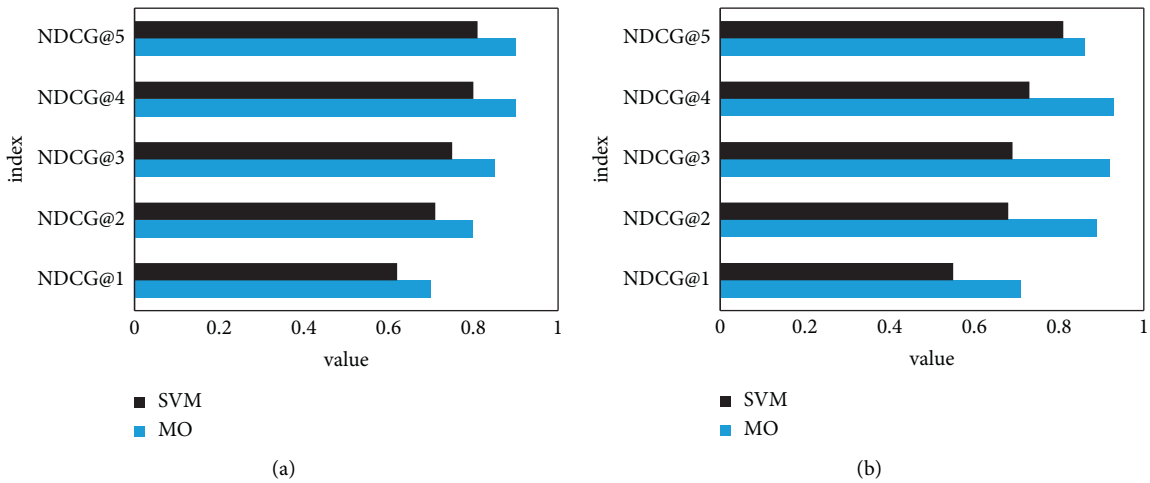

Figure 10: Algorithm ranking accurate performance analysis. (a) Performance comparison when the dataset is ML-100K. (b) Performance comparison when the dataset is ML-1M.

algorithm. When the dataset is ML-1M, the performance of our algorithm is the highest at NDCG@2–5. At NDCG@1, it is also much higher than the SVM algorithm.

5. Conclusions

This paper first analyzed the requirements of the personalized system, mainly introduced the shortcomings of the traditional recommendation methods provided by the current website and the necessity of using the algorithm in this paper for recommendation. Secondly, the architecture of the system was introduced. Then, the system database was introduced in detail, including user information data and hotel information data. In addition, the function design and function realization process of the system were described, and the function result diagram was given. Finally, the function and performance of the system were tested. Due to the limitation of time and energy, there are still some deficiencies in this paper and further efforts are needed in future study and life. (1) In terms of data sources, the data in this paper are the historical data of Ctrip. This data lacks real-time performance and up-to-date hotel appraisal data. In the future, Ctrip website data should be captured in real time based on expanding the total amount of data to improve the accuracy of recommendations. (2) Due to limited time, the hotel recommendation algorithm has not been tested and used by many tourists. Therefore, special problems may be encountered during the actual recommendation process. In the future work, it is necessary to combine the practical application of the algorithm to continuously optimize the algorithm.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Research Article

Teaching Mode in the Management of Higher Vocational Colleges in the Era of Big Data

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In the current information society, colleges and universities have produced a wealth of data on educational learning, research, personnel training, and student management. Changes in data formats and quantity lead to changes in quality. If university administrators can summarize these massive data, conduct effective mining and analysis, and finally present the analysis results in university management decision-making, then this should be the creative research of university administrators. In the construction of digital campuses, informatization promotes multiple innovations in teaching and management in vocational colleges, resulting in teaching big data, teaching big data, and data management needs. After analyzing the reading data of students' on-campus learning system through big data, it can be concluded that the learning data of Blue Nebula from 2017.09.20 to 2017.10.10 is 8.5 more than that of Chaoxing on average. During the period of 10.01–10.10, the learning data of the two platforms increased by 15 and 7, respectively, compared with the period of 09.20–09.30.

1. Introduction

In recent years, with the continuous expansion of the enrollment scale of colleges and universities, according to the 2017 National Higher Vocational College Rankings released by the China Science Evaluation and Research Center, the number of higher vocational colleges in China has risen to 1,346. It is also difficult for teachers to understand the real-time learning status of students and cannot implement personalized teaching for students. Graduates pour into higher vocational schools to maintain the normal learning style of the school and student life, becoming the focus of student management. Student management faces new challenges.

Big data refers to the need for new processing modes to process massive amounts of information. Influenced by big data technology, cloud computing and Internet technology have developed rapidly, and at the same time, they have provided new opportunities for teaching reform in colleges and universities. Therefore, deepening the integration of higher education models in the era of big data and colleges and universities, and understanding educational reform with systematic thinking, global awareness, and world outlook, will inevitably lead to the improvement of college education. Improving the quality will help colleges and universities to cultivate high-quality talents with both ability and political integrity.

Since the emergence of big data, the public's understanding of many disciplines has undergone tremendous changes, which also provides a new perspective for college management concepts and college knowledge construction. In the era of big data, data have become an important part of human and material resources. Colleges and universities can use high-tech data to establish effective communication between school management departments, teachers, and students and improve students' quality management and skills. Second, big data technology can be used to intervene in the learning of all students, understand and predict students' learning, learning strategies, and learning habits, and provide students with personalized and supervised teaching activities.

2. Related Work

Kuang et al. believe that diversity and accuracy are two distinct characteristics of large-scale and heterogeneous

data. It has always been a great challenge to represent and process big data efficiently with a unified scheme [1]. Barbu et al. propose a novel efficient learning scheme that enforces sparsity constraints by gradually removing variables based on criteria and schedules. The attractive fact that the problem size keeps decreasing throughout the iterations makes it particularly suitable for big data learning. Their approach is generally applicable to the optimization of any differentiable loss function and finds applications in regression, classification, and ranking. The resulting algorithm builds variable screening into the estimate, and it is very simple to implement. They provide theoretical guarantees for convergence and selection consistency. Furthermore, he uses one-dimensional piecewise linear response functions to account for nonlinearities and imposes second-order priors on these functions to avoid overfitting. His experiments on real and synthetic data show that the proposed method outperforms other state-of-the-art methods in regression, classification, and ranking, while being computationally efficient and scalable [2]. Zhang et al. proposed the cyber-physical system. The system consists of a unified standard data acquisition layer, a data management layer for distributed storage and parallel computing, and a data-oriented service layer [3]. Rathore et al. believe that the assets of the remote sensing digital world generate massive amounts of real-time data (mainly referred to as "big data") every day, and the insights therein have potential significance if they are effectively collected and aggregated. In this day and age, real-time remote-sensing big data is much more than it first seems. Its ability to extract useful information in an efficient manner exposes systems to significant computational challenges, such as analysis, aggregation, and storage, where data are collected remotely. Considering the factors, it is necessary to design a system architecture that supports both real-time and offline data processing. Therefore, they proposed a real-time big data analysis architecture for remote sensing satellite applications [4]. Janssen et al. identify factors that influence big data (BD)-based decision-making through case studies. Big data (BD) is collected from different sources with different data qualities and processed by various organizational entities, creating a big data chain. The scale of big data amplifies diversity (heterogeneity of data), speed (changing data sources), and accuracy (manipulation, noise). It requires relational and contractual governance mechanisms to ensure BD quality and to be able to contextualize data. Case studies show that leveraging big data is an evolutionary process, in which progressive understanding of the potential of big data and regularization of processes play a crucial role [5]. Zhou et al. believe that big data enables machine learning algorithms to discover more fine-grained patterns and make more timely and accurate predictions than ever before. On the other hand, it poses significant challenges for machine learning, such as model scalability and distributed computing [6]. Cai et al. provide a functional framework that identifies areas of IoT big data acquisition, management, processing, and mining. He defines and describes several related technical modules according to their key characteristics and capabilities. He then analyzes current IoT application research and identifies challenges and opportunities associated with IoT big data research [7]. Zhuo et al. believe that when the amount of data is very large, that is, big data, data collection, data aggregation, and data analysis have become challenges for resource-constrained requesters. Especially in data analysis, set operations, including intersection, union, and complement, exist in most big data analysis. It is used to filter redundant data and preprocess raw data. Faced with the challenge of limited computing and storage resources, cloud-assisted methods may be a promising approach to solve big data analysis problems [8]. Moral and Villavicencio presented a qualitative study, in which 11 primary schools participated in the full-time school curriculum. First, they introduced the concept of inclusivity and its relevance to such schools. They then go on to describe the government proposal by the school management and then describe how the Aboriginal school operates. Finally, he presents the methods and results. The analysis highlights that the management model is not suitable for this type of school and that it is necessary to reconsider the model from an inclusive perspective. They conclude with reflections on the principles of inclusive education, as they believe they provide further theoretical and methodological elements for inclusive teaching work in fragile settings [9]. Tamir and Arar findings contribute to the school's theory of incremental decisions about resource allocation, consistent with institutional approaches, and inform other schools dealing with similar tasks [10]. Adil et al. analyze the existing mechanism of the school management committee (SMC) and proposes an improved framework to strengthen its processes and outcomes [11].

3. The Method of Big Data Management Teaching Mode

In the information age, a variety of new publications such as digital terminals, cloud services, and microblogs have emerged, and a lot of information has also shown a growth trend. At present, there is no unified definition of big data, but the research group believes that "mass data" and "big data" are very different, the scope and content of "big data" and "big data" are different. It is essentially impossible to use traditional software and hardware tools. Machines are used to collect data required for identification, acquisition, maintenance, monitoring, and operation. In particular, it has the characteristics of low cost, variability, large scale, and fast speed and can often be divided into fixed data, static data, and nonstatic data. In the information age, big data has become a key factor in the comprehensive utilization of human and material resources and will inevitably become a key factor in intensifying competition. A key requirement for large-scale applications is the use of advanced and sophisticated techniques and methods to generate valuable data objects. The era of big data does not mean knowing more, and more importantly, in the field of education, distance learning using data has developed rapidly, and the application of LMS has become more and more extensive, resulting in an increase in the use of data

[12]. Based on the analysis of the development of all education companies, big data not only contributes to the development of technical skills but also the development of learning management strategies and ideas for improving learning.

3.1. Scientific Planning of Teaching Through the Teaching Platform. The teaching platform is an important part of professional teaching. School education must be undertaken by professionals and carry out social practice activities with clear goals, strict organization, perfect system, and strong planning in special places with the direct goal of affecting the physical and mental development of students. The most famous ones are Blue Moyun Class, Chaoxing Learning Pass, etc. Relying on the learning platform, on the one hand, schools can adopt blended teaching, flipped classroom, and other methods to break the traditional teaching method and teach students according to their aptitude. On the other hand, they can use online day-to-day management to mobilize and integrate core learning and improve teaching, management, and decision-making. For example, ordering a digitized school-based curriculum enables the permanent preservation of materials. It flexibly manages teaching practice and promotes effective communication between teachers and students. The management strategy of school knowledge ensures scientific decision-making in education.

3.2. Improving the Overall Level of Education and Teaching in Higher Vocational Colleges. In recent years, the role of big data in managing effective education in higher education and vocational training has become more and more obvious, and its benefits cannot be underestimated. To improve the overall level of education and teaching in higher vocational colleges, it is necessary to improve the comprehensive vocational teaching ability of higher vocational teachers. In the context of quality management training, big data indicates inclusiveness, timeliness, divergence, forward looking, and management dynamics. In the era of big data, educators will focus on mining the relationship between student behavior and professional skills. It tries to find the most suitable way for students to learn through data analysis, gradually reduce the daily performance monitoring of teaching quality, and establish a highly centralized system. It is used to solve the reliability problem of educational quality management and measurement. On the basis of satisfying the rights of higher education participants, the implementation of comprehensive data analysis provides a new way to evaluate and judge the process of quality education management [13]. Higher education incorporates big data forecasting, analysis, and decision-making in academic management to address weaknesses in analysis and judgment based on personal experience and perception.

3.3. Achieving Breakthroughs in Traditional Education Methods. In terms of teaching methods, the characteristics of traditional education are that it has a fixed place, specialized teachers, and a certain number of students and has a certain management system, prescribed teaching content, and training objectives, and big data can create teaching methods. Tailored teaching for specific business needs, and analysis of teaching methods according to the needs of different teachers and students, breaks the "similarity" of traditional teaching methods and modern training. Modern courses and advanced technology provide "precision" training that enables students to become specialists in professional skills. It enhances development skills and enables high-quality employment.

3.4. Promoting Information Exchange between Schools. All researchers want to share data about scientific research and its outcomes across universities and colleges. Due to the limitations of conditions, there is not much communication between colleges and universities [12]. However, the data technology in the era of big data has realized the sharing of scientific research and research results in colleges and universities.

3.5. Innovating the Work Mode of Ideological and Political Education for Students. In real life, the Internet has penetrated every place of life and study and has become a way of life for students. On the one hand, students' mood ups and downs are affected by the Internet, and on the other hand, students view online learning materials and watch videos, thus generating a large amount of data [14]. It is necessary to strengthen the construction of the main body of online ideological and political education, expand the channels of online education platforms, adhere to humanistic care, and do a good job in risk warning. Colleges and universities should use big data technology to involve students in the academic education process. It allows students to accept this type of academic work experience, truly corrects students' negative attitudes, and encourages students to grow up healthily.

4. The Application of Big Data in the Teaching Management of Higher Vocational Colleges

4.1. Carrying Out Personalized Teaching Activities. In higher vocational colleges, classroom teaching is the main teaching method, and teachers are always in the leading position of teaching [15]. However, with the popularization of big data, more and more open education has entered the education system, and online learning has become the second way of learning for many students. Compared with traditional teaching methods, online courses have advanced training, flexible learning time, and a variety of video formats and learning methods. Educational resources can be further modified and optimized, while personal learning relevant to students can be pushed to them.

The comparison between precise teaching based on big data and traditional teaching mode is listed in Table 1.

Table 1: Comparison of precise teaching based on big data and traditional teaching mode.

		Traditional mode	Big data collection, analysis, and compensation
On campus	Teach	Traditional teaching	Layered teaching
	Evaluation	Follow the score	Pay attention to the lack of knowledge points and abilities
	Review	Wrong topic	Find the source and talk about the method
Off campus	Operation	Unified work	Personalized homework
	Review	Independent review	Precise compensation

Relying on big data technology, teachers in training colleges can easily find what they really need in complex data. It improves the level of teacher training and data analysis based on career potential, which greatly improves the overall management of education. With proper instruction, skilled teachers can use a variety of online courses and online tools to employ teaching methods such as the more flexible flipped classroom. It helps to integrate teaching methods and learning concepts into classroom teaching, technical knowledge, and the workplace. By integrating teaching materials through cloud computing, educators can adapt their work focus to teaching methods and learning management, laying a solid foundation for achieving the ultimate teaching goal.

Through Table 2, the teaching situation of teachers can be monitored in real time, and schools can intervene in time for teachers with abnormal conditions, and teachers with excellent performance can be commended and encouraged.

The top ten attractive teachers in Guangdong Province in 2018 are listed in Table 2.

4.2. "4WD" Mode. "Four-wheel drive" is a training model for cultivating compound talents in the new century, which is proposed on the basis of analyzing the characteristics of the current situation of vocational education in China. The "four-wheel drive" model is a new model of Internet education and a subversion of the traditional education model. Individual "DIY learning" will replace the traditional "teacher-student" teaching model. Its basic elements are shown in Figure 1.

Practical needs are the foundation, driving teaching resources, teaching methods, and ensuring teaching quality. Teaching resources guarantee the implementation of teaching means; teaching means are specific measures that reflect the quality of teaching and can improve the quality of teaching. Teaching quality supports the needs of practice, which provides high-quality compound talents for time needs [16]. The four elements support each other and drive each other.

4.3. Experiential Teaching Mode. Based on the theory of information-informed teaching and constructivism, the teaching process is based on the five principles of lesson preparation, democracy, independence, unity, and freedom. It develops a new learning environment. Teaching activities should not be limited to classrooms, adopting a variety of new teaching methods such as knowledge and games in addition to teachers and students, allowing students to prepare themselves and teachers to help teaching. On the other hand, it breaks the teaching mode of the past. It creates a teaching method that is supervised by students and teachers in parallel by teachers.

The experiential teaching mode is shown in Figure 2.

4.4. Application of Database Course Teaching Reform Model. In this study, the random entry method is used to reconstruct the curriculum system. The content of database courses is complex and covers a wide range. The random entry method is used to reconstruct the curriculum system, and the knowledge is repeatedly infiltrated in different situations to achieve the integration of knowledge [17], as shown in the existing teaching mode diagram (Figure 3) and the reformed mode diagram (Figure 4).

From the comparison between the existing teaching model and the reformed model, it can be seen that the new curriculum is divided into four parts: the first stage uses practical technology and new cases of technology application to stimulate students' interest in learning and set learning goals. Parts 2, 3, and 4 organize courses from the DBMS system application operation level (such as using enterprise manager tools), DBMS system statement level (such as SQL statements), and development tool programming (such as ADO.NET programming) [18]. Combining the contents of these three parts is more conducive to students' continuous development of their cognitive abilities. Furthermore, it leaves theory behind. Once students are familiar with the process, it enhances their interest in learning the theory of work and achieves good learning outcomes.

4.5. Providing Powerful Tools for Student Behavior Management. The biggest headache for student administrators right now is that they cannot collect enough data in a timely manner to monitor education, much less expect regular monitoring at all times. This study uses big data to solve this problem. By collecting students' daily behavior information, each student's behavior can be accurately obtained. This may not provide early warning of all possible problems, such as disconnection, learning activities, alcoholism, and personal thoughts, and the entire management model is based on data repair and optimization. Through deep mining and extensive data analysis, it integrates the results of data analysis into school management and operations. With the scientific and intelligent management, the teaching service can be completed. For example, behavior records such as meal cards and access control information can analyze students' personalities and misbehavior. At the same time, once we have information on student behavior,

Table 2: Top ten charismatic teachers in Guangdong province in 2018 (vocational college group).

Ranking	Name	Annual growth charm	Total charisma	School
1	Che	6398	6399	Guangzhou Baiyun industrial and commercial advanced technical school
2	Lei	5103	5104	Shenzhen Longgang district teacher training school
3	Huang	4967	4967	Guangdong foreign language arts vocational college
4	Deng	3644	3669	Zhuhai art vocational college
5	Jiang	2953	2965	Shenzhen vocational and technical school
6	Gao	2747	2756	Guangdong foreign language arts vocational college
7	Huang	2722	2769	Huizhou city vocational college
8	Li	2561	2563	Huizhou city vocational college
9	Wang	2437	6693	Guangzhou Baiyun industrial and commercial advanced technical school
10	He	2181	2241	Huizhou city vocational college

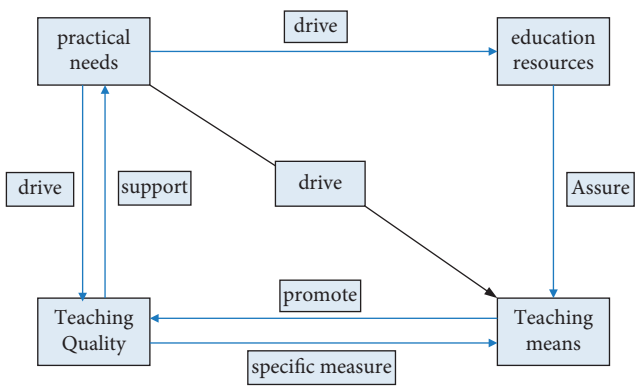

Figure 1: Schematic diagram of the basic elements of "four-wheel drive."

we can look more closely at the relationship between student performance and educational and career outcomes [19, 20]. In the past, when assessing student learning outcomes, we could simply "process" the "facts" by knowing them in the traditional way. Examples include the recent drop in grades for students due to their parents' divorce and the drop in grades for female students due to weight loss. With traditional methods, we may not be able to identify potential causes of student performance declines and provide early warnings. These problems are difficult to find from the teaching process, and students rarely talk to the counselor about related issues; it is even more difficult for teachers to learn about similar situations [21]. Through the mining and application of big data in student behavior, it is not only possible to discover the factors that may lead to the decline of students' academic performance but also give early warning and inform relevant teaching staff to provide timely guidance. The overall design framework of the application is shown in Figure 5.

In this study, the data in Figures 6–8 are obtained through the school's survey of student data. According to the weekly average data of the surveyed students for four weeks ($x1$, the first week; $x2$, the second week; $x3$, the third week; $x4$, the fourth week), the results show that when the student's highest grade is 8.9, the average student's other data are 7.98. When student grades were as low as 5.5, the student's other data averaged 5.41. This shows that the student's academic performance is closely related to other data of the student. The internal data of the data layer are shown in Figures 6–8.

4.6. System Module Establishment. "Six people" education is a big goal. The gist of the "six people" is that the reputation of the people is the standard, the support of the people's heart and the people's strength is the basis, the public opinion is the basis, the people's wishes and the people's aspirations are the directions, the people's benefit is the goal, and the people's suffering is the dereliction of duty. The evaluation index system of "six-dimensional citizens" is defined by information technology. Schools have every right to assess and record dynamic profiles of student growth, provide relevant information, and assess learning outcomes in various school departments. The system module is shown in Figure 9.

The main sources of data collection on "six people" education are listed in Table 3.

5. Big Data and Teaching Management in Higher Vocational Colleges

5.1. Fitness Formula. The complexity of the fitness function is the main component of the complexity of the genetic algorithm, so the design of the fitness function should be as simple as possible to minimize the computational time complexity.

The fitness function is defined as follows:

$$f_G = \frac{j_{\text{in}}^G}{\left(j_{\text{in}}^G + j_{\text{out}}^G\right)^{\alpha}}. \tag{1}$$

Among them, G is a divided community; j_{in}^G represents the sum of the number of interconnected edges of all nodes in the community G, which is twice the sum of the internal edges of the divided community G. j_{out}^G is the sum of the number of edges connecting the nodes in community G to the outside of community G; α is an adjustment parameter that controls the size of the community. According to experience, the α value of 1.0 to 1.7 is more appropriate, and the α value selected in this study is 1.4 [22, 23].

For any node A in the network, its fitness to community G is defined as the change of community G with and without node A, that is

$$f_G^A = f_{G+A} - f_G. \tag{2}$$

Among them, f_{G+A} and f_G represent the fitness of community G including node A and the original community

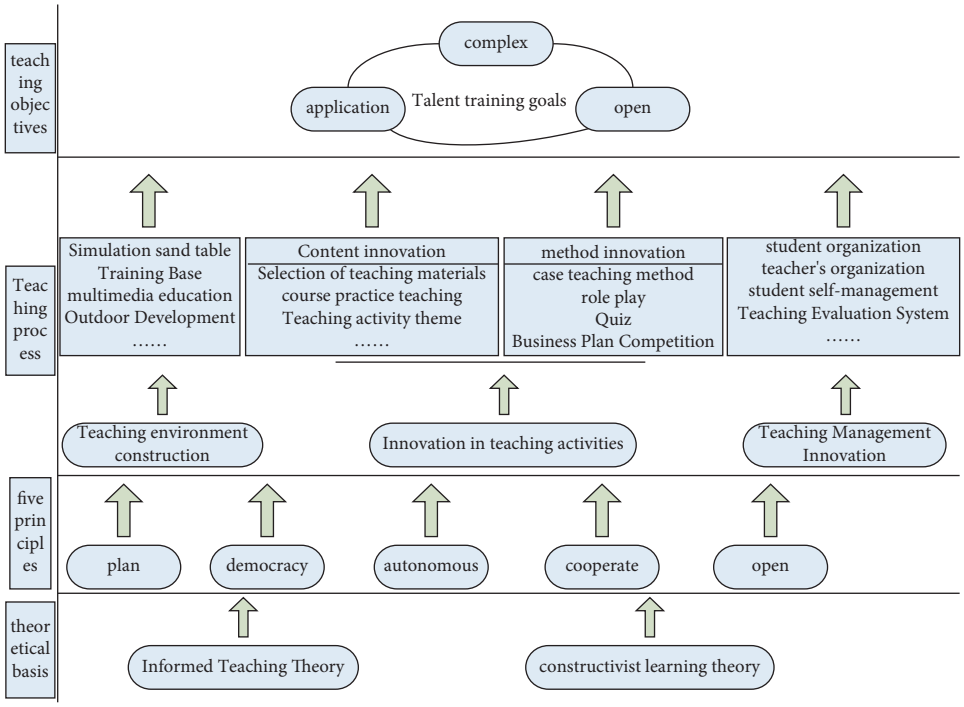

Figure 2: Experiential teaching mode diagram.

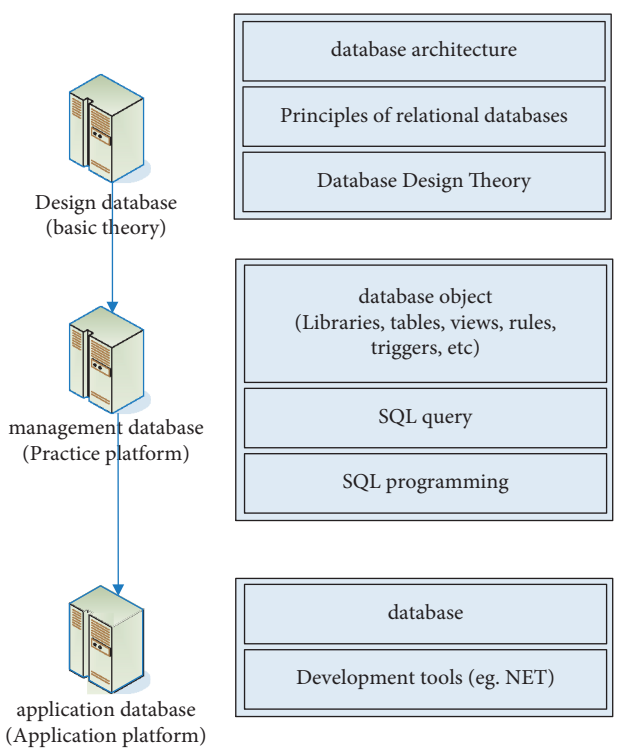

Figure 3: Existing teaching mode diagram.

G not including node A, respectively. If $f_G^A > 0$, then it means that the fitness of node A increases after joining community G; if $f_G^A < 0$, then it means that the fitness of node A decreases after joining community G [24].

To sum up, when judging whether each node wants to join the community, it is necessary to calculate the original community j_{in}^G, j_{out}^G and the community j_{in}^G and j_{out}^G after joining the node, which increases the computing time. Therefore, the fitness formula is improved. The original fitness formula of community G is as follows:

$$f_G = \frac{j_{\text{in}}^G}{\left(j_{\text{in}}^G + j_{\text{out}}^G\right)^{\alpha}}. \tag{3}$$

The fitness formula after community G joins node A is as follows:

$$f_{G+A} = \frac{j_{\text{in}}^{G+A}}{\left(j_{\text{in}}^{G+A} + j_{\text{out}}^{G+A}\right)^{\alpha}}. \tag{4}$$

After joining node A, the edge j_{in}^A connecting the node A to the community G and the edge j_A^G connecting the node A of the original community G are both internal edges, and the edge j_{out}^A connecting the node A and the external nodes of the original community G becomes the external edge, so

$$\begin{aligned} j_{\text{in}}^{G+A} &= j_{\text{in}}^G + j_{\text{in}}^A + j_A^G, \\ j_{\text{out}}^{G+A} &= j_{\text{out}}^G + j_{\text{out}}^A - j_{\text{in}}^A a. \end{aligned} \tag{5}$$

So

$$j_{\text{in}}^{G+A} = j_{\text{in}}^G + 2j_{\text{in}}^A. \tag{6}$$

That is, the community fitness after adding person A node is as follows:

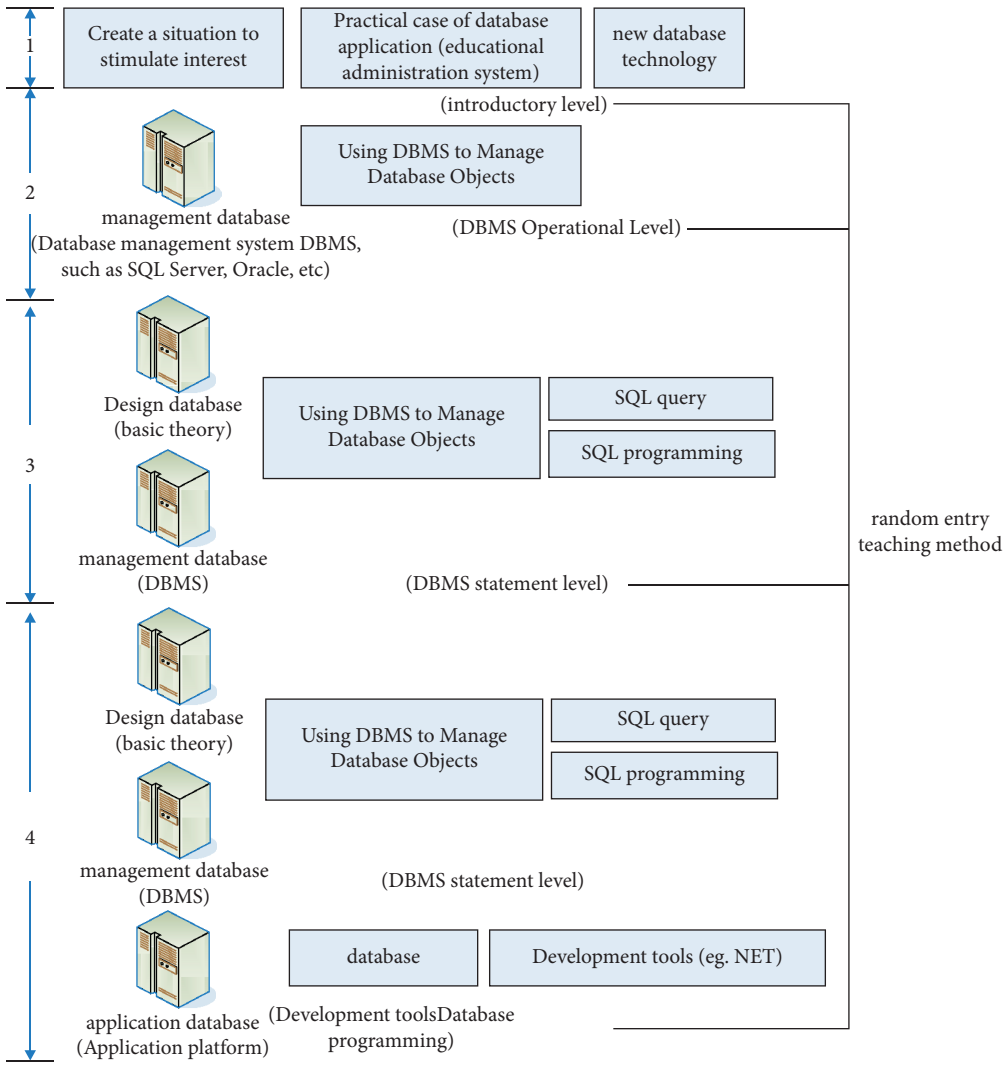

Figure 4: Teaching mode after the reform.

$$f_G = \frac{j_{\text{in}}^G + 2j_{\text{in}}^A}{\left(j_{\text{in}}^G + 2j_{\text{in}}^A + j_{\text{out}}^G + j_{\text{out}}^A - j_{\text{in}}^A\right)^\alpha} = \frac{j_{\text{in}}^G + 2j_{\text{in}}^A}{\left(j_{\text{in}}^G + j_{\text{in}}^A + j_{\text{out}}^G + j_{\text{out}}^A\right)^\alpha}. \tag{7}$$

Therefore, it only needs to calculate j_{in}^G and j_{out}^A of the initial community G once, and every time a new node is added, it only needs to calculate j_{in}^G and j_{out}^A to meet the requirements, which reduces the time consumption.

5.2. Principal Component Analysis (PCA). Principal component analysis (PCA) is a statistical process. The principle of PCA is to use the eigenvector matrix U to represent a high-dimensional vector x and project it to a low-dimensional vector to represent a low-dimensional vector y and only lose some secondary information. It uses an orthogonal transformation to convert a set of potentially correlated observations of each entity variable with distinct numerical values into a set of uncorrelated linear variable values, called principal components. The original PCA method can be refactored as follows:

Step 1. Suppose the data matrix of the sample is

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{bmatrix}. \tag{8}$$

The initial data are normalized as follows:

$$x_{nm}^* = \frac{x_{nm} - \overline{x}}{\sqrt{\text{var}\left(x_m\right)}}. \tag{9}$$

In the formula,

$$\overline{x} = \frac{1}{i}\sum_{n=1}^{i} x_{nm}, \text{var}\left(x_n\right) = \frac{1}{i-1}\sum_{i=1}^{i}\left(x_{nm} - \overline{x}_m\right)^2. \tag{10}$$

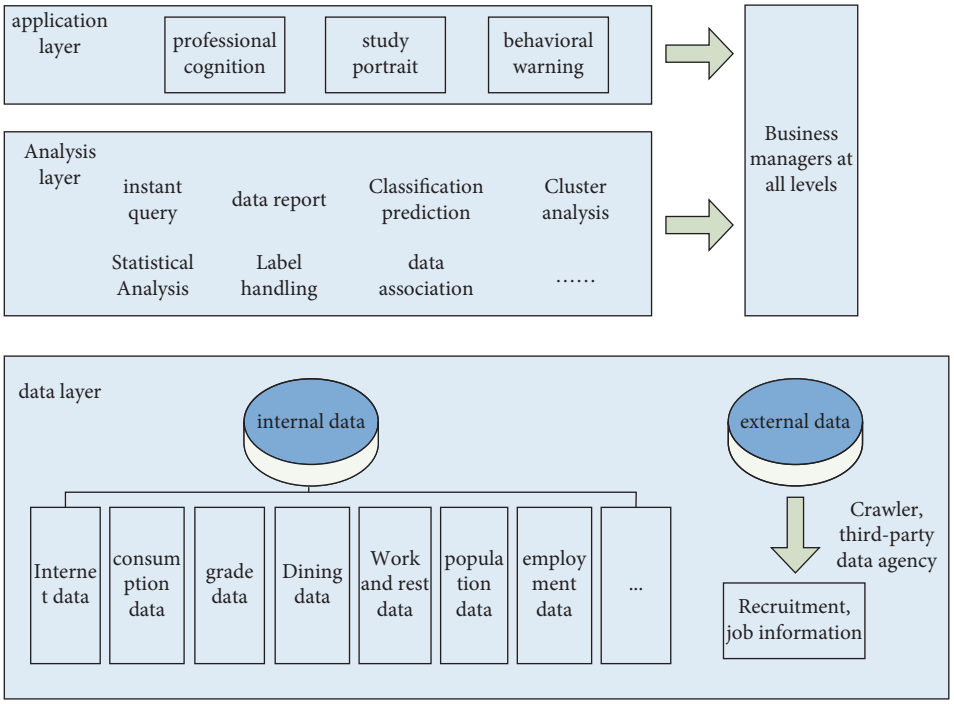

Figure 5: Overall design framework.

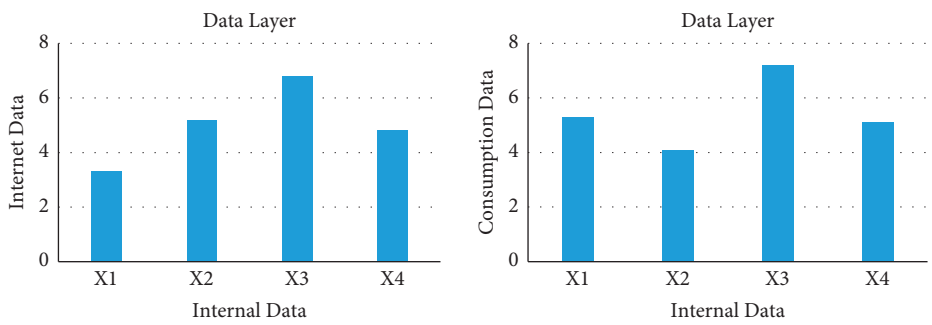

Figure 6: Internal data 1 of the data layer.

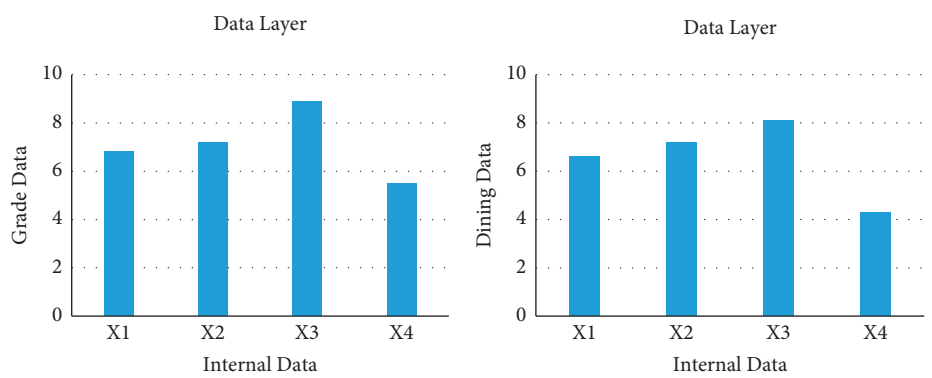

Figure 7: Data layer internal data 2.

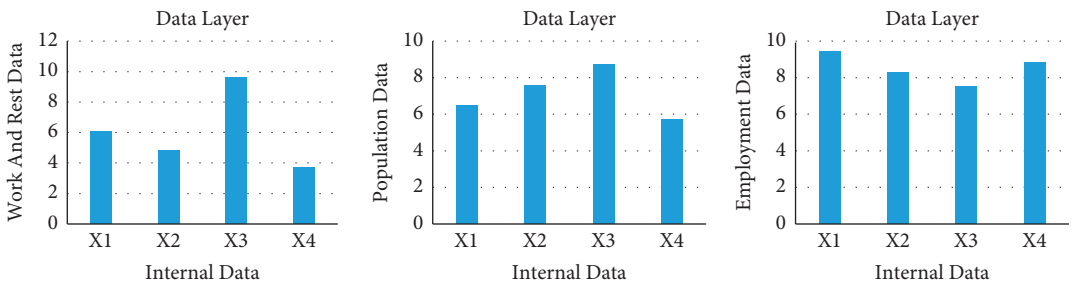

Figure 8: Internal data in the data layer 3.

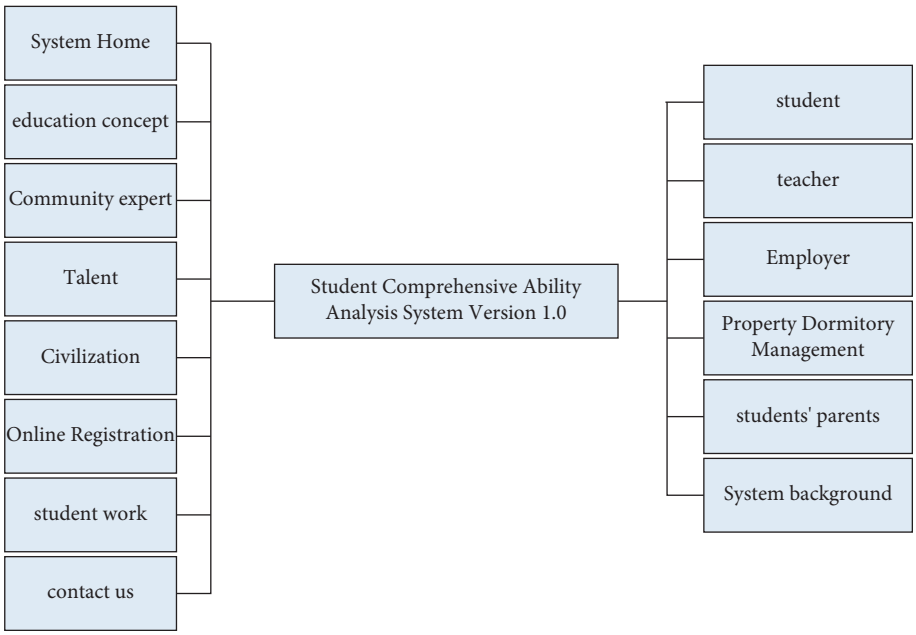

Figure 9: Modules of students' comprehensive ability analysis system.

Table 3: Main data sources.

Serial number	Content
1	Basic information of students (including whether they are members of the league or party members)
2	Student transcripts (by semester and class)
3	Classroom activity information (Blue Moyun and Chaoxing)
4	Reward and punishment information (reward name, reward level, punishment name, and punishment level)
5	Employment information (position, region, salary level, company comments, and instructor comments)
6	Club information (including club name and club title)
7	Social practice (including volunteer activities and corporate practice)
8	Graduation dissertation information (including writing, communication, structure, originality, dissertation comments, and dissertation defense speech)
9	College information (including dormitory score and discipline score)
10	College physical fitness test information
11	English AB, CET-4, CET-6 passing list and scores, and competition results information

$n = 1, 2, \ldots, i$; $m = 1, 2, \ldots, p$.

Step 2. Calculate the sample correlation coefficient matrix.

If the initial data are normalized, then X indicates that the data-related numbers after normalization:

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1p} \\ \vdots & \ddots & \vdots \\ r_{n1} & \cdots & r_{np} \end{bmatrix}. \tag{11}$$

In the formula,

$$\begin{aligned} r_{nm} & \frac{\operatorname{cov}(x_n, x_m)}{\sqrt{\operatorname{var}(x_1)}\sqrt{\operatorname{var}(x_2)}} \\ & = \frac{\sum_{k=1}^{k=i}(x_{kn} - \overline{x}_n)(x_{km} - \overline{x}_m)s}{\sqrt{\sum_{k=1}^{k=i}(x_{kn} - \overline{x}_n)^2}\sqrt{\sum_{k=1}^{k=i}(x_{km} - \overline{x}_m)^2}}, \quad n > 1. \end{aligned} \tag{12}$$

Step 3. Calculate the eigenvalues $(\lambda_1, \lambda_2, \ldots, \lambda_p)$ of the correlation coefficient R and the corresponding eigenvectors:

$$a_n = \left(a_{n1}, a_{n2}, \ldots, a_{np}\right), \quad n = 1, 2, \ldots, p. \tag{13}$$

Step 4. Select the principal components and write the principal component expression.

The principal components of P can be detected by PCA, and the amount of information that can be used is reduced because the variance in each principal component is reduced. Therefore, in practical analysis, it is generally based on the contribution rate, rather than selecting the P principal component. The contribution rate is the proportion of the variance of the principal components in the total variance and is actually a combination of a certain proportion of the total eigenvalues, namely,

$$\text{Contribution rate} = \frac{\lambda_n}{\sum_{n=1}^{p}\lambda_n}. \tag{14}$$

Step 5. Calculate the principal component score.

Up-to-date information is provided for each example section of the main section, according to each model, based on the raw data, in the following form:

$$\begin{pmatrix} F_{11} & L & F_{1K} \\ M & O & M \\ F_{n1} & L & F_{nk} \end{pmatrix}. \tag{15}$$

In the formula,

$$\begin{aligned} F_{nm} &= a_{m1}x_{n1} + a_{m2}x_{n2} + \cdots + a_{mp}x_{np}, \\ &(n = 1, 2, \ldots, i; m = 1, 2, \ldots, k). \end{aligned} \tag{16}$$

Step 6. According to the data in the principal components, further, test and analyze the problem.

5.3. Promoting the Value of Big Data Technology in the Teaching Management of Vocational Colleges. Big data technology is of great significance to the development of education. In the field of education, education management, teaching monitoring, thinking, and learning practices are all affected by big data. Big data can promote scientific and refined learning management. It is necessary to reflect the characteristics of vocational education such as the integration of production and education, school-enterprise cooperation, work-study integration, and the unity of knowledge and action. Curriculum improvement involves many things. It is based on capturing big data and publishing new content on a regular basis. It uses a wide range of data technologies, focuses on learning management tasks, various processes, and decisions [25], and fully integrates into big data management learning. For example, systematic planning and classification have been established in various fields such as scientific research, teaching evaluation, and quality teaching. The primary data for the implementation of all courses in the school come from the data collection standards. It can also record the data required to control the object from different sources and sources to observe each other and build the data of the multifunctional object [26, 27]. All in all, big data technology can strengthen scientific and refined course management, which needs to be promoted everywhere. After the school collects students' learning data in Blue Nebula and Chaoxing, the reading index of the school learning system is obtained. The reading index of the school learning system is shown in Figure 10.

It can be seen from the figure that the learning data of Blue Nebula from 2017.09.20 to 2017.10.10 are 8.5 more than that of superstar on average.

During the period of 10.01–10.10, the learning data of the two platforms increased by 15 and 7, respectively, compared with the period of 09.20–09.30. Big data teaching is gradually becoming the daily learning of students.

5.4. Big Data Brings Changes to College Teaching Management. Teaching management is an important part of management activities in colleges and universities. It has the characteristics of extensive coverage, cumbersome, and large amount of data and periodicity. The use of big data technology can provide a platform for teaching management innovation. In terms of teaching, big data is leading the reform of teaching mode. In terms of scientific research, big data is opening up new scientific research models. In terms of management, big data helps schools manage intelligently. The traditional teaching management mainly includes teachers arranging courses, students choosing courses, exams, score entry, and so on. At present, most colleges and universities have established a teaching management system, which makes teaching management systematized and computerized, and facilitates the use of teachers, students, and teaching administrators. However, these teaching

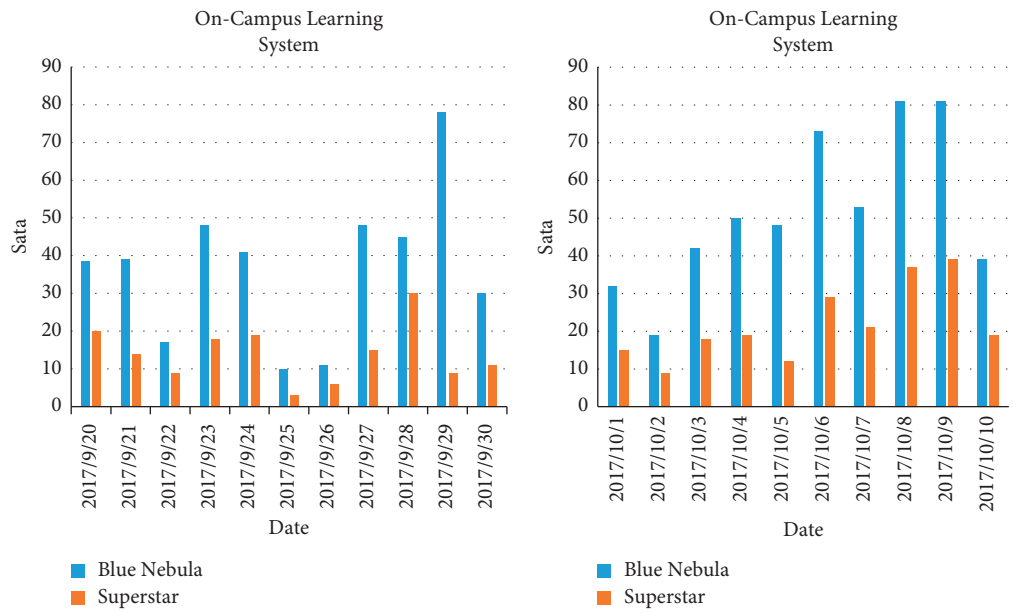

Figure 10: Reading index of intramural learning system.

management systems often have the problem of islanding and transactionalization. All kinds of personnel only complete basic functions such as query and input on the system. It cannot mine and analyze the internal data of the system, and the teaching systems of various colleges and universities cannot effectively communicate with each other, resulting in the formation of isolated islands between schools.

Using big data technology, on the one hand, the useful information hidden in the teaching system can be deeply excavated. For example, the corresponding elective and minor courses can be recommended for students based on their test scores in multiple semesters. It can provide each teacher with a teaching evaluation report based on the students' course selection and teaching evaluation information. On the other hand, big data technology can break through the barriers of colleges and universities and share educational resources. It provides students with a better educational environment. For example, the MOOC platform built through cloud computing and big data technology enables people to enjoy the education of first-class universities such as Harvard and Princeton without leaving home.

Due to the broad definition of university decision-making and the complexity of decision-makers, the decision-making process in universities is diversified. Some researchers categorize college decision-making models into four categories: "bureaucratic" models, which rely on the knowledge and ability of decision-makers to make decisions. It is a "college-type" model that balances the interests of multiple groups within a university through a process of "consensus." Various power groups and interest groups express "political" models of different demands through "communication." There is also an "organized anarchy" model of uncontrollable and inconsistent decision-making. The main weakness of these models is the lack of strong decision support, especially as policymakers only try to make "good" decisions based on "built-in thinking."

5.5. The Role of Big Data in Educational Applications. The ultimate goal of big data analysis in education is to improve students' academic performance:

(1) Big data in higher education can motivate teachers to improve teaching methods and improve teaching skills. Through the analysis of student behavior data, it is possible to identify students' study habits, study rules, and factors that affect students' study. Through mining, regularity can be found, and potential problems of student behavior can be intervened in advance. It allows teachers to guide and adjust their teaching and learning strategies. It creates and facilitates teaching strategies that are specific to students.

(2) Big data in higher education can promote the establishment of a learning platform for students, allowing students to adapt and improve learning efficiency. It understands students' learning status and their own situation, provides students with a learning experience that suits them, and provides students with personalized activities. The learning content is adjusted according to the students'

learning habits to meet the needs of the students' learning courses.

(3) Big data in higher education can provide useful data for educational decision-making. It contributes decisive data to the rise of vocational training in China. It can use educational big data prediction to realize the concept of decision-making, thereby improving decision-making ability. Some scholars suggest using big academic data and computer simulation technology to assist in optimizing academic choices. In this way, educational development options for higher education can also be adjusted to become more scientific and sustainable.

6. Conclusion

In the era of big data, the dissemination of data information is faster, and the data statistics for students' knowledge learning and skills mastery are also more convenient. Compared with the ability test, it can more accurately reflect the real situation of students' learning. This is more beneficial to the establishment of the education evaluation system, the overall improvement of the teaching level, and the transformation of the teaching method. The establishment of an information platform in higher vocational colleges can provide students with channels and platforms for communication and exchange, and at the same time, they can also collect real data of students in time to provide analysis data for the school's education quality management. Finally, in the process of education reform, colleges and universities need to integrate the characteristics of the era of big data, improve the application of Internet thinking, and pay attention to the improvement of academic skills. We should focus on solving the shortcomings of the traditional education model, formulate education reform plans from the perspective of the public, promote the reform plan of education and teaching in colleges and universities, improve the quality of teaching in colleges and universities, develop students' practical skills, and cultivate high-quality talents.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Research Article

Application of Machine Learning and Digital Information Technology in Volleyball

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Since the 1980s, machine learning has attracted extensive attention in the field of artificial intelligence. Following the expert system, it opened a precedent for the application of machine learning in the field of artificial intelligence and became one of the important topics of artificial intelligence. However, in the field of volleyball, the application of machine learning and information technology in volleyball is extremely limited. Volleyball has not developed widely in society nor has it become a common event in people's daily life. Therefore, the development of volleyball in China lags behind. Unlike other sports, volleyball requires both strong skills and playing tactics. While taking into account the technical and tactical aspects, the requirements for the comprehensive quality and learning ability of both sides of the teaching are relatively strict. If the application of modern information technology is neglected, it may affect the teaching effect of volleyball and hinder the long-term spread of volleyball. The article starts with the serving, landing, and blocking of two groups of volleyball players with different sports levels. Through the application of machine learning and digital information technology in volleyball, as well as the use of artificial neural networks and genetic algorithms, the reaction time and accuracy of judging serving, landing, and blocking are improved, and specific application strategies are further proposed. According to the influence of athletes of different levels on the cognition of volleyball landing points, it can be seen that there are three parts that account for 40% of the allocation.

1. Introduction

Although volleyball has developed rapidly in various countries and obtained many improvements and innovations, the rules have become more reasonable and scientific, the technology has become more standardized, and the development of volleyball has been unprecedentedly improved, but it still lacks the support of information technology. However, compared to football and basketball, the popularity of volleyball is relatively weak. As a confrontation project, volleyball requires each player to cooperate with each other to block, smash, defend, and respond; any part of the athlete's body can touch the volleyball, but they cannot land on the ball and hit the ball continuously during the game. For competitions, there is no time limit and no limit on the number of times. Volleyball requires comprehensive and sophisticated technology with its own unique characteristics.

The application of machine learning and digital information technology to volleyball can improve the accuracy of volleyball players hitting and blocking the ball. Applying machine learning and information technology to volleyball can observe the response and accuracy of players in different serving styles and provide an important theoretical basis for future volleyball training. Therefore, it is of great practical significance to prevent the injury of athletes in sports and prolong the sports years of athletes.

Machine learning and digital information technology are used not only in volleyball, but also in other fields. Using machine learning and combining the characteristics of artificial neural network and genetic algorithms can optimize and improve motion features and improve the accuracy and efficiency of digital processing and classification of motion information. It can provide certain help for different types of sports.

2. Related Work

Broecker et al. believe that the state-of-the-art machine learning techniques promise to be a powerful tool in

statistical mechanics, as they can distinguish different phases of matter in an automated way. They demonstrated that convolutional neural networks (CNNs) can be optimized for quantum multifermion systems to correctly identify and localize quantum phase transitions in such systems. It turned out that this QMC + machine learning approach is even applicable to systems that exhibit severe fermion sign problems. In this case, traditional methods of extracting information from Green's functions (e.g., in the form of isochronous correlation functions) fail [1]. Coley et al., in 5x cross validation, trained models to specify primary product ranking 1 in 71.8% of cases, 3 in cases ranking ≤86.7%, and 5 in cases ranking ≤90.8% of deaths. Combining traditional reaction templates and machine learning, it is possible to predict organic reaction products in silicon using open-source data from the patent literature [2]. Given and Willson used a constructivist grounded theory approach to examine the research practices of humanities scholars, including their use of various resources and digital technologies. Through in-depth research, several themes emerged related to the role of technology in shaping the research practice of humanities scholars. The various digital technologies used by humanities scholars support traditional ways of working within their disciplines and create potential for new academic practices [3]. Gijsbert suggested that the challenge for experts is to extend their skills and abilities into leadership roles. To increase their leadership contributions, it is recommended to utilize a joint approach that integrates professional organizations with academia and policy-relevant healthcare organizations. And along with the diagnostics or information technology industries, a partnership approach is being used in education and training in healthcare [4]. Voyant et al. outline the method for predicting solar radiation using machine learning methods. Although many papers describe methods such as neural networks or support vector regression, predicting the output power of a Solar System is necessary for a well-functioning grid or for optimal management of the energy flux of a Solar System [5]. Tavakkoli-Moghaddam et al. proposed a genetic algorithm (GA) to solve the redundancy allocation problem for series-parallel systems. When a single subsystem can choose a redundancy strategy, most solutions to the general redundancy allocation problem assume that the redundancy strategy for each subsystem is predetermined and fixed. In general, active redundancy has received more attention in the past. However, in practice, in a particular system design, active redundancy and cold standby redundancy can be used. The choice of the redundant policy becomes an additional decision variable. Therefore, the problem is to choose the optimal redundancy strategy, components, and redundancy level for each subsystem to maximize the system reliability under system-level constraints. This is an NP-hard problem. Due to its complexity, it is difficult to solve it optimally using traditional optimization tools. It proves that genetic algorithm is an effective method to solve this kind of problem. Finally, the calculation results of a typical scenario are given and the robustness of the algorithm is discussed [6]. Lamperti et al. provide fairly accurate proxies for real models using machine learning proxies obtained by the proposed iterative learning process and significantly reduce the computational time required for large-scale parameter space exploration and calibration [7]. The above research contents have great reference value for this paper. However, the time span of relevant studies is not large and the cases are relatively few, which may lead to inaccurate final results.

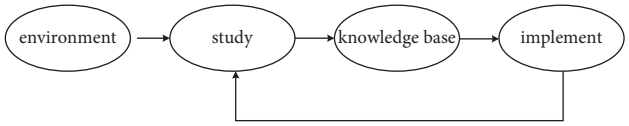

Figure 1: Basic composition of the learning system.

3. The State of the Art in Machine Learning

Definition. Machine learning is the study of computer programs that can self-improve their processing performance based on experience. Machine learning algorithms have been proven to be useful in many application domains [8]. In the field of data mining, they have a fairly high acuity for data mining. They can mine and analyze valuable rules from a large number of databases, for example, analyzing treatment results from patient databases, or obtaining general patterns of credit loans from financial data.

Basic Structure. Machine learning specializes in how computers simulate or realize human learning behaviors to acquire new knowledge or skills, and to reorganize existing knowledge structures to continuously improve their performance [9]. According to the definition of machine learning, we can build a learning system structure model, as shown in Figure 1.

The learning system is mainly composed of four parts: environment, learning, knowledge reserve, and execution. The environment interacts with the outside world to provide beneficial information for the learning part. The evaluation of the information provided by the environment to the system includes two aspects: information level and information quality. The level and quality of information in the environment are the first factor affecting the design of the learning system. The learning process processes the information extracted from the environment. The processed information becomes the knowledge reserve. Finally, the information obtained from the feedback in the whole process is fed back to the learning process [10]. At the same time, a structure that can repeatedly memorize and renovate knowledge is necessary for the entire learning system. Test the knowledge learned, acquire new knowledge, and apply the knowledge to practice, so that the entire system is continuously upgraded and evolved [11].

The environment is like the integration of external information. It acts as a work object in the whole link and is the source of external information. The learning link, as the core link, is connected with the environmental part. It mainly integrates, summarizes, and analyzes the learned information, improves or supplements the information database, and strengthens the efficiency of the system to complete tasks. Execution is mainly to perform systematic learning

tasks and feed the information gained in this process of learning back. Finally, the evaluation of the system is completed to guide the next work [12]. The complexity of the task depends on whether a single concept or multiple concepts are required to perform the task, and the way to perform the task is determined by one or more steps.

The main methods of machine learning are as follows.

3.1. Artificial Neural Network Method. A neural network is a set of connected input/output units. Each connection has a weight, and each neuron represents an output. By learning for each input or output unit, the corresponding weights are adjusted. After completing this stage, the corresponding predicted value is obtained according to the input value of the sample [13]. Neurons are the basic units that make up a neural network. It is generally a multi-input, single-output nonlinear element. In a neural network, there are many factors that affect neurons. For example, input signals and other factors within the neuron have a deep impact on the neuron. Therefore, in artificial neuron input modeling, bias is often used to input an input signal with a fixed value. Such input signals are sometimes also called threshold or gated neuron models [14] (as shown in Figure 2). The output vector of the neuron model can be expressed as

$$A = f\left(\sum_{i=1}^{w} t_{1,j} \bullet p_i + h\right). \tag{1}$$

The influence of hidden neurons on motion samples is described by the error expression:

$$\text{wxx} = \frac{1}{2wT}\sum_{T=1}^{T}\sum_{j=0}^{w=1}\left(r_{j,t} - y_{j,t}\right)^2. \tag{2}$$

Among them, T represents the number of samples, w is the number of neurons in the output layer, r is the sample output, and y is the model output.

According to the artificial neuron model, a fixed input component is used to activate the function. The bias is added to $W * P$, and the input component of the process is a fixed constant 1 that can be used as a weight. In the field of neural networks, bias plays an important role. It not only moves left and right on the function graph but also increases the reliability of the problem solving [15].

BP neural network algorithm can be said to be a continuous nonlinear optimization function learning method. The transformation is performed by input and output, and iterative operations are used to solve the weight problem in the negative gradient descent algorithm [16]. BP algorithm is a gradient descent search method with slow convergence speed. It is easy to fall into the local extreme points of the error function. For a large search space, multipeak and nondifferentiable functions often cannot effectively search the global minimum points. The process of the BP network learning algorithm is shown in Figure 3.

Input layer, output layer, and hidden layer are the three basic structures of BP neural network, as shown in Figure 4. The BP neural network adopts the method of error

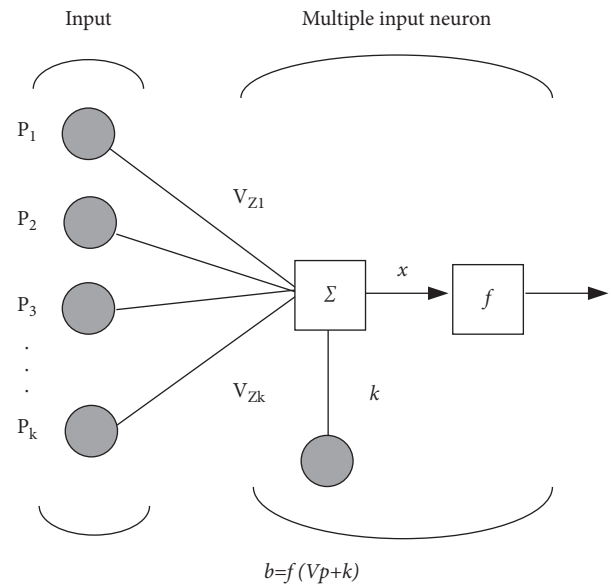

Figure 2: Artificial neuron model.

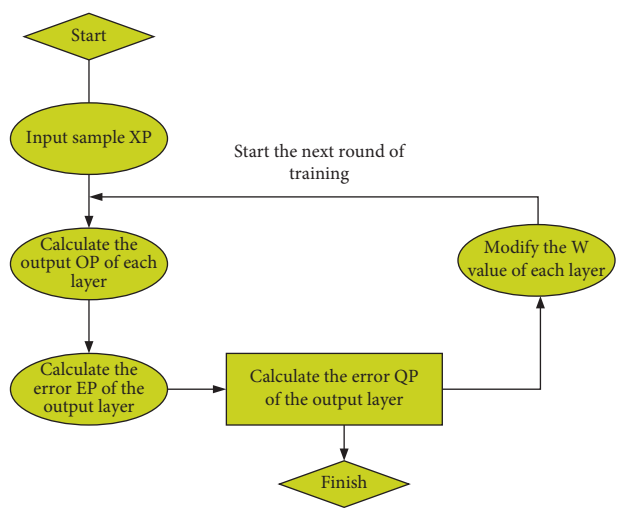

Figure 3: Flowchart of BP neural network algorithm.

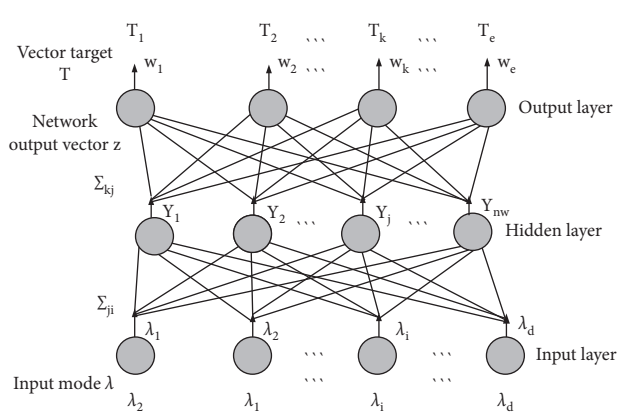

Figure 4: Three-layer BP neural network topology.

backpropagation to reduce the error. However, it has the weakness of small limitations, requires a lot of structure and learning parameters, and is easy to fall into local optimum [17].

According to each motion sample information $(F_x, E_x)(x = 1, 2, \ldots b)$, where F_x is the input and E_x is the corresponding output, the following operations are performed:

(1) Put the value of F_x into the unit layer; it can get

$$k_i = f\left(\sum_{i=1}^{b} V_{it} a_i + \theta_t\right), \text{Among them, } t = 1, 2, \ldots, n, \tag{3}$$

where f is a function of type S:

$$f(X) = \left(1 + e^{-w}\right)^{-1}. \tag{4}$$

(2) Then, get the activation value of the output layer:

$$e_j = f\left(\sum_{t=1}^{b} V_{tj} + R_j\right), j = 1, 2, \ldots, y. \tag{5}$$

(3) Calculate the generalization error of the previous unit layer:

$$g_j = f_j\left(1 - f_j\right)\left(f_j^{'} - f_j\right), j = 1, 2, \ldots, y. \tag{6}$$

(4) Then, get the error of (2) unit layer relative to g:

$$h_j = f_j\left(1 - c_j\right) \sum_{x=1}^{1} V_{jx} \bullet g_x, j = 1, 2, \ldots n. \tag{7}$$

This formula propagates the error from (3) to (4) unit layer.

(5) Adjust the connection weight from the second unit to the third unit, where β is the learning rate $(0 < \beta < 1)$; it can get

$$\Delta V_{tj} = \beta q_j \bullet h_t, j = 1, 2, \ldots, n; t = 1, 2, \ldots y. \tag{8}$$

(6) Adjust the threshold value of the third unit; it can get

$$\Delta R_x = \beta \bullet g_j, x = 1, 2, \ldots, y; 0 < \beta < 1. \tag{9}$$

(7) Adjust the connection weight of the first and second layers to get

$$\Delta V_{ti} = \alpha a_i \bullet h_r, r = 1, 2, \ldots, n; i = 1, 2, \ldots, m; 0 < \alpha < 1. \tag{10}$$

(8) Adjust the threshold value of the second unit to get

$$\Delta \theta_j = \alpha \bullet h_j. \tag{11}$$

Among them, $j = 1, 2, \ldots, n; 0 < \alpha < 1$.

3.2. Genetic Algorithm. First, a regular initial population is established, which is randomly generated. According to Darwin's principle of survival of the fittest, the groups that best fit the rules form new groups and offspring. The offspring establish a new population based on genetic manipulation [18]. Genetic operation is the operation of simulating biological genes. Its task is to impose certain operations on individuals according to their fitness and use genetic operations to optimize the solution of the problem generation by generation and approach the optimal solution. Each rule in the P population has a threshold that belongs to P until the population P completes the transformation. The standard genetic operation process is shown in Figure 5.

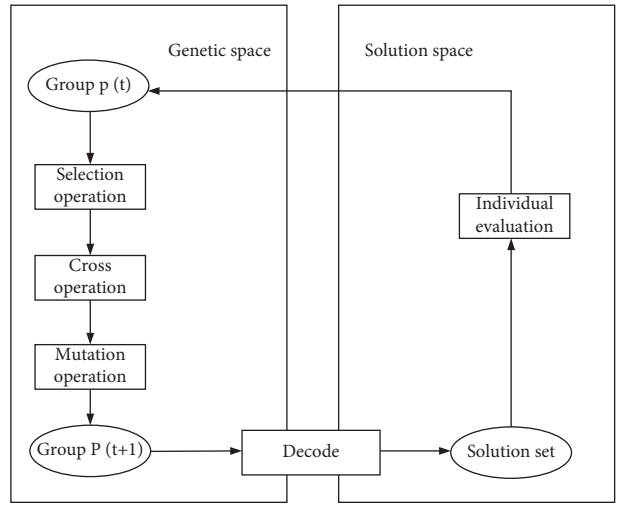

Figure 5: Schematic diagram of the standard genetic algorithm operation process.

The feature selection method can not only greatly select effective features but also reduce the dimension of feature space. It also further improves the accuracy of digital information processing and classification [19]. Firstly, the feature space of volleyball motion information is reduced in dimension by the feature selection metric method, and a feature subset with relatively low dimension is obtained. The 2χ-statistic (CHI) algorithm is used to quickly and efficiently perform the first feature selection on a large feature space [20]. χ's function is to balance imperceptibility and robustness. The larger the Chi value, the more the identification information related to the category C contained in feature t. The greater the correlation between features and categories, the more useful the identification information. Then, the second dimension reduction is performed by the method of the feature selection process of the genetic algorithm. To find the global optimal solution in the optimal feature subset, the schematic diagram is shown in Figure 6. Combining the advantages of volleyball's passing and jumping technology, it intercepts the net, improves the self-screening of the secondary ball, and changes the offensive rhythm.

The rules of the genetic algorithm can perform the survival of the fittest operation on individuals: individuals with high fitness have a high probability of being inherited into the next generation; individuals with low fitness have a low probability of being inherited into the next-generation population [21]. The probability of each individual being

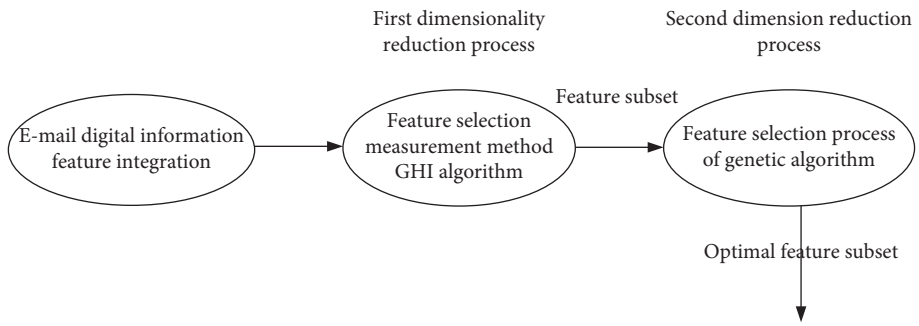

Figure 6: Schematic diagram of the feature selection method combining genetic algorithm and feature selection metrics.

selected is proportional to its fitness. The specific operation can be seen in the following formula:

$$Q(C_i) = \frac{f(C_i)}{\sum_{i=1}^{x} f(C_i)}, i = 1, 2, \ldots, n. \tag{12}$$

Among them, $Q(C_i)$ represents the probability of the *i-th* individual being selected. $f(C_i)$ represents the fitness function value of the *i-th* individual. n represents the number of individuals. Specific steps are as follows:

(i) Calculate the size of the fitness of each individual in the group

(ii) Calculate the probability of each individual being inherited into the next generation according to the formula

(iii) Calculate the cumulative probability of each individual based on the calculated probability of each individual being inherited into the next-generation population

(iv) Generate a random number in the [0,1] interval

(v) Select the corresponding individual according to the generated random number

(vi) Repeat the selection until enough individuals are selected. Here, the method that the next generation retains 10% of the individuals of the parents is adopted.

(1) Genetic Code. The crux of the encoding problem is to make the encoding represent the solution space of all possible subsets of a given feature set [22]. Assuming that W features need to be selected from a total of N feature sets ($W \leq H$), then a binary string of length H (chromosome) composed of "0" and "1" can be used to represent feasible feature combinations. "1" for any bit i of the chromosome (i is a natural number not greater than N) indicates that the i-th feature in the feature set is selected. "0" means that the feature is not selected. Clearly, the number of "1"s in the chromosomes that characterize feasible feature combinations is W.

(2) Generation of the Initial Population. The size of the initial population is generally between 50 and 100. A random method is used to select an initial group, and each individual selects an individual in {0,1} with equal probability according to the actual situation.

(3) Determination of Fitness Function. The choice of fitness function is of great significance to the optimization performance and speed of the genetic algorithm. In the heritage algorithm, a quantitative criterion is needed to measure the feature combination classification ability of each individual in the feature group:

$$f(x) = W_c - W_b. \tag{13}$$

The distance between classes is calculated as follows:

$$\begin{aligned} W_b &= \left[\left(v_i + v_j\right)\left(v_i + v_j\right)^T\right]^{1/2}, \\ v_i &= F\left[x_i\right], v_j = F\left[x_j\right]. \end{aligned} \tag{14}$$

Among them, x_i, x_j are the eigenvectors represented by the eigenvectors obtained by the first dimensionality reduction of the feature selection metric CHI method through the coding of individuals in the population. v_i, v_j are the mean eigenvectors, respectively.

Intraclass distance is calculated as follows:

$$\begin{aligned} W_b = &\frac{1}{n_i}\sum_{i=1}^{n_i}\left[\left(x_i - v_i\right)\left(x_i - v_i\right)^T\right]^{1/2} \\ &+ \frac{1}{n_j}\sum_{j=1}^{n_j}\left[\left(x_j - v_j\right)\left(x_j - v_j\right)^T\right]^{1/2}. \end{aligned} \tag{15}$$

Among them, n_i, n_j is the sample size, respectively.

(4) Genetic Algorithm Termination Rule. The feature space is first encoded. A certain number of features are selected from the feature set to form the initial feature group [23]. The termination condition of the genetic algorithm is that the algorithm finds the lowest standard solution, reaches a fixed number of generations, and reaches the allocated budget. Among them, several feature items form a genetic individual coding string. Several individual coding strings form the initial population. An individual code is a possible optimal subset of features. The fitness value of each genetic individual in the population and the average fitness of the population are calculated. Finally, the optimal genetic operation is carried out, and the next-generation population is obtained through selection, crossover, and mutation operations; the genetic algorithm termination rule is used to judge whether the genetic algorithm feature selection process is over. If the

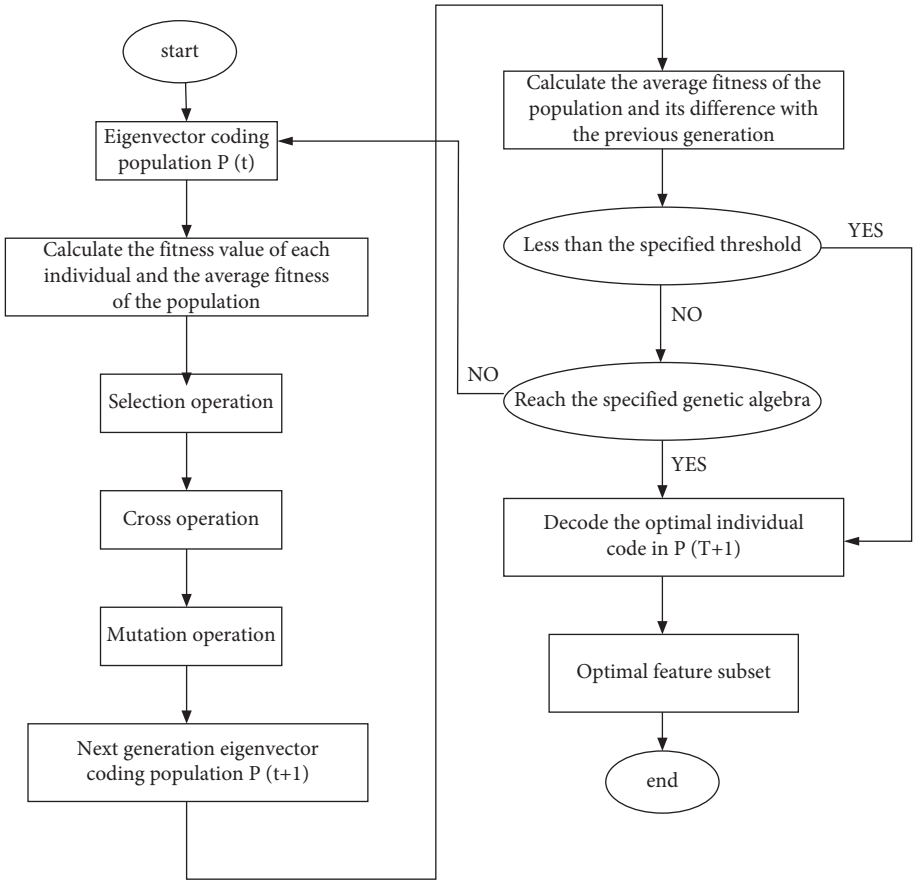

Figure 7: The flowchart of feature selection for the feature subset obtained by the feature selection metric by the genetic algorithm.

termination rule of the genetic algorithm is satisfied, the genetic individuals with the optimal characteristics are decoded and then combined to generate the optimal characteristic subset; if not, go to the second step to continue the genetic process. The flowchart is shown in Figure 7.

The weight of each feature item is calculated from the feature subset obtained by feature selection metric and two feature selections by genetic algorithm. Finally, the feature vector of mail digital information composed of feature items and weights is obtained. Through the feature selection method, the dimension of the high-dimensional vector of e-mail digital information can be reduced and a low-dimensional and better feature subset can be obtained. When selecting features according to a given feature selection measure, whether a feature can be selected only depends on the order of the corresponding measure of the feature in the set of corresponding measures of all features. This lays a solid foundation for the subsequent classification of digital information.

3.3. Clustering Algorithm. Clustering algorithms are relatively common machine learning algorithms. Their application is extensive. A clustering method is a process of dispersing the original data from a cluster to a series of data points. The algorithm starts with a given number of clusters K and then groups the data. Through continuous iterative optimization of the grouping, the clusters are finally obtained. The division of hierarchical clustering algorithm is based on the division of different objects into meaningful groups, so that the objects in the same group are similar, and the objects in different groups are not similar. K-means is the most common partition-based clustering algorithm. K-means is the most famous partition clustering algorithm. Because of its simplicity and efficiency, it has become the most widely used of all clustering algorithms. In Figure 8, an example of data clustering based on distance partitioning is given.

Hierarchical clustering algorithm is a kind of clustering algorithm. The main core content of the partitioned clustering algorithm is to divide a dataset containing N tuples or records into m groups. Each group is a cluster, $m < n$; hierarchical clustering method decomposes a given dataset hierarchically until certain conditions are met. Different from other algorithms, the hierarchical clustering algorithm builds a clustering tree according to the distance between different data. The leaf nodes of the tree are the respective raw data. Each nonleaf node in the tree is a collection of a series of original data, as shown in Figure 9.

3.4. Regression Analysis. The main object of regression analysis research is the statistical relationship between objective variables. It is based on a large number of experiments and observations on objective things, and it is a statistical method used to find statistical laws hidden in seemingly

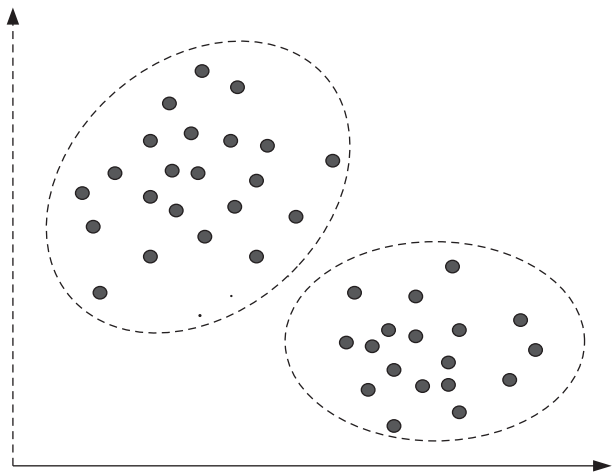

Figure 8: Example of data clustering based on distance partitioning.

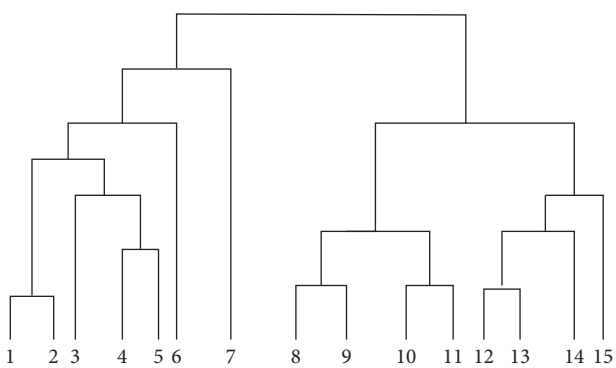

Figure 9: Example of hierarchical clustering.

uncertain phenomena. The application principle of regression analysis method is the least square method, which calculates the regression line that can best represent the relationship between business volume and mixed cost, to determine the method of fixed cost and variable cost in mixed cost.

3.5. Information Gain. As a feature selection method, information gain (IG for short) has been widely used in the field of machine learning [20]. The information gain is not symmetrical and cannot be directly regarded as a measure or distance. It starts from the perspective of motion feature information. It selects the corresponding motion features according to the value of each feature. For feature z and document category x, information gain examines the frequency of documents that appear and do not appear in z to measure the information gain for x. The information gain $IG(z,x)$ of feature z for document category x is calculated as follows:

$$IG(z) = -\sum_{i=1}^{m} P(x_i)\log P(x_i) + P(z)\sum_{i=1}^{m} P\left(\frac{x_i}{z}\right) + P(\overline{z})\sum_{i=1}^{m} P\left(\frac{x_i}{\overline{z}}\right)\log P\left(\frac{x_i}{\overline{z}}\right). \quad (16)$$

Table 1: Basic information of experimental athletes.

	Second-grade athlete	Elective class
Number	12	12
Age	20.32 ± 1.71	20.63 ± 1.92
Height	1.86 ± 0.11	1.81 ± 0.08
Training years	6–8	1–2

The higher the IG value, the more concentrated the feature in the distribution, indicating that the feature is more prominent.

3.6. The Digital Information System Is Divided into Three Subsystems of Induction, Acquisition, Analysis, and Calculation. Among them, the sensing and acquisition are the hardware system of the DIS, and the analysis and calculation are the software system of the DIS.

The hardware of the whole system and its principle are mainly sensors. In a broad sense, a sensor (transducer/sensor) is a device that can convert physical or chemical quantities into electrical signals that are easy to use. The International Electrotechnical Committee (IEC) considers that a sensor is a precomponent in a measurement system. It converts input variables into measurable signals. Common sensors in life are pressure sensors in a kettle, optical sensors in mobile phone, digital cameras, force sensors in electronic scales, temperature sensors in electronic thermometer, and so on. Of course, there are many things related to sensors in life. The working principles of these sensors are more or less similar. For example, the controllable potential electrolysis sensor measures the concentration of the gas by measuring the gas to determine the current generated during the potential electrolysis. Most of the physics experiments in middle school can be collected by sensors. DIS can use different kinds of sensors and computers to accurately obtain experimental data. In addition to saving time, this also greatly improves the accuracy of the experimental results.

4. Experiment and Result Analysis of Volleyball Based on Machine Learning and Digital Information Technology

A total of 24 subjects in this experiment were divided into two groups with different exercise levels. The high-level group are the national second-level volleyball players, and the low-level group are the ordinary students of the special class of the sports college. There are 12 players in both groups.

The basic situation of the main athletes is shown in Table 1.

The volleyball players judge the response time and accuracy statistics of the serve landing point (as shown in Figure 10).

A T-test was performed on the accuracy of volleyball players in judging their landing points. The reaction time and accuracy test of the volleyball players watching different

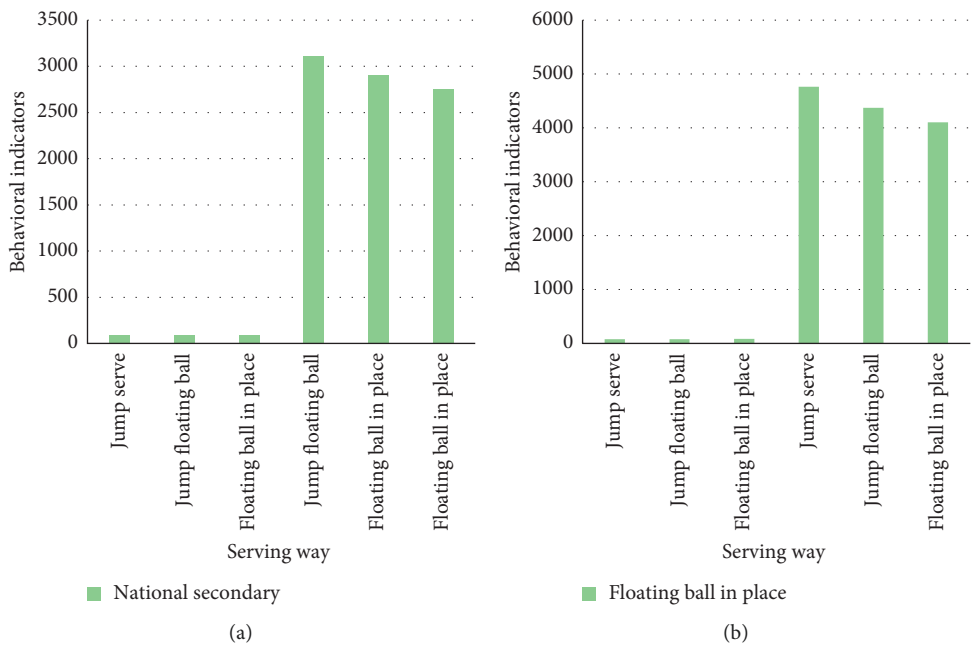

Figure 10: Athletes' behavioral indicators of serving prediction.

Table 2: The significance of accuracy comparison of volleyball players at different levels.

Main effect interaction	Freedom	F	P	Significance
Serving way	2	8.581	0.003	<0.01
Exercise level	1	11.022	0.001	<0.01
Serving way/exercise level	2	3.639	0.059	>0.05

serving styles were conducted according to the T-test when judging the landing point of the volleyball players (as shown in Table 2). It can be seen from the table that the main effect of the throwing method is significant ($F = 6.369$, $P = 0.013$). The main effect of exercise level was significant ($F = 4.103$, $P = 0.036$). There was no significant interaction between serving style and exercise level ($F = 1.537$, $P = 0.246$). After repeated tests, in different serving styles, the athletes' response to the floating ball was significantly shorter than that of the jumping ball ($P < 0.05$). The response time to the jumping ball was significantly shorter than that of the jumping serve ($P < 0.05$). This shows that the different serving styles of the players when judging the landing point of the ball have a significant impact on the players' reaction when judging the landing point. In terms of sports level, the reaction time of the students in the special class was significantly longer than that of the national second-level athletes.

The experimental results found that, in different sports situations, the levels of two different levels of athletes are not the same. The reaction time of the students in the special class was inferior to that of the second-level athletes. This shows that elite athletes can capture and extract valuable information for them in different situations and make corresponding and accurate responses.

The weight of the network is generated according to the conventional method of generating the initial weight of the neural network. BP network contains the essence of neural network. Because of its simple structure and strong plasticity, it has been widely used. In particular, its learning algorithm with clear mathematical meaning and clear steps makes it have a wide application background. Any complete network weight is

$$M_i = \{F_i, X_i, \varpi_i, \theta_i, i = 1, 2, \ldots, P\}. \tag{17}$$

It means that there are P individuals here, and P represents a weight group, which is a group size. The connection weight of the input layer to the hidden layer is denoted by F_i. The connection weight of the hidden layer to the output value is denoted by V_i. The threshold of the hidden layer is denoted by ϖ_i. Denoted by θ_i is the threshold of the output layer.

The connection weight and threshold are defined by binary coding. Each weight and threshold are represented by 0 and 1. Then, the corresponding binary strings are concatenated to form a long gene chain . A chain code represents a set of connection weights and thresholds. Since the coding string is only a parameter string of the weight and threshold of a neural network, an interpretation operator is used as the research object of machine learning and digital information technology to realize the conversion function between coding and weight. Its conversion formula is

$$m_x(t,b,c) = m_{\min}(t,b,c) + \frac{\mathrm{bin}_x}{2^x - 1}\left[m_{\max}(t,b,c) - m_{\min}(t,b,c)\right]. \tag{18}$$

Among them, $\mathrm{bin}(t)$ is a binary integer represented by a $\int$-bit string. The variation range of the connection weight is

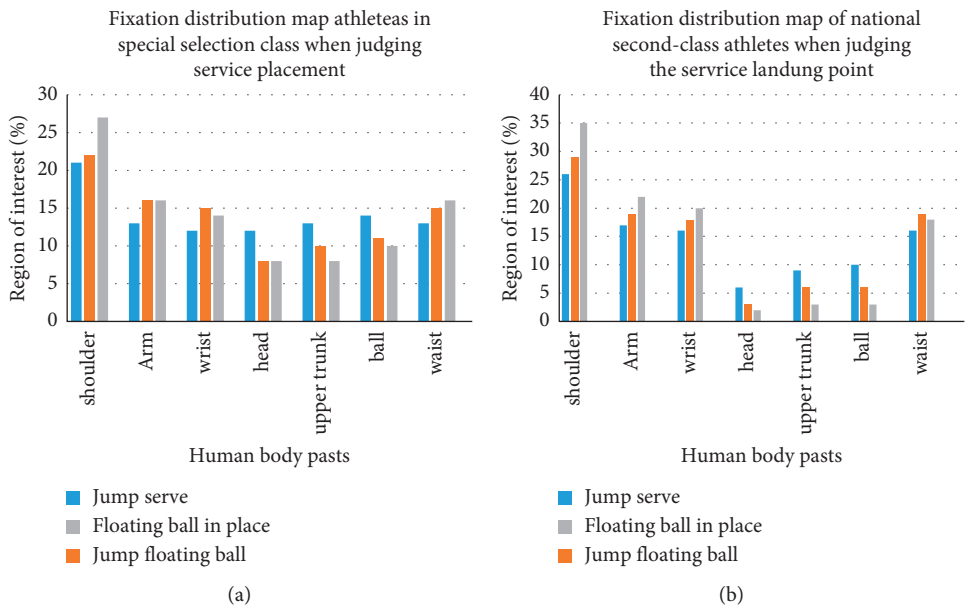

Figure 11: Comparison of gaze distribution when volleyball players judge where to serve.

Table 3: Descriptive statistics of various variables.

		$M \pm$ SD				
N		Decision accuracy	Decision response time	Decision response time	Inhibition reaction time	Conversion cost
Second-grade athlete	37	0.49 ± 0.102	839.1 ± 245.785	0.7 ± 0.170	57.90 ± 69.704	317.91 ± 114.633
Students in special elective class	49	0.6 ± 0.095	837.0 ± 320.360	0.7 ± 0.156	49.12 ± 61.178	343.02 ± 132.046
Population	86	0.5 ± 0.119	837.9 ± 289.038	0.7 ± 0.161	52.90 ± 64.734	332.22 ± 124.773
t		−6.40**	0.03	-0.16	0.62	-0.92

Note. ** representative $P < 0.01$.

denoted by $[m_{\max}(t,b,c) - m_{\min}(t,b,c)]$. Here, the length of the encoded string is set to 20, and the range of weights is $[-1, 1]$.

The sum of the squared errors between the network output value of the BP network and the expected output value can be expressed as a moderate function, and the error is used to test the performance of the network:

$$f = W - \sum_{i=1}^{N} (g_i - \hat{g}_i)^2. \tag{19}$$

Among them, W is a constant. In the *i-th* sample, the expected output value is $\hat{g}_i$, the actual output is g_i, and N represents the number of motion information samples.

The BP neural network model is an important psychological mechanism in cognitive processing. Executive function in this model plays a crucial role in motor decision-making. Through the statistics of the gaze distribution ratio of the volleyball players' served landing point judgment (as shown in Figure 11), the athletes have all points of the body that can obtain information, such as shoulders, arms, wrists, upper limbs, torso, head, ball, and waist. The data shows that the two groups of athletes have stronger cognition of shoulders, arms, and wrists and have the most gaze time. It shows that these three items are the main basis for athletes to judge where the tennis ball is. It can also be seen from the information in the figure that the national athletes pay more attention to these three parts than the athletes of the special class. In addition to this, the distribution of gaze to the ball, head, and upper torso was significantly less.

Attention must be paid to the athlete's subjective initiative to block, and in the process of practicing blocking skills, it is necessary to pay attention to the principle of gradual differentiation and the principle of overall coordination. It is also necessary to pay attention to various factors on the decision-making ability of volleyball players to block shots, recognize the shortcomings of athletes, and improve the refreshment function of athletes. The digital information system just supports the athlete's subjective position in the experiment, allowing the athlete to use the refresh function to respond to the decision in the interference situation. Descriptive data statistical analysis was performed on the study variables, and the differences in exercise levels were compared. The results are shown in Table 3.

Table 4: Correlation matrix of various variables.

	1	2	3	4	5	6
(1) Decision accuracy	1					
(2) Decision response time	−0.19	1				
(3) Decision response	0.13	−0.13	0.02	1		
(4) Inhibition reaction	−0.15	0.02	−0.07	−0.06	1	
(5) Conversion cost	−0.11	0.04	0.1	0.15	30**	1
(6) Exercise level	0.57**	0	1			

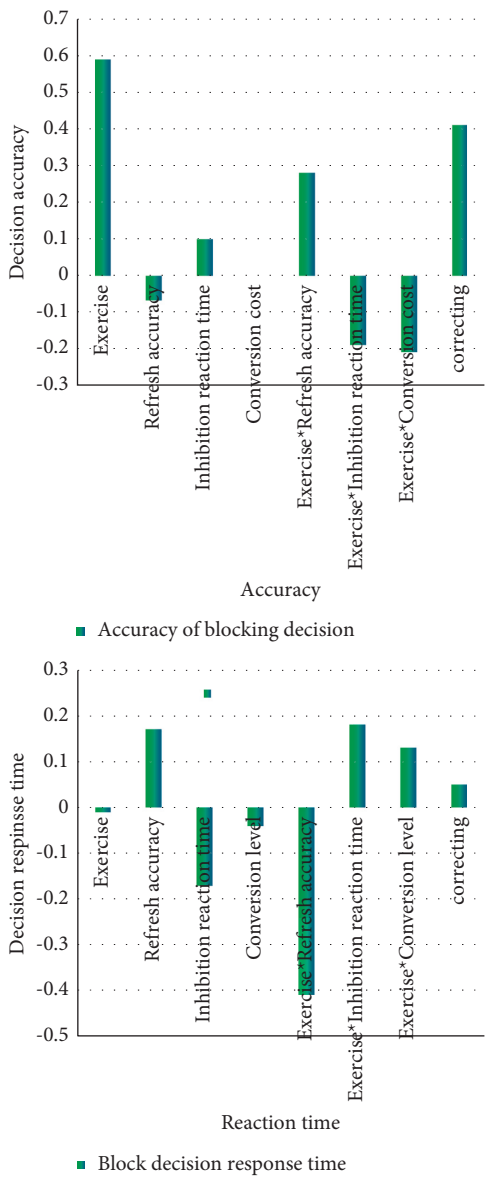

Figure 12: Comparison of regression analysis with block decision accuracy and reaction time variables.

The results showed that the correct rate of blocking decision-making of secondary volleyball players was significantly higher than that of selected volleyball players ($t = 6.40$, df = 84, $P < 0.05$); in the block decision reaction ($t = 0.03$, df = 84, $P = 0.97$), refresh correct rate ($t = -0.16$, df = 84, $P = 0.87$), inhibition reaction ($t = 0.62$, df = 84, $P = 0.54$), and the conversion cost ($t = -0.92$, df = 84, $P = 0.36$), there was no significant between-group difference in exercise level.

Correlation analysis was carried out on the variables of the study. The data showed that the sports level of the athletes had a great relationship with the decision-making accuracy, but the correlation with the decision-making response time was not significant, and the correlation with other variables was also not obvious. For second-level athletes, the refresh accuracy rate can intuitively and clearly predict the block decision accuracy rate. The higher the refresh accuracy rate, the higher the decision accuracy rate; for athletes in the low-level group, the refresh accuracy rate cannot predict the block decision accuracy rate. Comparing the two groups of athletes at different levels, it is obvious that the second-level athletes are more affected by the refresh function of decision-making accuracy, as shown in Table 4.

Regression analysis of blocking decision based on two sets of different variables is shown in Figure 12.

It can be seen from the figure that the block decision of the volleyball player by the refresh function is regulated by the sports level. Compared with high-level athletes and low-level athletes, the high-level athletes' block decision-making response was more affected by the refresh function. For low-level athletes, refresh accuracy does not predict the accuracy and response of their blocking decisions. The results all show that the national second-level long-distance mobilizers are better than the special class athletes in terms of blocking decision-making rate.

5. Discussion

In this article, through experimental comparison, we know that there are many methods of machine learning, which are widely used, and there are many methods that can act on volleyball. As an optimization search method, genetic algorithm has the characteristics of intelligence, process, robustness, and overall optimization. Through the application of artificial neural network and genetic algorithms in volleyball, this paper provides more effective methods for players to serve, land, and block volleyball and at the same time improves the players' prediction ability and accuracy.

6. Conclusions

This paper studies the impact of athletes' athletic level, decision-making accuracy, and decision-making response time, as well as the refreshment function and cognitive level of athletes on hitting, landing, and blocking during tennis. The higher the exercise level is, the less it is affected by other factors, the faster the reaction speed is, and the more accurate the judgment is. Executive function influences block decision-making in high-level volleyball players. Refresh, transform, and suppress functions play different roles in motor decision-making.

Data Availability

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Research Article

Professional Construction and Talent Training Mode in the Era of Intelligent Internet of Things: Take Asset Appraisal Major as an Example

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With the continuous development of Internet technology, mobile terminals are becoming more and more popular in people's lives, and the unprecedented wave of informatization promotes the development of all aspects of people's lives. The intelligent Internet of Things can not only bring people the information age but also allow learners to continuously learn and innovate online, breaking through the limitations of time and space. This paper aims to study how to make good use of the technology of intelligent Internet of Things to promote the development of professional construction and talent training mode in the era of intelligent Internet of Things. Based on the intelligent Internet of Things, this paper proposes data mining technology and an algorithm for association rules. The country should continue to innovate and research the mode of professional construction and personnel training. The experimental results of this paper show that, in 2015, there were about 106,000 asset appraisal practitioners and 34,000 Asset Appraisers in China. By 2019, there were about 121,000 asset appraisal practitioners and 41,000 Asset Appraisers in China. People and talents in the field of asset evaluation are in great need of intelligent IoT technology to improve the objectivity and accuracy of evaluation results, and the asset evaluation profession also needs intelligent IoT technology to innovate talent training models, and relevant personnel should continue to work hard on themselves to improve their own strength and continue to learn in combination with the intelligent Internet of Things.

1. Introduction

As the trend of economic globalization becomes more and more obvious, the cooperation and exchanges between countries are getting closer and closer, and the division of labor is becoming more and more detailed. Traditional trade methods coexist with many new foreign trade methods. In the face of various new situations in the era of financial crisis, the traditional talent training model has become less and less suitable for the needs of the market and industry. How to deliver high-quality and compound talents to the society has become a new focus.

The Internet of Things refers to the connection of any object with the network through information sensing equipment and according to the agreed protocol, and the object exchanges and communicates information through the information transmission medium to realize intelligent identification, positioning, tracking, supervision, and other functions. Innovative education is carried out through the innovative talent training platform based on the intelligent Internet of Things. The use of the innovative talent training platform based on the intelligent Internet of Things will change the activities of learners, educators, and managers and improve the effect of education and teaching. It can provide new conditions and means for cultivating innovative talents and enrich the content of mobile learning research and application.

The innovations of this paper are as follows: (1) The theoretical knowledge of the intelligent Internet of Things and the talent training mode is introduced, and the intelligent Internet of Things is used to analyze how the interaction of the intelligent Internet of Things plays a role in the professional construction and talent training mode. (2) Data mining and association rules are expounded. Through

experiments, it is found that the professional construction and personnel training mode based on the intelligent Internet of Things can promote the development of social economy.

2. Related Work

With the development of modern economy, the intelligent Internet of Things has also been widely used. Vijay S found that Internet of Things (IoT) devices have the ability to perform transmission control protocol communication on their own, which can handle part of the application logic. IoT, therefore, refers to a network of physical objects embedded with electronics, software, sensors, and connections to enable objects to exchange data with manufacturers, operators, and other connected devices. He expects the number of IoT devices to grow rapidly in the next few years. Although the scholar discovered the capabilities of IoT, he did not explain the importance of IoT [1]. Deebak [2] found that the Internet of Things (IoT) leverages smart technologies to facilitate the design and development of smart city projects. It provides long-range communication between smart devices and application systems via low-power wide-area networks (LP-WAN) but fails to enable channelized access security. Therefore, he proposes a scheme for authentication and key management for smart IoT assistance systems. Although this scholar discovered that IoT has security problems and proposed a solution, he did not give a specific explanation of the solution [2]. Tan et al. [3] found that, with the proliferation of 5G, sufficient interaction between Internet of Things (IoT) devices and cellular users will generate massive flows of cyber-physical information in real time. How to capture the insights behind this data in a smart city environment is receiving a lot of attention these days. They presented a highly functional metropolitan scene covered by multiple drones acting as caching edge computing nodes. Although the scholars introduced the large scene used, there is no experiment to prove the practicability of the scene [3]. Liu et al. [4] found that wireless body sensing plays a crucial role in human-computer interaction environments, where human activities and even emotions can be recognized by computers. Each sensing technology has its own characteristics and advantages, making it suitable for specific application scenarios. For example, WiFi-based solutions can enable noninvasive human sensing, while RFID-based solutions can enable individual human sensing in multiperson scenarios. The scholars only roughly described the application of wireless human body sensing and did not describe it in detail [4]. Razzaque et al. [5] discovered that the Internet of Things (IoT) envisions a future where digital and physical things can be connected through information and communication technologies to enable a range of applications and services. The nature of IoT, including hyperscale IoT, heterogeneity at the device and network level, and the large number of events that arise spontaneously from these things, will make developing diverse applications and services a very challenging task. Although they found the task to be very challenging, they did not introduce the challenges faced or give corresponding solutions [5]. Lin et al. [6] found that edge computing has been proposed to be combined with IoT to enable computing service devices to be deployed at the edge of the network. It aims to improve the user's experience. With the advantages of distributed architecture and closeness to end users, edge computing can provide faster response and higher quality of service for IoT applications. Although the scholars found that the combination of edge computing and the Internet of Things can enhance the user experience, they did not explain how to combine the two specifically [6]. Dobkin [7] found few trials showing better treatments after stroke. Improvements in therapy have also not been as clinically robust as had been hoped. But, via the Internet, it is possible to remotely monitor the type, quantity, and quality of exercises in homes and communities and provide feedback to optimize training frequency, intensity, and progress at home. A suite of home-based rehabilitation Internet of Things (RIoT) devices could provide a theory-driven foundation for strengthening and fitness. RIoT may include wearable activity recognition sensors and instrumented rehabilitation devices with radio transmission to a smartphone or tablet to continuously measure repetition, velocity, accuracy, force, and spatiotemporal characteristics of movement. Although the scholar proposed a method to use the Internet of Things to improve the recovery rate of patients, the scholar did not have specific experiments to illustrate the feasibility of this method [7]. Singh et al. [8] found that, to realize the broad vision of ubiquitous computing underpinned by the "Internet of Things" (IoT), application- and technology-based challenges must be broken. Working in IoT tends to be subsystems; it often focused on a specific technical problem or application area, before offloading data to the cloud. Therefore, this presents a problem of security risks. They focused on IoT security considerations from both the end user perspective and cloud provider perspective to identify security considerations that require further work. Although the scholars put forward the problem of security risks in the Internet of Things, they did not propose corresponding solutions [8].

3. Overview of the Data Mining Method Based on the Intelligent Internet of Things

3.1. Data Mining Technology Based on Intelligent Internet of Things. Data mining refers to the use of machine learning algorithms to obtain new knowledge from large amounts of data, which have the characteristics of large amounts of data and real data. The definition of data mining shows that, in practical applications, information with potential use value that people do not know in advance can be mined from a large amount of incomplete noise and fuzzy random data [9].

Data mining is more and more widely used in enterprises and institutions, and it has become a new economic asset. It is regarded as the minerals and oil of the new century, which has brought a new entrepreneurial direction, business model, and investment opportunities to the whole society. Data mining is the process by which researchers obtain valuable knowledge from large amounts of data, and it is

defined as an important part of knowledge discovery. The implementation process of data mining is shown in Figure 1.

As shown in Figure 1, the realization process of data mining includes data cleaning, data integration, data selection, and data mining. The first four steps are the preprocessing stage of the data. Generally speaking, the implementation process of data mining is divided into several processes, such as determining the object of the mining task, data preprocessing, data mining, pattern evaluation, and knowledge expression [10].

3.1.1. Association Rule Algorithm. The confidence of the rule $A \Rightarrow B$ in the transaction set refers to the ratio of the item set including A and B to the item set including A, which is used to measure the credibility of the association rule [11]. Association rules are not limited by the number of dependent variables and can find associations between data in large databases, so they are widely used. It is written down as follows:

$$\text{confidence}(A \Rightarrow B) = \frac{\sup(A \cup B)}{\sup(B)}. \tag{1}$$

Association rule mining is a very important research direction in the field of data mining. Through this technology, valuable data items can be mined from a large amount of data [12].

3.1.2. Perceptron Algorithm. The perceptron algorithm is an algorithm used to solve linearly separable problems. Its shortcoming is that it cannot solve nonlinearly separable problems. The following is an introduction to the perceptron algorithm [13]. The perceptron is a binary classification algorithm, the input instance is a feature vector, and the instance category of the output instance has only two values of +1 and −1. Perceptron is a linear classification model, which is a kind of discriminant model. The structure diagram of the perceptron model is shown in Figure 2.

As shown in Figure 2, a_i represents the value of the input sample on the i-th dimension, w_i represents the weight connecting the perceptron and the input, $i \in \{1, 2, 3, \ldots, d\}$, b represents the values calculated by the perceptron, and θ represents the threshold corresponding to the perceptron. Then the linear model represented by the perceptron model is as follows:

$$b = f(a, b \mid w, b) = \text{sgn}(wa + b). \tag{2}$$

The training purpose of the perceptron model is to find the parameters, so that all categories can find a best hyperplane, so that all sample points are closest to the hyperplane [14]. Consider the sample composition of the training set in the following formula:

$$(A, B) = \left\{\left(a^1, b^1\right), \left(a^2, b^2\right), \left(a^i, b^i\right), \ldots, \left(a^n, b^n\right),\right\}. \tag{3}$$

In order to explain the algorithm simply, it is assumed that the algorithm is a binary classification problem, assuming that the positive class is +1 and the negative class is −1; then $A_i \in R^d, b^i \in \{+1. - 1\}$, assuming that the input through the perceptron model is a_i, and the corresponding output is represented by $\tilde{v}$. The correct classification can be expressed as follows:

$$\tilde{v}, b^i = 1. \tag{4}$$

Thus, the error is calculated by all the misclassified points in the model, and the error function is as follows:

$$L(w, b) = -\sum_{i=1}^{m} b^i\left(w.A^i + b\right). \tag{5}$$

The perceptron model has a good effect on linear classification, but the processing of simple nonlinear problems often fails to meet the requirements, and the algorithm cannot be iterative [15].

3.1.3. Gradient Descent. The gradient descent algorithm is a kind of convex optimization, and its core idea is as follows: the opposite direction of the gradient is the fastest direction in which the value of the convex function decreases. Through this idea, different values are generated for the continuous iteration of the function, which will eventually converge to a local optimal value [16]. Consider its cost function as follows:

$$J(a, b \mid \theta) = \frac{1}{2}\sum_{i=1}^{n}\left((A \mid \theta) - b_i\right)^2. \tag{6}$$

In applications, the loss function is usually associated with the optimization problem as a learning criterion. The cost function is the objective function used to find the optimal solution, which is also the role of the cost function. Among them, (a_i, b_i) represents a piece of sample data in the training set, and n represents the total number of samples. Then it is easy to find the following formula:

$$\frac{\partial J}{\partial \theta} = \frac{\partial f}{\partial \theta}\sum_{i=1}^{n}\left((f A_i \mid \theta) - b_i\right). \tag{7}$$

The gradient descent algorithm learns like this until the algorithm converges or reaches the set number of iterations and finds the minimum value. Although the gradient descent algorithm is very good, there are still many problems [17]. Gradient descent is widely used in machine learning, whether in linear regression or in logistic regression. Its main purpose is to find the minimum value of the objective function through iteration or to converge to the minimum value.

The stochastic gradient descent algorithm refers to randomly selecting a sample from the training dataset for learning each time; that is,

$$\theta = \theta - \eta\frac{\partial J(a_i, b_i \mid \theta)}{\partial \theta}. \tag{8}$$

In the above formula, (a_i, b_i) represents a randomly drawn sample. The batch gradient descent algorithm uses the entire training set each time, so these calculations are redundant because the same dataset is used each time. However, the disadvantage of the stochastic gradient descent

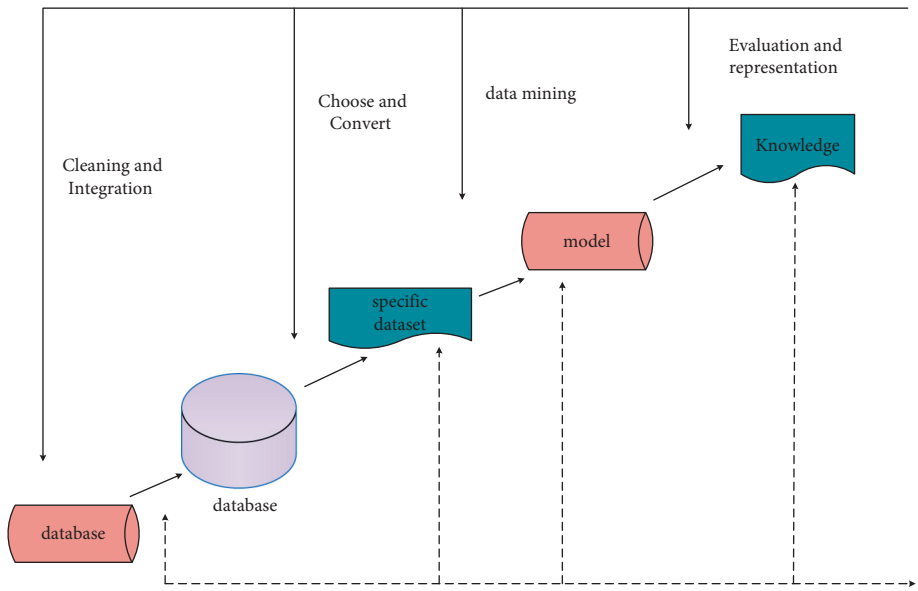

Figure 1: Data mining implementation process.

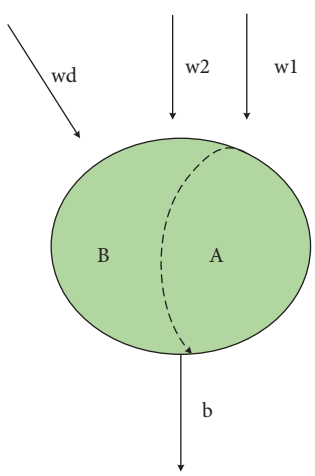

Figure 2: Perceptron model diagram.

algorithm is that each update of the simulation parameters does not follow the correct direction, so it may cause optimization fluctuations [18].

The AdaGrad algorithm uses a different learning rate η_i for each different model parameter θ_i in each update process, and the gradient of the parameter θ_i of the objective function is $g_{t,i}$; that is,

$$g_{t,i} = \nabla_\theta J(\theta_i). \tag{9}$$

The AdaGrad algorithm is to square the gradient of each iteration of each parameter and accumulate it and then divide the global learning rate by this number as a dynamic update of the learning rate. The main advantage of AdaGrad is that each parameter adapts to different learning rates. The disadvantage is that the sum of squares of the parameter gradient sequence must be calculated, and the learning efficiency continues to decline, eventually reaching a small value [19].

The Adam algorithm is also a method to determine gradient descent at different rates according to different parameters. The Adam algorithm obtains the advantages of the AdaGrad and RMSProp algorithms at the same time. Adam not only calculates the adaptive parameter learning rate based on the first-order moment mean like the RMSProp algorithm but also makes full use of the second-order moment mean of the gradient. Its calculation is shown as follows:

$$m_t = \beta_1 m_{t-1} + (1 - \beta_1) g_t, \tag{10}$$

where m_t and g_t are the weighted average and weighted biased variance of the gradient, respectively, and the bias correction for m_t and g_t is shown as follows:

$$\widehat{m}_t = \frac{m_t}{1 - \beta_1^t}. \tag{11}$$

Ultimately, Adam's update formula is

$$\theta_{t+1} = \theta_t - \frac{\eta}{\sqrt{v_t + \varepsilon}} \widehat{m}_t. \tag{12}$$

The adaptive learning rates of Adam and AdaGrad are compared, and the effect is better [20].

3.1.4. Data Warehouse. A data warehouse is a strategic collection that provides all types of data support for decision-making processes at all levels of an enterprise. It is a single data store, created for analytical reporting and decision support purposes. The object to be classified is called a sample; for example, $u_{i1}, u_{i2}, \ldots, u_{im}$ is a sample set. That is,

$$u = (u_{i1}, u_{i2}, \ldots, u_{im}), \quad (i = 1, 2, \ldots, n). \tag{13}$$

In the above formula, u_{ik} represents the data obtained by the i-th sample for the k-th indicator, and their average is calculated according to the following formula:

$$u_k = \frac{(u_{1k} + u_{2k} + \cdots u_{nk})}{n} = \frac{1}{n} u_{ik}. \quad (14)$$

Then the standard deviation of these raw data is calculated as follows according to formula (14):

$$S_k = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (u_{ik} - u_k)^2}. \quad (15)$$

As a higher education institution, the central task is to cultivate high-level talents. Nowadays, the education informatization of various universities has made great progress [21]. Although a large amount of educational data has been accumulated, it is rarely possible to analyze these data in detail with the research basis for training faculty members with data mining technology. The result of data mining and analysis in the process of talent training is that the daily management of talent training, the realization of database decision-making and management, and the construction and layout of database experts will be suitable for continuous tracking and evaluation of student training [22, 23].

3.2. Review of Talent Training Models in Foreign Universities. As a talent nation, American colleges and universities have always attached great importance to talent training. With the continuous development of the American economy and society, the curriculum system and talent innovation training of American colleges and universities have been in the process of reform and development. Their representative talent training models mainly include Harvard, MIT, and Columbia [24].

(1) Harvard's multitalent training model. Harvard University attaches great importance to cultivating students' talents within and outside the discipline and sets up a diversified curriculum system. This will help guide students to establish a good self-concept, develop conscious study habits, absorb diverse knowledge, and give full play to their potential. This training mode can expand students' vision of analyzing problems and provide students with a series of methods for understanding, analyzing, and solving problems in professional courses, and it can promote all-round development and innovation ability of human beings [25, 26].

(2) MIT's "dual system" talent training model. The "dual system" training mode not only means that students learn knowledge in school but also means that they also need to practice skills in enterprises. Among them, the training is in charge of vocational schools and enterprises. MIT attaches great importance to students' hands-on ability.

(3) Colombia's extensive talent training model. The talent training model of Columbia University is characterized by compulsory education and interdisciplinary courses called "large-caliber training model based on general education." Students can choose different levels of training packages according to their learning ability, learning status, and interest in learning. This talent training model promotes students' innovative thinking mode, actively thinking about problems on the basis of general education, enabling students to have a wide range of knowledge and depth in and outside the field.

3.3. Professional Construction and Personnel Training of Asset Appraisal. The general purpose of asset appraisal or the basic purpose of asset appraisal is determined by the nature of asset appraisal and its basic functions. As a social intermediary activity for professionals to estimate and judge the value of assets at a specific time point and under specific conditions, the general purpose of asset evaluation can only be the fair value of assets at the time of evaluation. China's asset appraisal industry has gradually developed in the process of the reform and opening up of the socialist market economy. As an independent professional market service industry, it has been recognized by the society and played an indispensable role. This article analyzes the number of appraisal practitioners and registered Asset Appraisers in China from 2015 to 2019, as shown in Table 1.

As shown in Table 1, China's asset appraisal industry continues to grow, and the numbers of appraisal entrepreneurs and registered Asset Appraisers are also increasing, basically forming a talent team that meets the development needs of the appraisal industry. At the end of 2019, there were more than 100,000 Asset Appraisers and more than 40,000 registered Asset Appraisers in China. The asset appraisal talent training process is shown in Figure 3.

As shown in Figure 3, talent training in China's asset appraisal industry has just started, and the training system is imperfect, resulting in uneven abilities, low overall level, and weak basic knowledge, making it difficult to adapt to the needs of the structure, appraisal industry, and social development. The problems that arise in evaluating the existing talent training system in the industry are shown in Figure 4.

As shown in Figure 4, the existing talent training system in China's evaluation industry is not perfect, and there are some problems such as unclear training purposes, imperfect training methods, and unclear training objects. Therefore, the establishment of a new model must clarify the content and responsibilities of each component and adopt an effective adjustment mechanism that organically combines each component.

3.3.1. The Main Problems Existing in Talent Training in the Industry. Cultivating professionals with insufficient asset appraisal business limits the cultivation of high-end talents in the appraisal industry. It is not conducive to the establishment of a high-quality appraisal expert team and is not conducive to the healthy development of China's asset appraisal industry. The low educational level of some asset appraisal industrialists is the main problem of the current appraisal team and the main obstacle in the process of talent training. The main obstacles in the talent training process are shown in Figure 5.

Table 1: The number of appraisal practitioners and Asset Appraisers in China from 2015 to 2019.

Types of	2015 (10,000 people)	2016 (10,000 people)	2017 (10,000 people)	2018 (10,000 people)	2019 (10,000 people)
Assessing practitioners	10.6	10.7	11.3	11.7	12.1
Asset Appraiser	3.4	3.5	3.7	3.9	4.1
Total	14	14.2	15	15.6	16.2

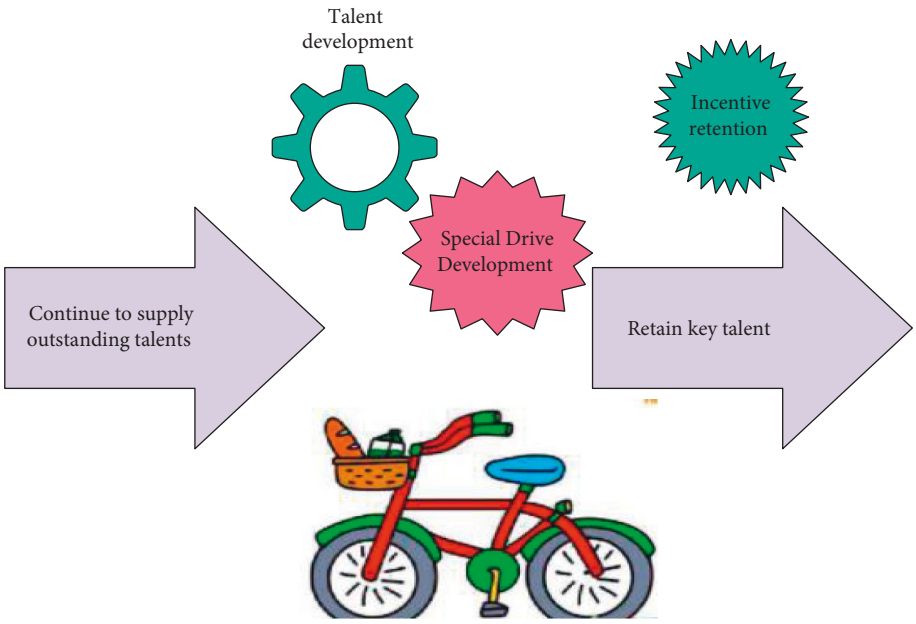

Figure 3: Asset appraisal talent training process.

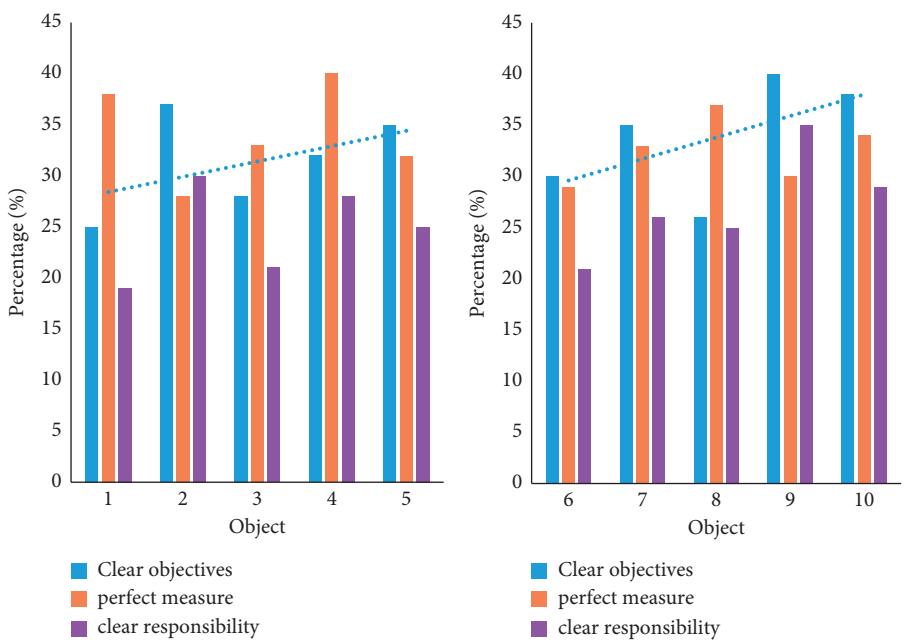

Figure 4: Assessing problems with the industry's existing talent development system.

As shown in Figure 5, follow-up education is an educational activity for all members of society, especially adults, after school education and an important part of the lifelong learning system. Undoubtedly one of the best ways to achieve this is through follow-up education and training, and follow-up education should be standardized. As the initial intermediary service industry in China's asset appraisal industry, in order to meet the needs of the development of the asset appraisal industry, it is necessary to continuously update knowledge and adjust the deviation

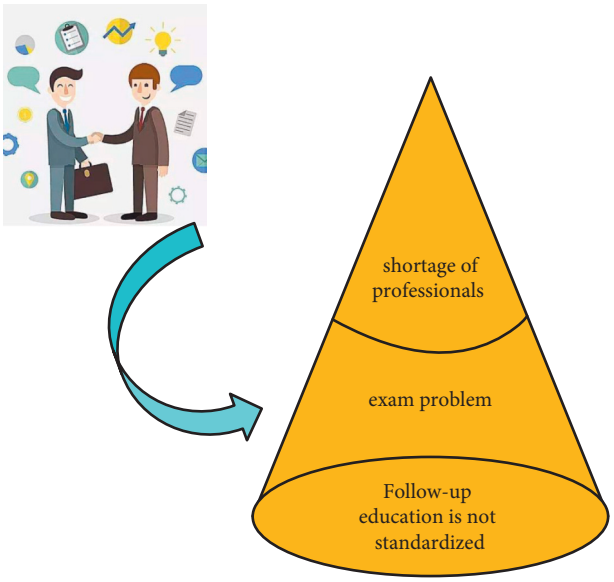

Figure 5: The main obstacles in the talent development process.

from registered asset appraisal experts. One of the best ways to do this is through follow-up education and training.

3.3.2. Approaches to the Reform of the Talent Training Model. In order to enable students to integrate the learning of knowledge, attitudes, and skills, it is necessary to promote the combination of learning and work, implement cooperation between schools and enterprises, and implement the curriculum model of "open courses + courses + educational projects." According to the professional characteristics, the educational model of practical training is constantly innovated. Scholars have put forward the talent training model of higher vocational education "teaching according to the position and integrating the curriculum certificate." The integration of teaching by post and class certificate is shown in Figure 6.

As shown in Figure 6, taking the occupational standpoint as the starting point, the professional training process of various research projects is integrated. The job competency requirements are consistent with the purpose of professional training, and professional curriculum phases must be set. In order to achieve a high level of skills, a high-quality talent training model is opened.

(1) Clarify the Training Objectives and Accelerate the Improvement of the Professional Training System. According to the survey of talent training needs, Chinese enterprises currently have a low demand for students with secondary vocational education. Colleges must have a clear training purpose, mainly to cultivate practical international experts for enterprises. Specifically, it is to cultivate talents in the all-round development of morality, intelligence, and physique to meet the needs of enterprise development.

(2) Strengthen Practical Teaching and Establish an on-Campus Simulation Training Base. To cultivate applied asset evaluation talents, it is necessary to pay attention to the cultivation of students' skills and quality, which is also in line with the teaching characteristics of secondary vocational schools. But, at present, the application forms of asset appraisal in various enterprises are various. Only relying on the simulation training platforms of the existing secondary vocational schools cannot effectively achieve the training effect, and it is far from enough, because these simulation training platforms are simple and incomplete. The simulation training platform is shown in Figure 7.

As shown in Figure 7, setting up a simulation company in a school can be combined with a simulation platform. By establishing a simulation company, it can improve students' interest in learning and awareness of participating in the classroom, improve vocational skills and employment skills, enrich students' cultural life after school, and cultivate students' professional ethics. In addition, it can strengthen students' social ability and organizational management ability and provide students with practical experience in society.

(3) Create a Workplace and Strengthen the Cultivation of Students' Professional Quality. At present, the orientation of talent training in vocational schools needs to be further clarified, and the students trained lack skills and characteristics, which are still far from the requirements of enterprises. Graduates have to go through a long period of practice to adapt to their jobs, and the adaptation period is too long. At the same time, the content of students' learning in school is very different from the actual requirements. Many graduates reflect that the knowledge they have learned in school cannot be used in actual positions, and the teaching content is seriously lagging behind. In addition, graduates have poor adaptability after transfer and are facing great reemployment pressure. All kinds of situations show that the current teaching mode and training method must be reformed, and, by reshaping the "student work site," the training method is in line with the actual needs of enterprises and the development needs of students.

(4) Promote School-Enterprise Cooperation and Realize Seamless Connection of Talent Training. The "student work site" is close to the actual situation of the enterprise, creating an environment conducive to students' skill learning and of course learning the strengths of the enterprise. The goal of talent development is to cultivate highly skilled personnel. Therefore, schools must create a good environment for students in terms of hardware equipment, curriculum, practical education, and so forth and increase students' practical skills to improve their competitiveness.

4. Experiment and Analysis of Data Mining and Talent Training Mode

4.1. Performance Analysis of Adam Algorithm and AdaGrad Algorithm. This paper conducts experiments on the performance of Adam algorithm and AdaGrad algorithm. Since this experiment uses a multiclassification problem, the Softmax function is finally used as the basis for classification.

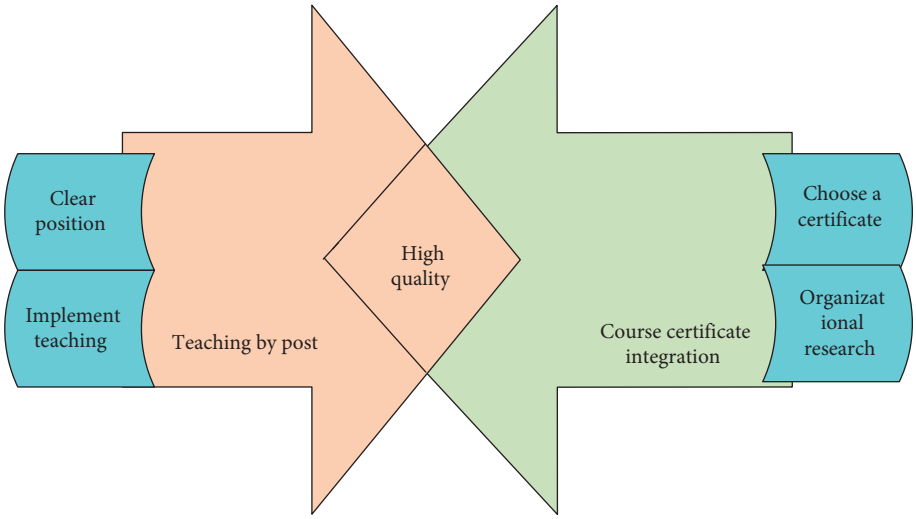

Figure 6: The operation mechanism of the talent training model of "teaching for posts and integrating courses and certificates."

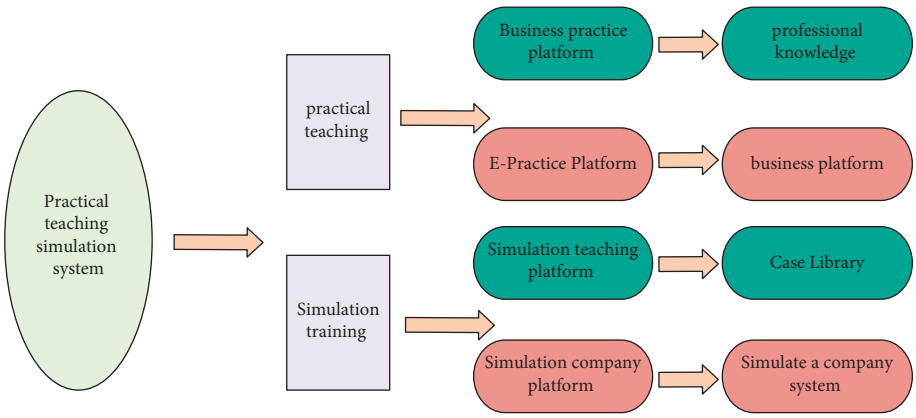

Figure 7: Simulation training platform.

In the process of designing the neural network, the number of neurons in each layer of 4 groups of experiments is designed as shown in Table 2.

As shown in Table 2, Softmax function, also known as normalized exponential function, is the generalization of the binary classification function sigmoid in multiclassification, and the purpose is to display the results of multiple classifications in the form of probability. Through optimization by different optimizers, the correct rate of classification results in the training process changes with the increase of the number of iteration steps as shown in Figure 8.

As shown in Figure 8, it can be seen from these figures that when the number of iteration steps is 10–100, the recognition accuracy rate of Adam algorithm reaches about 85%. The accuracy of the AdaGrad algorithm is about 75%. With the increase of the number of iterations, the correct rate of training continues to increase, and the increasing trend is basically caused by different optimization algorithms. It is found that the Adam algorithm is better than the AdaGrad algorithm in the training process.

When testing, the correct rate of the method using Adam gradient update is shown in Table 3.

As shown in Table 3, the correct rate of Adam algorithm increased from 50.67% at the beginning to 80.41% at the end, which increased by 29.74%. It is found that increasing the number of parameters makes the neural network model more prone to overfitting. If the number of parameters is too small, the model will be underfitted, and finally the Adam gradient update method is used.

4.2. Significance of the Talent Training Model in the Era of Intelligent Internet of Things. At present, with the rapid development of mobile Internet, the mobile phone market is booming. More and more information and data are transmitted and exchanged in society through these platforms. In such a development period with fierce competition, rapid social changes, and limited resources, as the source of national development, the importance of innovation is self-evident. With the development of the times and the advancement of technology, the training mode of innovative talents cannot be limited to the traditional teaching mode. Figure 9 shows the significance of the talent training model in the era of intelligent IoT.

Table 2: Performance analysis of Adam algorithm and AdaGrad algorithm.

Number of experimental groups	First hidden layer	Second hidden layer	Third hidden layer
1	30	9	9
2	90	30	30
3	120	90	90
4	150	120	60

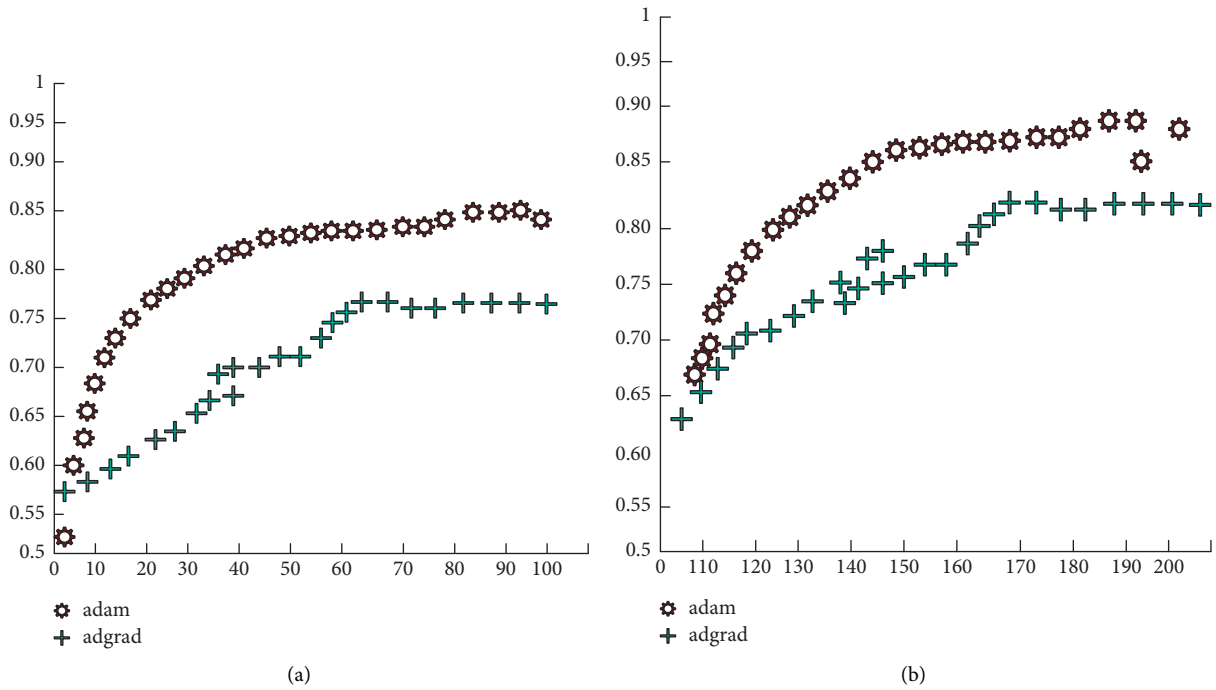

Figure 8: Comparison of AdaGrad and Adam algorithms. (a) Comparison of AdaGrad and Adam algorithms with 10–100 iteration steps. (b) Comparison of AdaGrad and Adam algorithms with 110–200 iteration steps.

Table 3: The correct rate of Adam's gradient update method.

Gradient updated method	First hidden layer	Second hidden layer	Third hidden layer (%)
Adam	30	9	30.00
Adam	90	50	55.56
Adam	120	90	75.00
Adam	150	120	80.00

As shown in Figure 9, the significance of the talent training model in the era of intelligent Internet of Things has the following points:

(1) The use of the innovative talent training platform based on the mobile Internet will change the activities of learners, educators, and managers and improve the effect of education and teaching. The platform will enable learners to break through the limitations of time and space on the mobile learning platform. Through the mobile learning mode, the learning of innovative knowledge is completed, so as to effectively support the innovative activities of learners.

(2) The use of innovative talent training platform based on mobile Internet will enrich the content of mobile learning research and application. Mobile learning, as a new learning mode that emerged in the 1990s, is in a stage of vigorous development with the progress of the times.

(3) The innovative talent training platform based on the intelligent Internet of Things is learner-centered, which is convenient for learners to break the limitation of time and space and obtain learning resources. Its functions include the integration of system message sending, course learning, theoretical learning, and search and sharing of learning

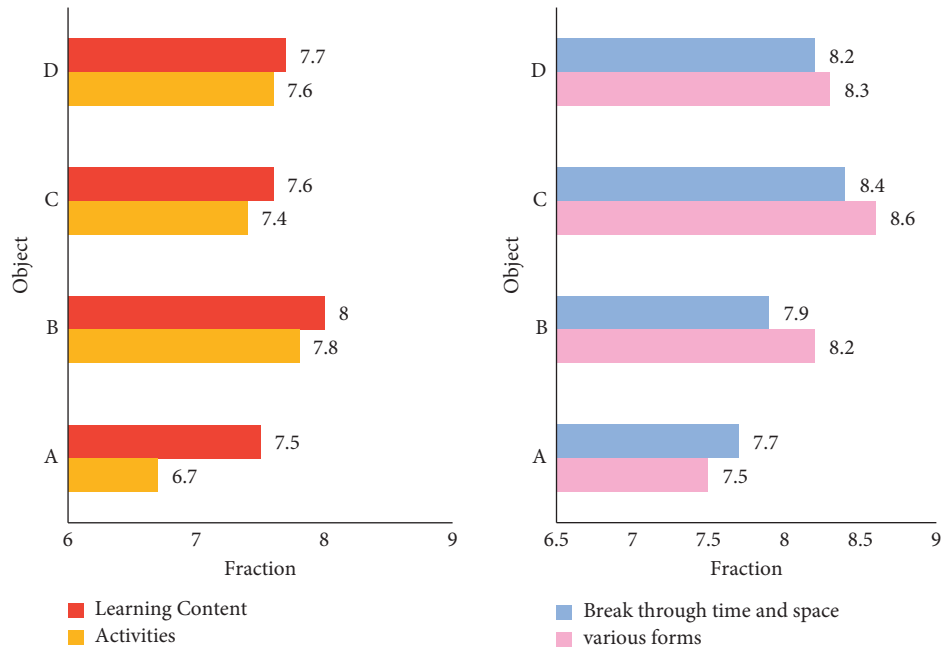

Figure 9: The significance of the talent training model in the era of intelligent IoT.

resources, which bring learners a more flexible and innovative learning experience.

(4) The use of the innovative talent training platform based on the intelligent Internet of Things will provide new conditions and means for cultivating innovative talents. The research and development of innovative talent training mobile learning platform take advantage of the technological advantages of the mobile Internet. The high degree of temporal and spatial freedom of the mobile learning platform fills the gaps in the previous innovative talent training methods and provides teaching resources for innovative talent training.

5. Conclusions

In this era of rapid economic development, enterprises have higher and higher requirements for talents, so relevant personnel can only improve their own abilities through their own continuous progress to meet the talent needs of enterprises. Not only do they need to work hard but also relevant departments need to strengthen professional construction and the development of talent training models. The intelligent Internet of Things can bring unlimited knowledge to the relevant personnel and bring inspiration to the relevant departments to innovate the talent training model. This article elaborates on the training of asset evaluation talents. The method part of this paper is mainly based on the intelligent Internet of Things, and the association rules and perceptron algorithms in data mining technology are discussed in detail. Through the experimental analysis of this paper, it can be seen that, in order to strengthen professional construction and personnel training and improve professional ability, we must first further improve the review system of registered asset appraisers, improve the evaluation system, and improve the evaluation organization and management capabilities. This will play a role in selecting truly outstanding talents, and then a multilevel follow-up education and innovation system needs to be established and improved. Combined with the intelligent Internet of Things, it is very necessary to conduct research on professional construction and talent training mode.

Data Availability

This article does not cover data research. No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Research Article

Remote Sensing Recognition and Classification of Forest Vegetation Based on Image Feature Depth Learning

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In order to study the remote sensing recognition and classification of forest vegetation based on image feature depth learning, this paper presents a deep learning method using classical algorithms such as the maximum class method and maximum entropy method, as well as the FRFCM algorithm and convolutional neural network. In this method, SVM is used to train, classify, and recognize the color information of a high-resolution remote sensing image, remove the nongreen background of the classified image, and finally convert it to HSI space for morphological opening and closing reconstruction, so as to obtain the final extraction target. Then, a visual interface is designed to facilitate operation, which can compare the forest vegetation extraction results and operation processing time under different algorithms, so as to realize the rapid and accurate monitoring of karst forest vegetation change with remote sensing big data. The algorithm research shows that the overall accuracy of multifeature ant colony intelligent classification based on vegetation zoning is 88.85%, Kappa = 0.86, which is better than the traditional remote sensing image classification method, and provides an effective method for land use land cover remote sensing information extraction in large-scale complex terrain areas. In this way, the error extraction and missing extraction can be reduced in the extraction results of forest vegetation area in remote sensing images, and the experimental extraction results will be further close to the optimal segmentation effect.

1. Introduction

As a special type of image taken by satellites and other aircraft, high-resolution remote sensing image has important value and position in military and civil fields. Forest vegetation is one of the main factors affecting the Earth's ecological environment. Forestry departments need to use forest surveys to obtain basic data such as the quantity and quality of forest vegetation and dynamically monitor changes in forest vegetation. Deep learning is a machine learning method emerging in recent years. It can automatically learn the deep essential characteristics and laws of a large number of historical data, so as to identify, judge, or predict the future of new data, and improve the accuracy of classification and recognition to a certain extent. Therefore, using the depth learning method to classify remote sensing images is of great significance. Remote sensing technology provides the Ministry of forestry with the only effective and economic method to quickly monitor the current situation and dynamic change of large-area forest vegetation. In

recent years, it has been widely used in forest investigation, especially the emergence and application of high-resolution remote sensing images such as quick bird with submeter spatial resolution, which makes it possible to investigate forest vegetation carefully. Remote sensing image contains rich feature information, which is the most intuitive expression of the overall appearance of features. Feature extraction of remote sensing image is the most basic operation to study target features and obtain feature information (Figure 1). The research on remote sensing image classification and recognition not only has scientific theoretical significance but also has practical significance [1].

2. Literature Review

Jaime and others proposed using the feature training classifier of image pixels in remote sensing images for target extraction. This method has great advantages in controlling the statistics of color images and can bypass a large number of tasks to find the optimal threshold. This method is used for image segmentation [2, 3]. Meng and others obtained a land-use type map with an accuracy of 98.2% by combining supervised and unsupervised classification methods in the study of land use classification and obtained better results than using these two methods independently [4]. Shakya, A. and others used the decision tree method to classify land cover and compared it with other methods. The results show that the decision tree method improves the classification accuracy by 3%–6% [5]. Cao and others applied the fuzzy classification method to the study of impervious surface performance and compared it with the LSMA method. The results show that the fuzzy classification method is better than the LSMA method in any season, and the performance of the fuzzy classification method is better in both high-density residential areas and low-density residential areas [6]. Gao and others studied the land use types of Xinqiao town based on quick bird images. Due to the shortcomings of visual interpretation, many scholars have gradually sought other effective image classification methods [7]. Chen and others compared the K-means clustering method based on three similarity measures on virus remote sensing data. The experiment shows that the K-means clustering method based on Euclidean distance has the best accuracy and efficiency [8]. Wang and others used BP neural network to classify high-resolution remote sensing images. Through experiments, it is found that the adaptive dynamic system classification of the BP neural network has a better effect on land cover classification than other commonly used classifications [9]. Zhao and others proposed a method for texture segmentation of forest vegetation in remote sensing images based on the visual attention mechanism. Firstly, the crown shape and structure inside the image are regarded as visual attention targets, and then, the texture is enhanced. The forest vegetation area is segmented through the improved region growth method [10]. Khelifi and others believe that, at present, there are many kinds of classification algorithms for remote sensing images, such as ISODATA, K-means, minimum distance, maximum likelihood, and other algorithms. For this reason, people divide the above classification algorithms into supervised and unsupervised, parametric, and nonparametric, based on different principles, and focus on the above classification algorithms based on several categories such as pixels, subpixels, and objects. Due to the influence of many external factors, such as the complex surface environment, the screening of remote sensing images, the quality of image preprocessing, and the selection of classification methods, there is still much room for improvement [11].

3. Image Feature Extraction

Image feature extraction is the use of a computer to extract the relevant information contained in the image. In this process, it is judged that the features contained in the pixels in the image are suitable for classification, and the feature extraction method is used under certain requirements. Image feature extraction is to use the computer to extract the relevant information contained in the image. In this process, it is judged that the features contained in the pixels in the image are suitable for classifying them, and the method of feature extraction is used when certain requirements are met. The original image is classified, and there are points, curves, and connected blocks in the classified regions. The original image is classified, and there are points, curves, and areas connected into blocks in the areas of each category after classification. If the algorithm used is used to calculate some characteristic parts of the image data, then the characteristic extraction itself can be attributed to the image processing algorithm used. Image segmentation plays an indispensable role in the entire image research field (as shown in Figure 2). The work quality of this step will have a very intuitive impact on the entire image processing process.

For a long period of time, the threshold-based segmentation method has always been the basic content of image segmentation research, which is convenient to use and has obvious effects. The use process is that the gray histogram information of the obtained remote sensing image is first used for calculation and analysis, to obtain the threshold value, and then, the image is divided into different marked blocks by the threshold value, and formula (1) is used to express. It can be seen that finding the optimal threshold has become the key to research. Generally, the algorithm is divided into the global threshold method and local threshold method in the research. The global threshold method is to find the optimal threshold according to all gray information in the image to divide all data in the image. When double peaks are observed from the gray histogram of the experimental data, the lowest point of the curve between the double peaks can be regarded as the threshold, and the target area can be distinguished from the irrelevant area [12] as shown in Figure 3.

$$g(x, y) = \begin{Bmatrix} 1 & g(x, y) < Th \\ 0 & f(x, y) < Th \end{Bmatrix}, \tag{1}$$

If the size of the image is set to $M \times N$, the number of pixels can use H, indicating that G is used to represent the gray level of the image. When i is used to represent the gray

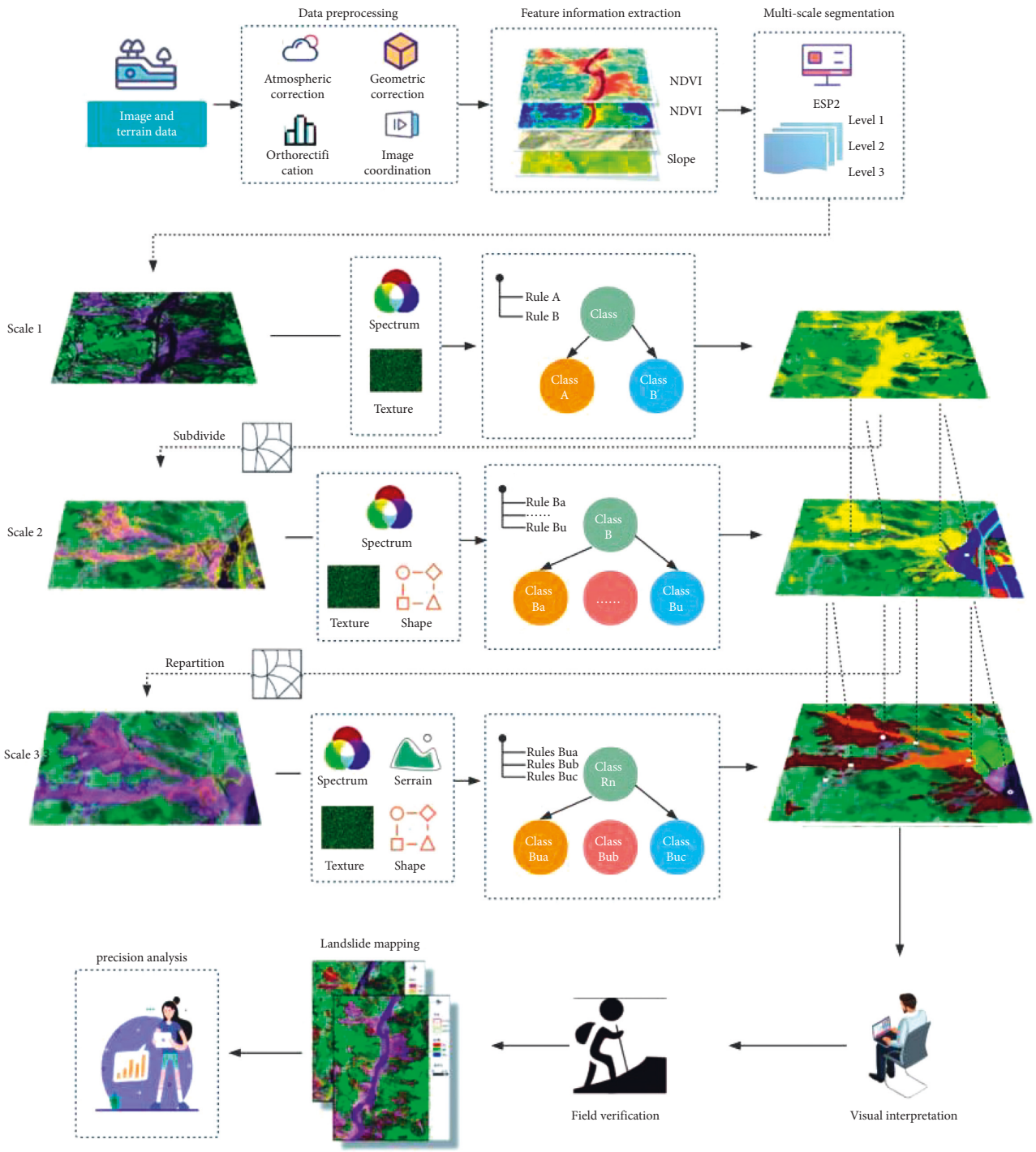

FIGURE 1: High-resolution remote sensing image recognition.

value, the probability of i can be expressed by the following formula:

$$p_i = \frac{H_i}{M \times N}. \tag{2}$$

In order to form a comparison with equation (2), $p_0(t)$ is used to represent the probability of class C_O, and the formula is as follows:

$$P_0(t) = \sum_{i-0}^{t} p_i, \tag{3}$$

$p_1(t)$ represents the probability generated by category C_O, and the formula is as follows:

$$P_1(t) = \sum_{i-i+1}^{L-1} P_i = 1 - P_0(t), \tag{4}$$

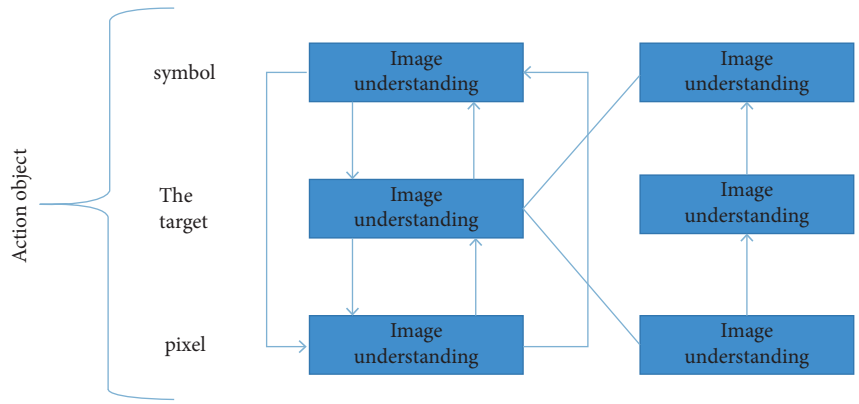

Figure 2: The position of image segmentation in image engineering.

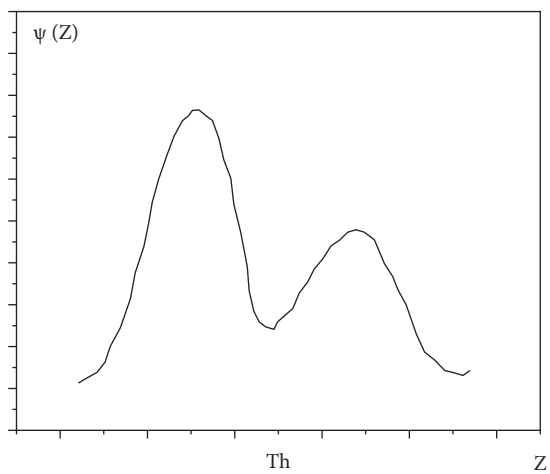

Figure 3: Threshold segmentation.

$\mu_0(t)$ represents the average gray level of pixels in the category C_O, and the formula is as follows:

$$\mu_0(t) = \sum_{t-0}^{i} \left(i \frac{p_i}{p_0(t)} \right), \tag{5}$$

$\mu_1(t)$ represents the average gray level of pixels in the category C_1, and the formula is as follows:

$$\mu_1(t) = \sum_{i-i+1}^{L-1} \left(i \frac{p_i}{p_1(t)} \right). \tag{6}$$

Then, the interclass variance $\delta_b(t)$ of the image can be calculated as shown in the following formula:

$$\delta_b(t) = P_0(t)\mu_0^2(t) + P_1(t)\mu_1^2(t). \tag{7}$$

At first, support vector machines were only used to solve two types of classification problems. In the field of experimental research, BSVM is used to represent two kinds of support vector machines, which can solve the classification problem of two kinds and obtain the structure type data with categories. However, most of the problems encountered in practical applications are multiclassification problems, so support vector machines complete the multiclassification goals through different paths. Then, in the research, BSVM can be combined to obtain the support vector of multiple classifications. The current support vector machine for multiple classification systems mainly includes two directions:

(1) The one-time solution method refers to the construction of a hyperplane between every two types of samples. The samples with a total number of class k can construct $K(K-1)/2$ BSVM, and each BSVM needs to distinguish the two categories in class K. And the two classification methods are used to construct the most potential classification function:

$$\begin{aligned} f_{st}(t) &= \omega_{st} \cdot \varphi(x) + b_s t \\ &= \sum_{i-sv} a_i^{st} y_i k(x_i, x) + b_{st}. \end{aligned} \tag{8}$$

When the value of the total number k is 4, the system diagram is shown in Figure 4.

(2) On the premise that the number of all categories is (k), K kinds of BSVM can be formed by combining different categories [13].

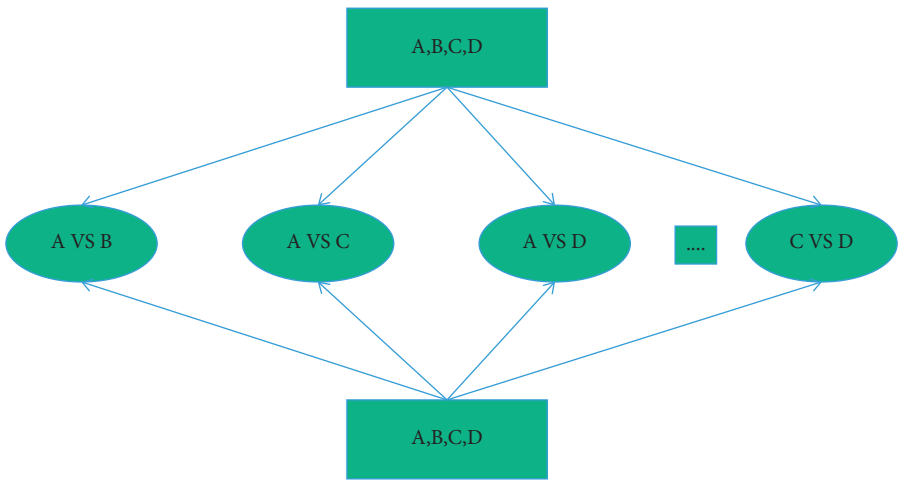

Figure 4: One-time solution method.

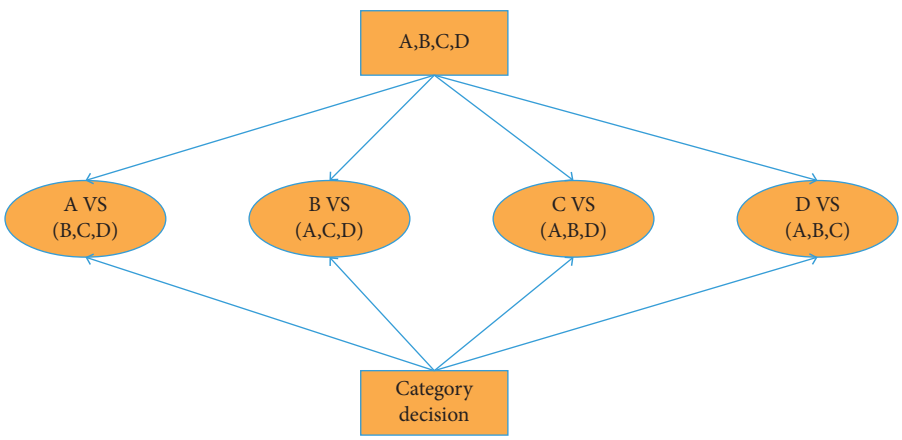

Figure 5: Multiple SVM solving methods.

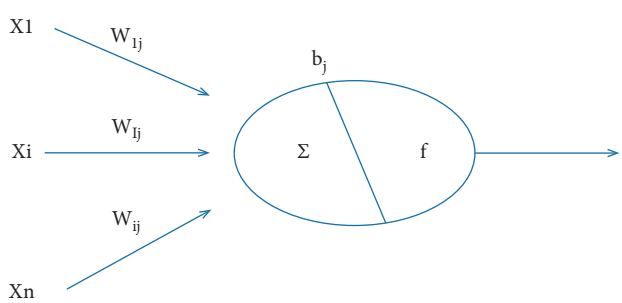

Figure 6: Neuron model.

When the value of total number k is 4, the system diagram is shown in Figure 5.

The advantage of the one-time solution method is that for each sub-SVM, because there are fewer training samples, the training time is less than that of multiple SVM, and its accuracy is also relatively high. However, its disadvantage is that when the number of classes K increases, the number of SVM will further increase, and its training time will be longer and longer.

As a multi-input single-output processing unit, the structure of the neuron itself is shown in Figure 6.

In Figure 6, n input signals are input to neuron J at the same time. w_{ij} represents the weight value of the connection between the input signal x and the neuron J, and the relationship between input and output can be expressed by the following formula:

$$y_i = f\left(b_i + \sum_{i-1}^{n}\left(x_i \times w_{ij}\right)\right). \tag{9}$$

Convolutional neural network structure, the feature space that the network can represent will also become larger, and the learning ability of the network will be strengthened [14].

3.1. Remote Sensing Classification

3.1.1. Multifeature Data. The combined use of remote sensing data and nonremote sensing data can make up for the shortcomings of single remote sensing data, play the auxiliary role of nonremote sensing data, and effectively

improve the classification accuracy of remote sensing data. The experimental area in this article is located in the west with complex terrain and large altitude differences. DEM data and slope and aspect data generated by DEM data can effectively reflect the vertical zoning of vegetation and the local growth environment, which is an effective aid to improve the accuracy of remote sensing classification. Therefore, this paper uses TM image, DEM, slope, and aspect data as the characteristic bands for classification.

3.1.2. Vegetation Zoning. According to the vegetation characteristics of arid and semiarid areas, the experiment is divided into vegetation-dominated areas and non-vegetation-dominated areas, so as to reduce the influence of the foreign matter homospectrum phenomenon in the overall classification. The normalized difference vegetation index (NDVI) is the best indicator of plant growth status and vegetation spatial distribution density and has a linear relationship with vegetation distribution density. It is a commonly used vegetation index in remote sensing estimation of vegetation coverage research. For this reason, NDVI is used for vegetation zoning. Use the preprocessed TM image to generate NDVI, statistically analyze the NDVI value of the training samples, and determine the vegetation or nonvegetation threshold NDVI = 0.18, so as to divide the experimental area into vegetation-based areas and non-vegetation-based areas [15].

The calculation method of the first-order moment of color is shown in formula (10). The first-order moment can represent the average intensity of each color component in the image.

$$\mu = \frac{1}{N}\sum_{j-1}^{N} p_{i\Delta j}. \tag{10}$$

The calculation of the second moment of color is shown in formula (11), which refers to the color variance of the image area and represents the nonuniformity of color distribution.

$$\sigma = \left(\frac{1}{N-1}\sum_{j-1}^{N}\left(P_{i,j}-\mu_i\right)^2\right)^{1/2}. \tag{11}$$

The calculation of color third-order moment is shown in formula (12), which refers to the skewness of color component and represents the asymmetry of color distribution.

$$s = \left(\frac{1}{N-1}\sum_{j-1}^{N}\left(P_{i,j}-\mu_i\right)^3\right)^{1/3}. \tag{12}$$

3.1.3. Intelligent Mining of Classification Rules. ACIOA algorithm is used to mine remote sensing classification rules for the above two regions. The algorithm takes the discrete values of each band of training samples as attribute nodes and each target class as class nodes and mines the corresponding remote sensing classification rules by searching the connection between attribute nodes and class nodes. The steps of rule mining include the following.

Before mining the classification rules, the discretization method based on information entropy is used to discretize the training sample data. In order to shorten the search time of ants, a heuristic function related to the problem is constructed to guide the search of the ant colony [16]. When the rule is constructed, the gambling wheel mechanism is used to select attribute nodes until all attributes are included in the path; then, one class node is selected and there can only be one class node, so far a complete initial classification rule is formed [17, 18]. After completing the construction of the initial classification rules, each attribute node is selected as a condition item of the rule; through rule pruning, the attribute nodes that reduce the effectiveness of the classification rules are removed, the classification rules are simplified, and the effectiveness of the classification rules is maximized. After the initial classification rule is constructed, each attribute node is selected as a condition item of the rule. Through rule pruning, remove the attribute nodes that reduce the effectiveness of classification rules, simplify classification rules, and maximize the effectiveness of classification rules.

4. Vegetation Extraction Method of High-Resolution Remote Sensing Image

Threshold segmentation is one of the most commonly used methods for remote sensing of forest vegetation. The operation steps of this method are as follows: the first step is to select indicators with obvious differences among different types, and the second step is to find out the threshold value of related indicators, so as to achieve the purpose of identifying forest vegetation cover information [19]. In the experimental research, the threshold segmentation algorithm is usually used in the research objects with a large gray difference between the extracted region and other irrelevant regions. Therefore, to achieve the best segmentation results, it should be used as a pretreatment at the beginning of the experiment.

(1) Extraction of forest vegetation by the maximum interclass method is as follows:

Step 1: Set the gray level of the used image to M, and its range is $[0, M-1]$. If the value of gray level i of the pixels contained in the image is equal, the number at this time can be expressed as N, then the total number can be expressed as e, and the probability that the value is equal to $N = N_0 + N_1 + \ldots + N_{M-1}$.

Step 2: Carry out the operation of step 1 for many times until the threshold value obtained can maximize the variance of different categories. At this time, t is the threshold value that can achieve the best segmentation effect of the image under this method.

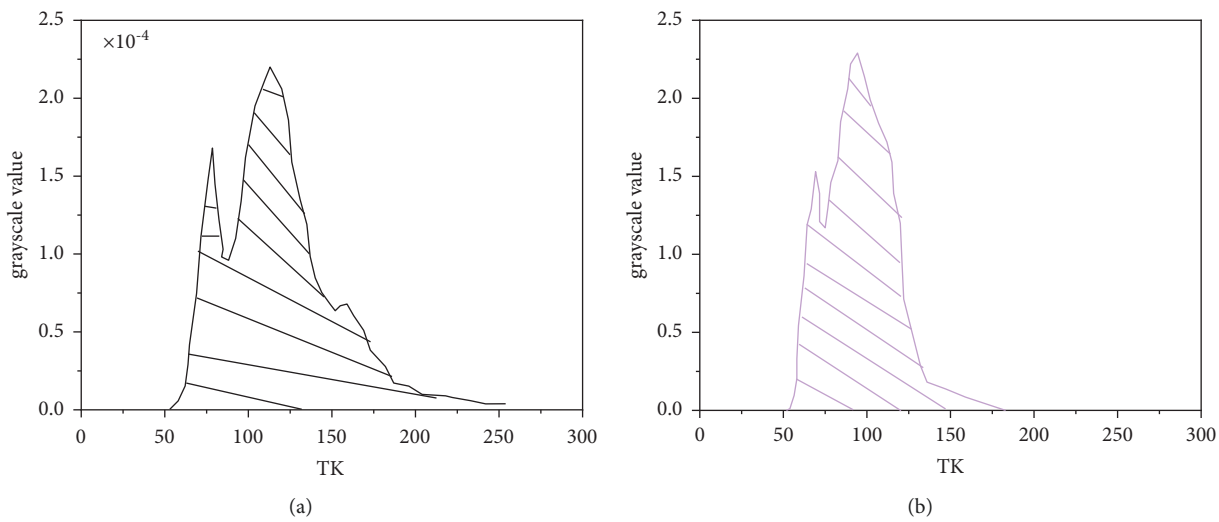

Figure 7: Gray histogram of quick bird image. (a)Histogram of experimental image 1. (b) Histogram of experimental image 2.

(2) Iterative method for forest vegetation extraction is as follows:

Step 1: First calculate the maximum gray value and minimum gray value of the image, and record them as $Z_{\max}$ and $Z_{\min}$, respectively, so that the initial value is $T_0 = (Z_{\max} + Z_{\min})/2$

Step 2: Divide the image into front and back by TK threshold, and then calculate the average gray values ZO and ZB under the two scenes respectively

Step 3: Calculate the new threshold value $TK + 1 = (ZO + ZB)/2$

The iterative method is to obtain the gray value TK through iterative calculation, so that the gray value TK can segment the remote sensing image into forest vegetation area and nonforest vegetation area [20]. The average gray value of forest vegetation area plus the average gray value of nonforest vegetation area is equal to TK. Figure 7 shows the gray histogram of the image used.

Figure 7 shows the gray histogram of two quick bird remote sensing images. The iterative method is to find a TK, TK can divide the gray histogram into two parts with equal area, and then TK is the required optimal threshold. Through experiments, it can be concluded that the optimal threshold of the experimental image a is 130 and the optimal threshold of experimental image b is 101 [21].

Combining the image segmentation effect and the two line graphs, the extraction result when $K = 4$ should be selected as the final segmentation result under the K-means algorithm (Figure 8). Therefore, in combination with the image segmentation effect and two broken line images, the extraction result when $k = 4$ should be selected as the final segmentation result under the k-means algorithm [22].

The steps of forest extraction in a fuzzy c-means clustering algorithm are not very difficult. It is a clustering algorithm that uses affiliation to determine whether each pixel of a remote sensing image belongs to a specific set. FCM is the sum of n vectors x; $x_i\,(i = 1, 2, \ldots, n)$ crack becomes c uncertain sets [23], and the center points of the boxes in all sets are calculated at the same time, so as to minimize the dissimilar characteristics. FCM splits a vector into an indeterminate set and, at the same time, calculates the center points of the inner boxes of all sets, so as to minimize the dissimilar characteristics. FCM distinguishes based on uncertainty. It can make the given data points fall into a certain value in the range of [0,1]. At the same time, the sum of the membership degrees of these data points is equal to 1, which can be expressed by the following formula:

$$\sum_{i=2}^{c} \mu_{ij} = 2, \qquad \Delta y = 1, 2, \ldots, x. \tag{13}$$

Furthermore, the value function (objective function) of FCM can be expressed as

$$J(C, u_1, \ldots u_n) = \sum_{i-1}^{c} J_j = \sum_{i-1}^{c} \sum_{j}^{n} \mu_{ij}^{m}. \tag{14}$$

4.1. Analysis of Experimental Results. The experimental effect diagram has been shown for the experimental method used above, which can only have a general understanding of the extracted results. In order to make the experimental effect contrast more intuitive, the extraction accuracy and use time of the experimental method are compared in the form of data, as shown in Tables 1 and 2.

The experimental results in the above table show that the remote sensing images are the same, the segmentation method combining convolution neural network method, FRFCM algorithm, and Otsu and K-means algorithm is more prominent, the contour of the extracted forest vegetation area has high internal consistency, and the forest vegetation area and nonforest vegetation area have been effectively separated.

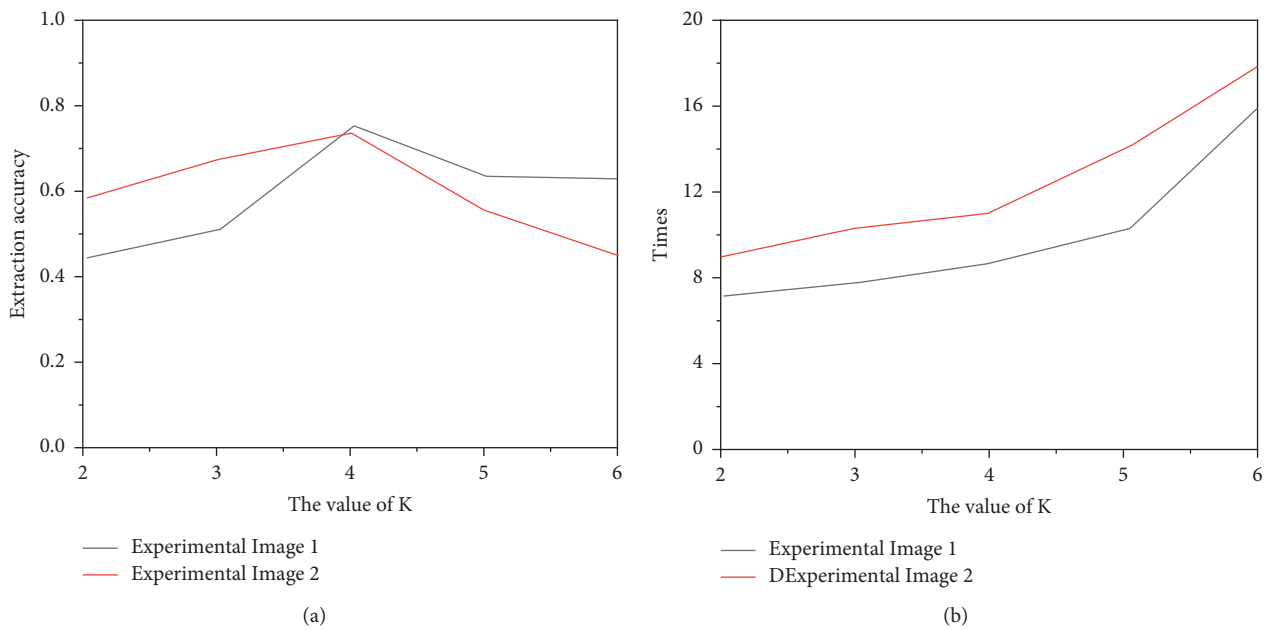

Figure 8: Extraction accuracy and time of two remote sensing images under different K values. (a)Variation of extraction accuracy with K value. (b)Variation of extraction time with K value.

Table 1: Performance comparison of experimental image 1 extraction methods.

Extraction method	Running time (s)	Extraction accuracy (%)
Maximum interclass method	6.5	75
Maximum entropy method	2.1	62
Iterative method	10.8	63
K-means algorithm	8.4	74
ISODATA algorithm	4.3	68
FCM algorithm	34.6	70
FRFCM algorithm	21.5	83
Otsu and K-means combination method	20.9	78
Convolution neural network method	13.0	90

Table 2: Performance comparison of experimental image 2 extraction methods.

Extraction method	Running time (s)	Extraction accuracy (%)
Maximum interclass method	2.1	57
Maximum entropy method	12.3	53
Iterative method	23.6	75
K-means algorithm	9.8	71
ISODATA algorithm	4.1	74
FCM algorithm	68.2	79
FRFCM algorithm	18.7	81
Otsu and K-means combination method	9.2	82
Convolution neural network method	20.4	94

In the RBF function, Y is the function setting in the kernel function, and the relationship between a and Y can be expressed by the following formula:

$$\gamma = \frac{1}{2 \cdot \sigma^2}. \tag{15}$$

By observing the data and parameter calculation images in Figure 9 and table, it can be found that the classification error rate of the two images is the lowest when they are in $C = 1$ and $\sigma = 2$, and the extraction accuracy can be obtained to be 90.62% and 91.33%, respectively. At this time, the

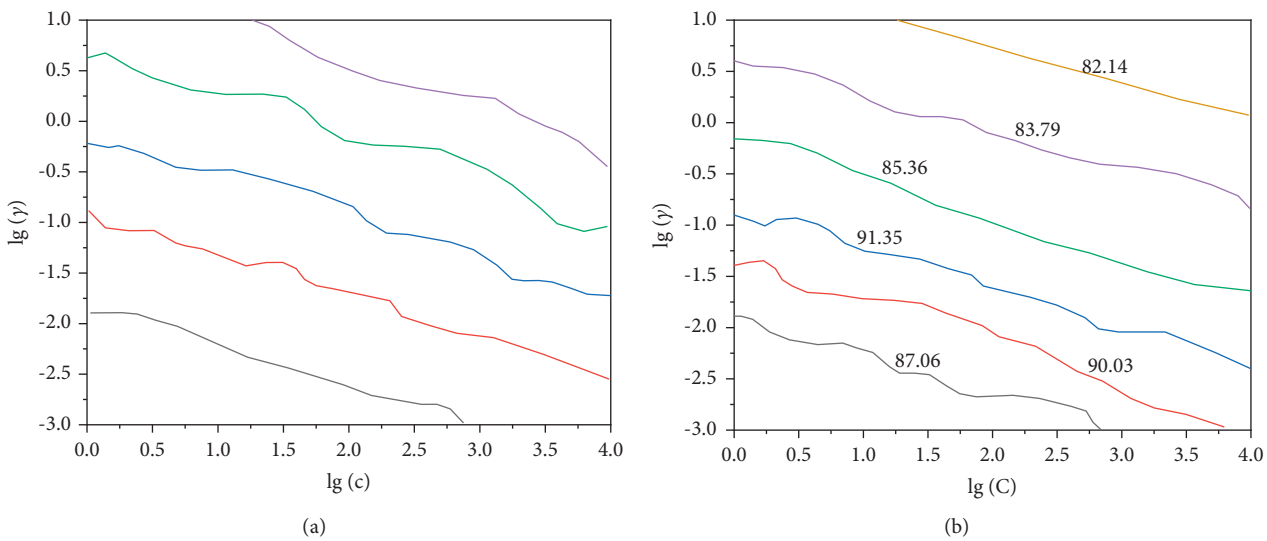

Figure 9: Calculation diagrams of optimal parameters. (a)Experimental image 1. (b) Experimental image 2.

Table 3: Comparison of running time and extraction accuracy of experimental image 1 extraction method.

Extraction method	Running time (s)	Extraction accuracy (%)
Algorithms in this chapter	9.8	90.2
FRFCM algorithm	21.5	79.3
Convolution neural network method	19.7	92.7
Otsu and K-means combination method	13.0	78.0

Table 4: Test Figure 2 comparison of extraction method running time and extraction accuracy.

Extraction method	Running time (s)	Extraction accuracy (%)
Algorithms in this chapter	10.2	91.5
FRFCM algorithm	18.9	83.0
Convolution neural network method	19.6	95.3
Otsu and K-means combination method	9.5	85.0

corresponding test time is 10.20s and 10.32s, respectively [24].

As shown in Tables 3 and 4, the running time and extraction accuracy of four extraction methods for forest vegetation area extraction of experimental image 1 and experimental image 2 are compared. It can be seen from the table that the extraction accuracy of the disturbed neural network is about 2070 higher than this group of algorithms. But the running time is nearly twice that of the algorithm in this chapter. For the "forest vegetation extraction system" developed by the forestry bureau and other departments, it is necessary to find an optimization method between high extraction accuracy and fast operation processing time, monitor the change of karst vegetation, and process the remote sensing data of dozens of GB data. Due to the large number of parameters and the long training time of the convolutional neural network model, overfitting and time-consuming are almost common problems of deep learning. Although the current deep learning methods have high accuracy, they cannot meet the requirements of fast processing of large amounts of data, which needs to be further studied. The algorithm in this chapter provides a feasible method for the development of the "Forest Vegetation Extraction System" of the Guilin Forestry Bureau, which requires high precision and fast speed, and realizes the fast and accurate processing of remote sensing big data.

5. Conclusion

Based on the synthesis of high-resolution remote sensing image target extraction research, this paper puts forward the research topic of forest vegetation target extraction based on the ecological evolution of suburban forest vegetation. The main research object of this paper is the quick bird high-resolution remote sensing images taken by satellites. Various types of image segmentation algorithms are used for experimental comparison, which provides ideas and methods for subsequent in-depth research. For the design and implementation of the forest vegetation extraction system, the methods used in this article are compiled on the Visual Studio platform, and the visual interface is designed for easy operation. Different algorithms can be compared, and the system can obtain relatively accurate forest vegetation areas.

During the experiment, because the high-resolution remote sensing image used will be affected by noise, sunlight, and other factors, the target area extracted from the image will be confused with shadow, similar or similar areas, which will make the extraction of the whole forest vegetation area difficult. There are large errors, which need to be paid attention to and improved in the follow-up research.

By looking for new algorithms or improving existing algorithms, we can obtain more information contained in remote sensing images and enrich the reference features of remote sensing image experiments, so that there will be no errors in the acquisition of training samples. This can reduce the wrong extraction and missing extraction in the forest vegetation area extraction results of high-resolution remote sensing images, and the experimental extraction results will be closer to the optimal segmentation effect [25].

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

Acknowledgments

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Retraction

Retracted: Low-Carbon Awareness Information Technology of Enterprise Executives Based on Big Data and Multimodal Information Fusion

Mobile Information Systems

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] G. Yang, "Low-Carbon Awareness Information Technology of Enterprise Executives Based on Big Data and Multimodal Information Fusion," *Mobile Information Systems*, vol. 2022, Article ID 1534440, 13 pages, 2022.

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Research Article

Low-Carbon Awareness Information Technology of Enterprise Executives Based on Big Data and Multimodal Information Fusion

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The so-called multimodal information refers to the information from different information sources on different or the same side of the same description target. These pieces of information are different in terms of storage structure, representation, semantic connotation, credibility, and emphasis, but there is a certain inevitable connection between them. This paper aims to study how to analyze and study the low carbon of enterprises with the help of multimodal information fusion based on the background of big data and construct the evolutionary neural network of the improved adaptive genetic algorithm. This paper puts forward the problem of low carbon in enterprises, which is based on multimodal information fusion, and then elaborates on the concept and related algorithms of multimodal information fusion. Information fusion has carried out case design and analysis. Through the research and analysis of enterprise low carbon and self-adaptive algorithm, it can be obtained that the neural network has reached the threshold of 3.95 after iterating for nearly 60 generations, and stopped iterating to obtain the best individual. The evolutionary neural network in this paper reaches stability after a small number of iterations and can basically achieve a certain low carbonization.

1. Introduction

Since human society entered the 21st century, the depletion of natural resources, air and water pollution, and global warming have caused huge damage to the global ecological environment. Under the constraints of strict environmental code of conduct, the environmental cost of enterprises is increasing, and the environmental risks are increasing day by day. Countries around the world urgently need to coordinate the harmonious development of humans and nature under the guidance of the scientific outlook on development and sustainable development, and need to establish a low-carbon economic growth model. In the background of a low-carbon economy, standardizing enterprise cost accounting requires to be innovated in all aspects. It requires that when formulating and developing low-carbon economic policies and strategies, people must always understand their basic content, optimize the economic structure, and ultimately achieve the strategic goal of low-carbon economic development. Therefore, it is particularly important to study the low-carbon development of enterprises with multimodal information fusion.

Through the experimental process of the multimodal information fusion experiment of evolutionary neural network based on adaptive genetic algorithm, it is concluded that compared with the traditional RNFN algorithm, this paper has better training speed and efficiency, and the network can converge faster and achieve the goal. The innovations of this paper are as follows: (1) this paper combines multimodal information fusion with enterprise low carbon and introduces the theory and related methods of multimodal information fusion in detail. (2) In the face of the data set produced by the enterprise, the rough neuro-fuzzy network is compared with the multimodal information fusion algorithm and the hybrid multimodal information fusion algorithm of the adaptive genetic algorithm and neural network proposed in this paper.

2. Related Work

Low-carbon economy is an important model for implementing circular economy and sustainable energy development. Liu et al. [1] started from the system of the impact of corporate financial environment on financial accounting under the background of low-carbon economy, established a corresponding evaluation system, and studied the impact of corporate financial environment on financial accounting from the perspective of low-carbon economy [1]. Wu et al. [2] proposed the evolutionary game of low-carbon strategy between government and enterprises under the background of complex network [2]. Zhang et al. [3] developed carbon resource of the executives' pointers, including carbon reserve turnover rate, fossil fuel byproduct rate, carbon turnover rate, carbon innovation transformation effectiveness, and fixed carbon resource benefit [3]. Hillman et al. [4] analyzed the worth of social undertaking as a driver of low-carbon progress at the local area level, with an attention on the energy area [4]. Ma et al. [5] analyzed the characteristics of disruptive innovation and continuous innovation and their relationship with green manufacturing from the perspective of dynamic competitive advantage of an independent research and development enterprise in the context of green manufacturing. However, the low-carbon environmental protection awareness of enterprises has not been well implemented.

The information fusion method is the basis for the construction of the subject knowledge field. The multimodal information fusion mainly involves the feature layer and its fusion decision layer. Zhang [6] proposed a cross-modal speech text retrieval method using an interactively learned convolutional autoencoder (CAE) [6]. Nie et al. [7] introduced MMFN, a novel multimodal combination network for 3D shape acknowledgment that takes advantage of the connection among various modalities to create more powerful combination descriptors [7]. Zhao et al. [8] introduced a multimodal fusion method for generating descriptions to explain image content [8]. Domingues et al. [9] explored the important topic of multimodal data fusion in the current medical context [9]. These algorithms integrate the data to a certain extent, but the operation is more complicated and the accuracy needs to be improved.

3. Multimodal Information Fusion Method Based on Improved Algorithm

3.1. Enterprise Low-Carbon Awareness

3.1.1. Low-Carbon Manufacturing Concept. "Low-carbon manufacturing" is a brand-new concept, its meaning and significance are still in the exploratory stage, and there is no effective definition at home and abroad. In this paper, combined with research in related fields, it is defined as follows:

(1) Low-Carbon Manufacturing (LCM)

"Low-carbon fabricating" is an assembling model described by low energy utilization, low contamination, and low fossil fuel byproducts, through low-carbon innovation, low-carbon executives, low-carbon administrations, and different means to limit ozone-depleting substance (GHG) discharges in the whole life pattern of items from configuration, producing, bundling, transportation, and use to end-of-life removal to realize economic and social development and ecological and environmental protection.

(2) The difference between low-carbon manufacturing and green manufacturing

The research related to low-carbon manufacturing is green manufacturing, and there are some differences in concept and application between the two. Literally, the difference between the two is "low-carbon" and "green." For a clearer understanding, a brief introduction to "low carbon" and "green" is given first. It can be understood broadly that "low carbon" refers to lower greenhouse gas (CO_2-based) emissions and "green" refers to all positive impacts on the environment and safety, including impacts on global warming, eutrophication, acidification, photochemical ozone synthesis, and other factors [10, 11]. "Manufacturing" is a general term for a series of related activities and operations in the manufacturing industry, including product design, material selection, production planning, production process, quality assurance, business management, and marketing. Therefore, it is believed that "low-carbon manufacturing" is more targeted and evaluable than "green manufacturing," focusing on reducing greenhouse gas emissions and preventing global warming more effectively. "Low-carbon manufacturing" is an important part of "green manufacturing."

3.1.2. Architecture of Low-Carbon Manufacturing. Low-carbon production technologies include the entire life cycle of a product, especially considering resource consumption and carbon emissions, as well as technical and economic factors to coordinate and optimize the economic and social benefits of enterprises. The architecture is shown in Figure 1.

3.1.3. Key Technologies of Enterprise Low-Carbon Manufacturing Information Services. Enterprise low-carbon manufacturing information services mainly include the following key technologies:

(1) Enterprise low-carbon manufacturing knowledge service technology includes knowledge co-construction, knowledge ordering, cognitive navigation, patent analysis, and so on. It supports enterprise employees to effectively utilize low-carbon manufacturing knowledge and realize low-carbon manufacturing.

(2) Enterprise low-carbon manufacturing evaluation service technology includes low-carbon standard

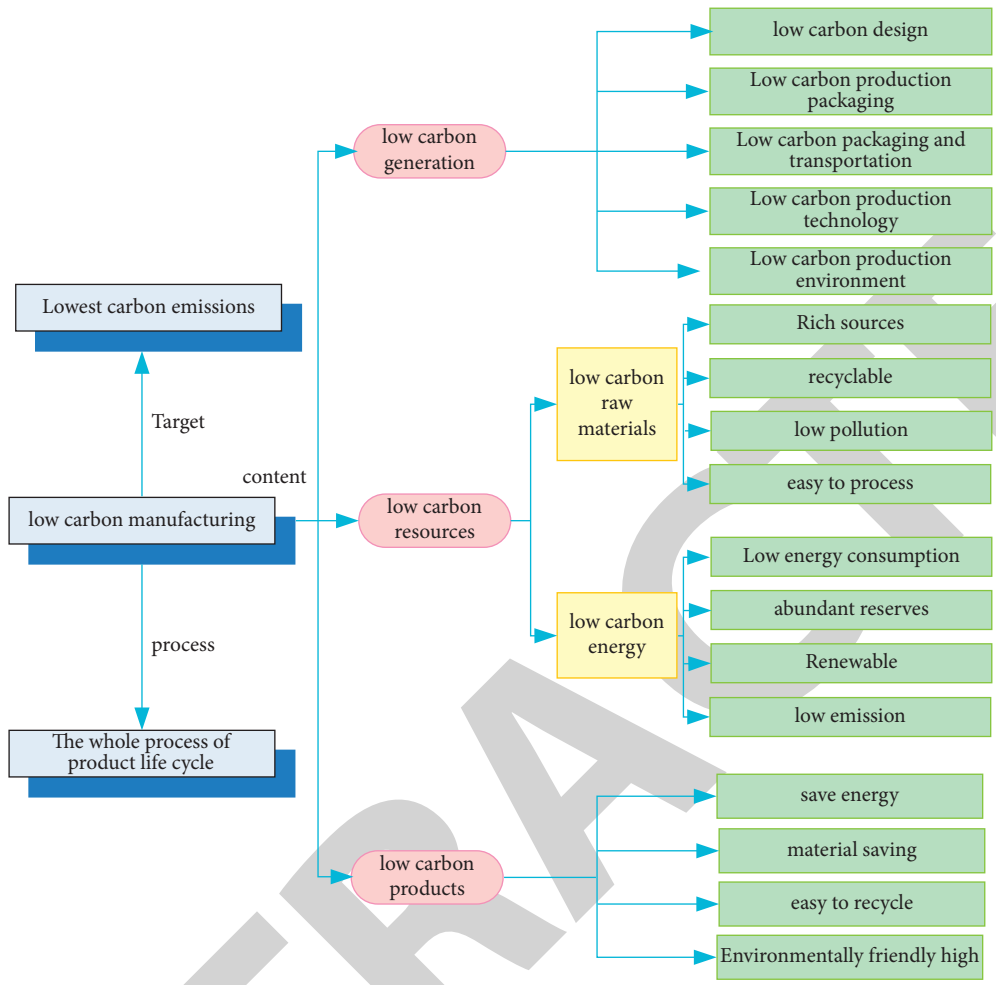

Figure 1: Architecture of low-carbon manufacturing.

collaborative construction, design scheme evaluation, product carbon footprint calculation, product life cycle carbon emission analysis, and so on. It helps enterprise employees understand the carbon emissions in products and manufacturing processes to take targeted measures to promote low-carbon manufacturing [12, 13].

(3) The enterprise low-carbon manufacturing life cycle management technology includes energy consumption analysis, resource consumption analysis, pollution analysis of the whole production process of the enterprise, and so on. It helps enterprise employees collect data in the product life cycle process in a timely and accurate manner, and provides a data foundation for low-carbon manufacturing.

(4) Enterprise low-carbon manufacturing information service unit technology aims at the garment industry. It includes clothing modular design technology for low-carbon manufacturing, clothing process optimization technology for low-carbon manufacturing, clothing production management technology for low-carbon manufacturing, clothing sales management technology for low-carbon manufacturing, and so on. It helps corporate employees implement low-carbon manufacturing into production management and sales.

(5) Design technology for low-carbon manufacturing plays a vital role in the implementation of low-carbon manufacturing in enterprises. It mainly helps employees to design products based on the concepts and methods of low-carbon manufacturing [14, 15].

3.2. Big Data

3.2.1. The Basic Definition and Basic Characteristics of Big Data. As far as the concept of big data is concerned, it is difficult to have a very quantitative definition. Existing definition is qualitative description from the perspective of data scale, supporting software processing capabilities. For example, Wikipedia's qualitative description is big data that refers to unobtainable datasets, managed, and processed within a certain period of time using traditional and commonly used software techniques and tools.

Compared with traditionally processed small data, big data has the "5 Vs" characteristics, as shown in Figure 2.

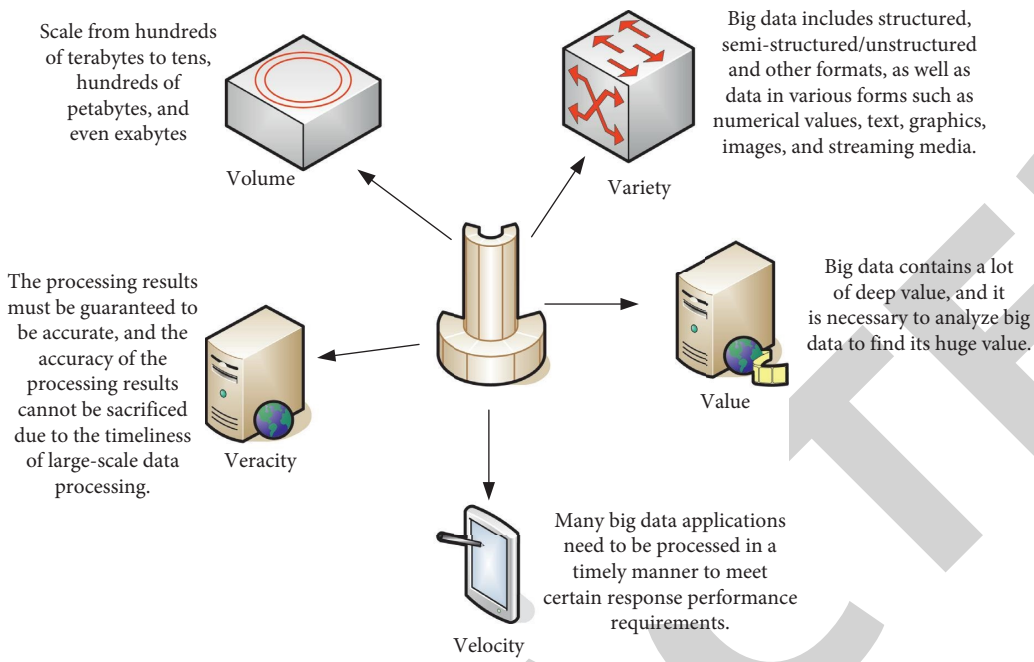

Figure 2: Big data "5 V" characteristics.

3.2.2. Big Data Processing Technology Stack and Its Processing Framework. Enormous information is the combination of numerous PC advancements at various levels, and huge information handling is an exhaustive data handling innovation, including all levels of the whole programming and equipment framework. A total large information handling framework is a bunch of advances, including huge information stockpiling, PC, examination, and other specialized viewpoints. Therefore, the processing of big data has strong technical integrity and intersectionality. From base to top, the whole innovation stack fundamentally incorporates foundation and asset levels, huge information framework programming layer (counting circulated capacity and equal PCs), investigation calculation layer, and large information application layer [16, 17].

Table 1 describes the main technical aspects and technical contents of the big data processing technology stack. Each layer in the technology stack has its own functions and features.

3.2.3. Big Data Parallel Computing Technology and System. The big data parallel computing system is the computing core layer in the whole big data processing process. Hadoop MapReduce was almost the only platform for processing big data in the early years. With the popularity of big data applications, people realize that the big data processing requirements in practical applications are complex and diverse, and it is difficult to have a single computing model that can cover different big data computing characteristics. Table 2 summarizes common big data computing patterns and their typical systems.

3.3. Multimodal Information Fusion

3.3.1. Research on Information Fusion Methods. In past research, information fusion methods can be mainly divided into three categories. The rule-based information fusion method, the classification-based information fusion method, and the estimation-based information fusion method together constitute the basic methods of information fusion at different levels, as shown in Table 3.

3.3.2. Multimodal Information Fusion Model Based on Brain Cognition. The perception of the intelligent subject to the outside world or its own state can be abstracted into the human body's perception of the response to external stimuli and changes in its own state. Figure 3 shows the information fusion model based on brain cognition. Human organs such as eyes, ears, and nose are like various sensors for intelligent agents. Through them, complex multimodal information is obtained and fused through the cognitive mechanism of the brain, combined with the prior domain knowledge base, to form perception, judgment, and reasoning and decision-making for the target. Intelligent agents can also rely on multisensor and intelligent information fusion models to achieve the same purpose [18, 19].

3.3.3. Functional Model of Multimodal Information Fusion. The functional model of multimodal information fusion includes various functional modules. According to the level of information in the transmission process, it is divided into low-level processing and advanced processing, as shown in Figure 4.

Table 1: Big data processing technology stack.

Big data application layer	Application and administration layer in the field of large information	Transportation/Telecom/Medical/Finance/Public Security/Business/ Biology/Remote Sensing/Mineral Exploration...
	Application design and development layer	Domain application/service requirements and analysis model Huge information application improvement climate and device stage
Big data analysis algorithm layer	Comprehensive analysis algorithm layer	Informal organization examination, picture handling, regular language handling, biological information processing, media analysis and retrieval, Web information mining and retrieval, visual computing, etc.
	Basic algorithm layer	Parallelized basic analysis algorithms
Big data computing layer	Parallel computing system platform	General equal registering framework Hadoop, Spark, diagram processing framework GraphLab, stream figuring framework Storm, and so forth.
	Parallel computing mode	Clump handling, streaming processing, chart registering, iterative figuring, inquiry examination, memory computing, and other computing modes
Big data storage layer	Distributed database	Distributed database storage system
	Distributed file system	Distributed file storage systems
Big data processing resource layer	System architecture and hardware resources	Deeply, half breed heterogeneous stage distributed computing assets and backing stage

Table 2: Typical big data computing modes and systems.

Big data computing model	Typical systems and platforms
Iterative calculation	Apache Spark, HaLoop, iMapReduce, Twister, etc.
In-memory computing	Dremel, Apache Spark, Apache Flink, etc.
Streaming computing	Storm, Apache Spark Streaming, s4, etc.
Batch computing	Apache Hadoop MapReduce, Apache Spark, etc.
Graph computation	Pregel, Giraph, GraphLab, GraphX, etc.
Big data query analysis and calculation	Apache Hive, Impala, Apache Spark SQL, Apache Kylin, etc.

Table 3: Introduction of different types of information fusion methods.

Method	Introduce
Classification-based fusion methods	Support vector machines, Bayesian inference, DS evidence theory, dynamic Bayesian networks, neural networks, and maximum directed models
Estimation-based fusion methods	Kalman filter, extended Kalman filter, and particle filter
Rule-based fusion methods	Linear weighted fusion, majority voting rules, and custom rules

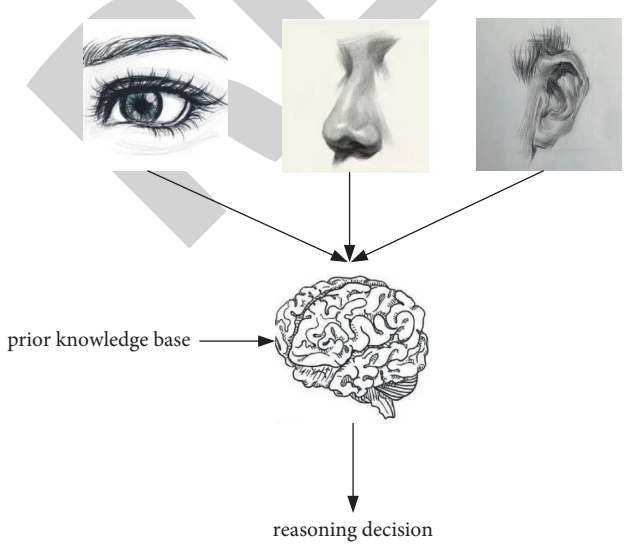

Figure 3: Information fusion model based on brain cognition.

In the early stage of the low-level processing process, numerical results are formed by mining the characteristics of the information data. These results can reflect the basic signal signs of multimodal information and can realize the correlation and identification between data. The advanced processing process is analyzed in the later stage of information fusion and reflects the characteristics of the semantic level. It mainly extracts information features for symbolic logic and can realize functional modules such as logical reasoning and situation estimation.

3.3.4. Analytic Hierarchy Process of Multimodal Information Fusion. The process of signal information processing is information data processing [20, 21], and the level of information fusion is shown in Figure 5.

Data layer fusion is the first layer of fusion. The system directly merges data after using multiple sensors to collect raw data, which is characterized by less information loss and

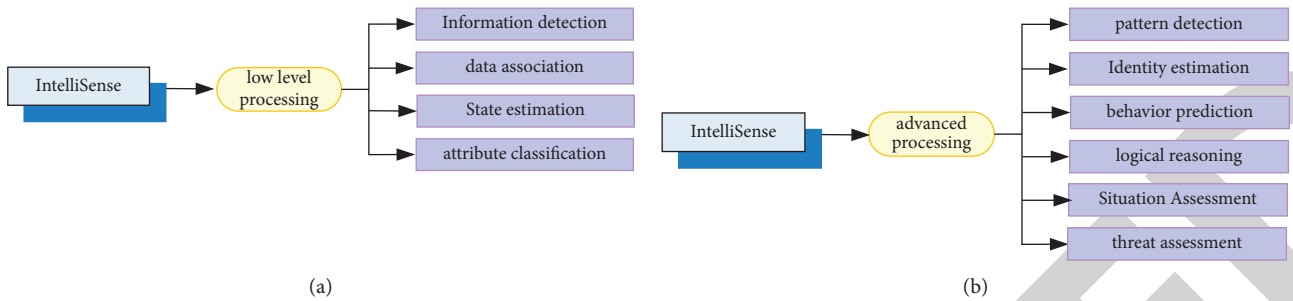

Figure 4: Multimodal information fusion functional model. (a) Low-level processing. (b) Advanced processing.

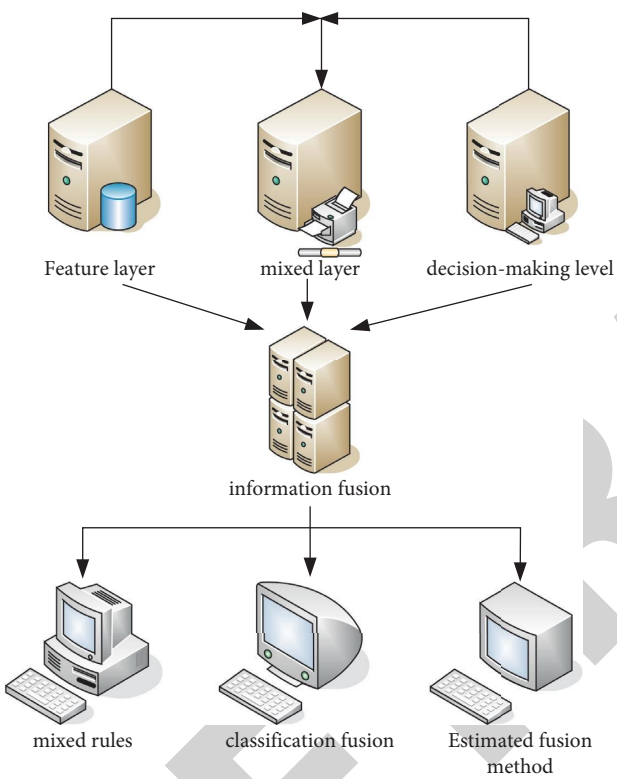

Figure 5: Information fusion methods based on different layers.

more accurate fusion results. However, due to the complex and noisy data collected, and the large amount of fusion calculation, the sensor types must be consistent, and the information synchronization requirements are relatively high. The feature layer is merged into the second layer. After data processing, the information expressed by the data is purer. Therefore, the information can be extracted by features, and the obtained feature vectors can be uniformly processed to judge. This fusion method requires relatively little computation and does not require high sensor types and synchronization, but the fusion results are greatly affected by feature information and are susceptible to interference [22, 23].

The moment of fusion processing at the decision-making level is that the system has formed the preliminary detection results of the target, but these results are the judgment of the sensor on the single-source signal, which is one-sided. At this time, the decision-level fusion processing can make the system fuse the single-source detection results to form a more complete and accurate judgment. This method requires the least amount of calculation and has the strongest anti-interference ability. However, due to the difficulty of obtaining prior knowledge and the difficulty of constructing a huge knowledge base, the related theories need to be further improved.

3.3.5. Commonly Used Multiphysical Domain Multimodal Information Fusion Methods and Their Characteristics. As a branch of signal processing, there have been many research achievements in information fusion. From the perspective of the integrated functional model, it can be divided into three aspects: correlation, estimation, and identification. The specific processing methods and the characteristics of some methods are shown in Table 4.

3.4. Multimodal Information Fusion Algorithm Based on Improved Adaptive Genetic Algorithm and Neural Network Hybrid

3.4.1. Genetic Algorithm. In standard genetic algorithms, selection criteria are based on the principle of proportionality. Therefore, through the action of the ath selector, the expected value of the number of people who will continue to exist in the next generation is $m(f_a/\sum f)$, and then, there is

$$\overline{f}(K,e) = \frac{1}{m(K,e)} \sum f_a. \tag{1}$$

So,

$$m(K,e+1) = m(K,e) \cdot \overline{f}\,\frac{(K,e)}{f(e)}. \tag{2}$$

The equation shows that the effect of the selection operator will increase (decrease) the ability of a pattern above (below) the average to be applied across generations, and improve quality.

Then, the effect of the crossover operator is analyzed. This plan can obviously be maintained in the next generation if there is no intersection or if the intersection point is beyond the character positions specified on the left and right ends of the figure. Therefore, the probability W_s that the K mode continues to exist in the next generation should satisfy

Table 4: Fusion methods and their characteristics.

Fusion method	Specific description	Advantage	Shortcoming
Neural networks	Perform forward calculation and reverse parameter adjustment on labeled data to construct a model with appropriate weights and biases.	In theory, it can fit any complex function and has strong generalization ability.	The amount of calculation is large, and the parameter adjustment process depends on human experience.
D-S evidence theory	The generalization of Bayesian estimation, introducing the trust function, and the likelihood function to obtain the basic probability distribution function.	The required prior knowledge is more intuitive and easier to obtain than that in Bayesian estimation, and the knowledge and data of different experts or data sources can be integrated, and the description of uncertain problems is very flexible and convenient.	Evidence needs to be independent. The theory of evidence synthesis has no solid theoretical basis, and there is a potential exponential explosion in calculation.
Kalman filter	Utilizing the straight framework state condition, through the framework information and result perception information, the ideal assessment calculation of the framework state.	Using original data for fusion, less information loss.	The equation of state is difficult to establish and solve, and its scope of application is limited.
Weighted average method	A number of observations of the same variable arranged in time order are weighted by the time order number, and the weighted arithmetic mean of the observations is calculated.	The model is simple, and less information is lost.	The weights have a great influence on the fusion results and are not easy to determine.
Bayesian estimation	Utilize Bayes' hypothesis to consolidate new proof with past earlier probabilities to get new probabilities.	There are specific mathematical models, which are easily accepted.	Certain prior knowledge needs to be obtained, and the prior knowledge has subjective differences, which affects the posterior results.

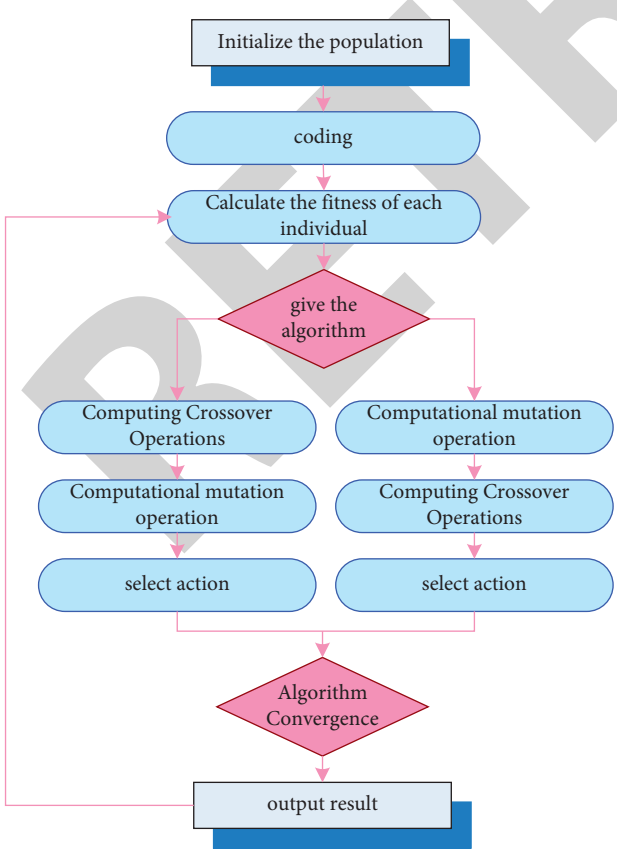

Figure 6: Adaptive genetic algorithm solution process.

$$W_s \geq 1 - W_c \cdot \varphi \frac{(K)}{(L-1)}. \tag{3}$$

Taking into account the effects of selection and crossover, there is

$$m(K, e+1) \geq m(K, e) \cdot \overline{f}(K, e) \cdot \frac{[1 - W_c \cdot \varphi(K)}{(L-1)/\overline{f}(e)}. \tag{4}$$

Under the action of the mutation operator, the probability that K continues to exist is

$$(1 - W_n)^{O(W)} \approx 1 - W_n \cdot O(W). \tag{5}$$

The probability of unreserved is about $O(K) \cdot W_n$. Therefore, considering the functions of selection, crossover, and mutation operators, this equation can be finally gotten

$$m(K, e+1) \geq \frac{m(K, e) \cdot \overline{f}(K, e) \cdot [1 - W_c \cdot (\varphi(K)/L-1) \cdot W_n]}{\overline{f}(t)}. \tag{6}$$

Specifically, if $\overline{f}(K, e) = f(e)(1+c)$, $c > 0$ and it is constant, then

$$m(K, e) = m(K, e-1)(1+c) = m(K, O)(1+c)^e. \tag{7}$$

3.4.2. Improved Algorithm Design and Method. The improvement is applied to the traditional genetic algorithm, and the execution flow is shown in Figure 6.

Combining evolutionary algorithms with neural networks is a great way to complement each other's strengths.

There are usually two forms of genetic algorithm optimization neural network: auxiliary and cooperative. The advantages of the genetic evolution neural network in the field of deep learning that it can adaptively learn evolution make it more and more applications and research, but there are many issues to be considered for specific implementation:

(1) Encoding Method. In recent years, due to the high complexity of practical problems, many improvements have been made to the traditional binary coding method of genetic algorithms. These include the real number encoding method that improves the solution accuracy, the permutation encoding method l81I that performs well in combinatorial optimization problems, the matrix encoding method that can transmit multidimensional information, and so on.

(2) Fitness Calculation. In hereditary calculation, the size of wellness addresses the benefits and detriments of people in natural development. It figures out which top notch people can develop into the future and which substandard people should be wiped out.

The basic expression equation of fitness function is as follows:

$$F(z) = gf(z). \tag{8}$$

f is the objective function, the moment when g is positive or negative depends on $f(z)$, and F is the relative fitness of the population.

If the objective function is a minimization problem, then

$$F(z) = -f(z),$$
$$F(z) = \begin{cases} D_{\max} - f(z), & f(z) < D_{\max}, \\ 0, & \text{others}, \end{cases} \quad F(z) = \frac{1}{1 + d + f(z)}, \quad d \geq 0,\ d + f(z) \geq 0. \tag{9}$$

$D_{\max}$ is the maximum estimate of $f(z)$, and d is a conservative estimate of the bounds of the objective function.

If the objective function is a maximization problem, then

$$F(z) = -f(z),$$
$$F(z) = \begin{cases} f(z) - D_{\max}, & f(z) > D_{\max}, \\ 0, & \text{others}, \end{cases} \quad F(z) = \frac{1}{1 + d - f(z)}, \quad d \geq 0,\ d - f(z) \geq 0. \tag{10}$$

$D_{\max}$ is the maximum estimate of $f(z)$, and d is a conservative estimate of the bounds of the objective function.

For the likelihood of individual selection, there are two widely used allocation methods: proportional fitness allocation and classification-based.

(1) Proportional Fitness Allocation Method. Proportional allocation must satisfy that f_{avg} does not change before and after transformation, and the maximum value of $f(z_a)$ after transformation should be equal to the multiple of f_{avg} before transformation. It can ensure that the number of individual copies remains unchanged and can control the individual with the greatest fitness not to replicate in large numbers, preserving the diversity of the population. At this time,

$$F(z_a) = mf(z_a) + n, \tag{11}$$

where $f(z_a)$ is the fitness of the individual z_a, m is the scalar coefficient, n is the offset value, and $F(z_a)$ is the fitness value generated by the individual.

$$f_{\min} > \frac{\text{Smul} \times f_{\text{avg}} - f_{\max}}{\text{Smul} - 1.0}. \tag{12}$$

Usually, the range is [1.0, 2.0], and the coefficient of the linear scale can be obtained according to the preconditions

$$m = \frac{(\text{Smul} - 1.0)}{f_{\max} - f_{\text{avg}}} f_{\text{avg}},$$
$$n = \frac{f_{\max} - \text{Smul} - 1.0)}{f_{\max} - f_{\text{avg}}} f_{\text{avg}}. \tag{13}$$

Otherwise,

$$m = \frac{f_{\text{avg}}}{f_{\text{avg}} - f_{\min}},$$
$$n = \frac{-f_{\min} \times f_{\text{avg}}}{f_{\text{avg}} - f_{\min}}. \tag{14}$$

Smul is a user-specified multiple, and f_{avg} is the average among the current offspring.

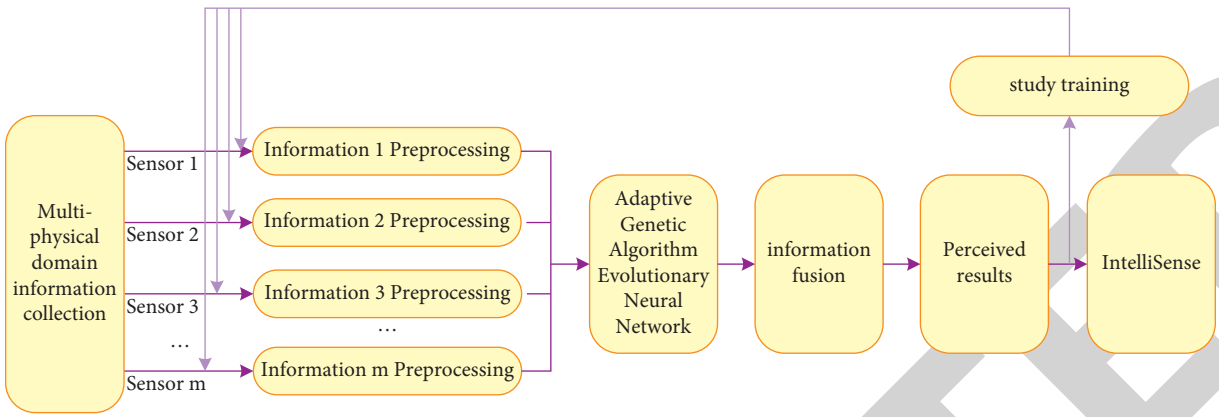

Figure 7: Multiphysical domain information fusion model process.

(2) Rank-Based Fitness Assignment Method. This method can limit the living range of offspring and calculate the fitness according to the order of individuals in the population, which can prevent individuals from producing extreme offspring, and restrains premature convergence to a certain extent.

For linear sorting, the fitness value is calculated as follows:

$$\text{Fitn}V(\text{Pos}) = 2 - sp + \frac{2 + (sp-1)(Pos-1)}{W_{\text{ind}} - 1}, \quad sp \in [1.0, 2.0]. \tag{15}$$

The number of individuals in the population is denoted as W_{ind}, and the difference in selection pressure is denoted as sp, which determines the displacement or force of selection.

For nonlinear sorting, the fitness value calculation equation is as follows:

$$\text{Fitn}V(\text{Pos}) = \frac{W_{\text{ind}} \times Z^{\text{pos}-1}}{\sum_{a=1}^{W_{\text{ind}}} Z^{a-1}}. \tag{16}$$

Z is the absolute value of the roots of the polynomial equation

$$(sp - B_{\text{ind}})Z^{B_{\text{ind}}-1} + spZ^{B_{\text{ind}}-2} + \cdots + spZ + sp = 0. \tag{17}$$

(3) Parameter Setting. Boundaries characterized in transformative calculations incorporate chromosome length, populace size, hybridization likelihood, change likelihood, number of redundancies, and organization levels. Every boundary will influence the exhibition of the calculation. As of now, analysts have done a great deal of exploration on the determination and streamlining of transformative calculation boundaries. The selection of boundaries straightforwardly influences the redundancy pace of the calculation and the precision of the arrangement. The hybridization likelihood, which influences the general flexibility, and the change likelihood, which decides the adequacy of the neighborhood search, are the two most significant boundaries.

4. Multimodal Information Fusion Experiment of Evolutionary Neural Network Based on Adaptive Genetic Algorithm

4.1. Multiphysical Domain Information Fusion Model Process. The process of multiphysical domain information fusion of intelligent agents is shown in Figure 7, and the specific process is as follows:

(1) The handling object is furnished with different designated sensors, and the securing framework is utilized to acquire the applicable data of the article and get multistation signal information.

(2) The gained data are turbulent and uproarious, which cannot be straightforwardly melded. The sign should be mined and the commotion eliminated.

(3) Multi-actual space data highlight layer combination. The sign highlights acquired from (2) are taken as information, and the data combination model in view of brain network is utilized to incorporate the multimodular sign elements and get the combination results.

4.2. Data in the Production Process of the Enterprise

4.2.1. Neural Network Simulation and Result Analysis. To confirm the possibility of the versatile hereditary calculation brain organization, the python language is utilized for programming considering the PyCharm stage, and the perfect python module is utilized to build a versatile brain organization, which is utilized to pass judgment on the exemplary XOR issue. The XOR problem is a modified version of the OR problem, and its rules are as follows:

(1) Input true, true, output false;

(2) Input false, true, output true;

(3) Input true, false, output true;

(4) Input false, false, output false.

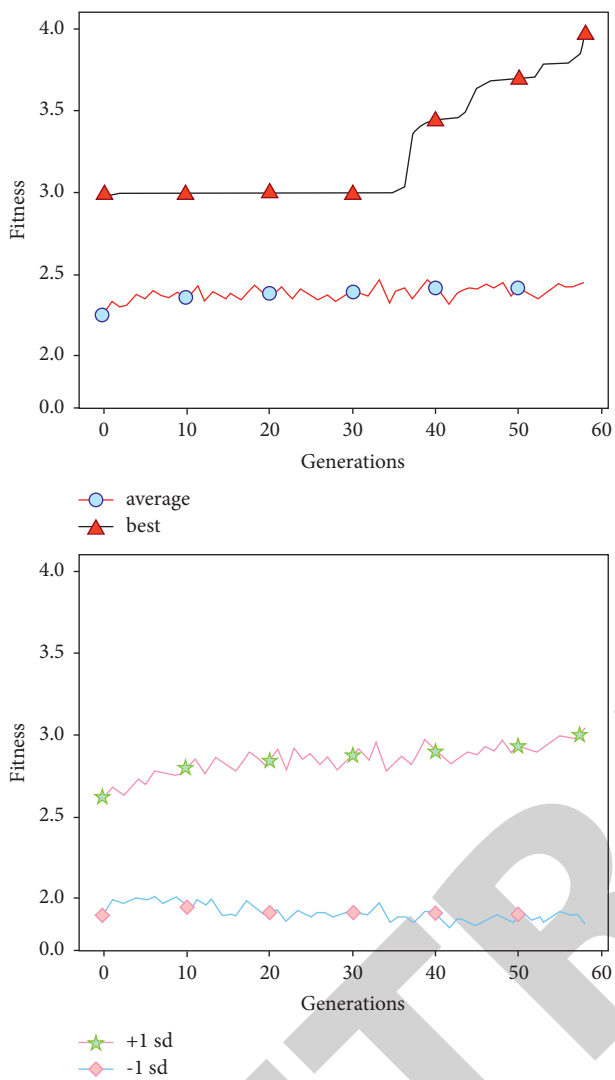

Figure 8: Population fitness curve based on neural network.

Figure 8 shows the population average and highest fitness change curves. The fitness of the neural network reaches the threshold of 3.95 after iterating for nearly 60 generations, and the iteration is stopped to obtain the best individual.

4.2.2. Simulation Results and Analysis. In order to verify the feasibility of the multimodal information fusion method based on the evolutionary neural network of adaptive genetic algorithm, this paper conducts algorithm simulation through the low-carbon production experiment of enterprises, which is a typical intelligent low-carbon experiment.

The network sets the initial hidden layer to be 0, which allows the neural network to evolve from the simplest structure and achieve the purpose of light weight, which is also the advantage of the evolutionary neural network. The population size (pop_size) is set as 100, and two outputs are set as left and right offsets, respectively. Relu is used in the activation function, so that the function has nonlinear fitting ability. The fraction of each production energy consumption is used as individual fitness, and the fitness threshold of offspring is set as 1. After the network is created and evaluated, a neural network can be generated for each individual, and each neural network can be tested for production energy consumption. In one iteration, the network will test the network of each individual for 10 rounds and finally select the round with the least reward among all rounds of an individual as the fitness of the network. When any fitness reaches 1 or the number of iterations reaches 300 times, iterating and updating the population will stop, and output the winner with the best performance. The final output winner neural network is used to predict. Figure 9 selects the average and highest fitness change curve of the population in the three experiments. It can be seen that there are children in the neural network population that quickly reach the fitness threshold, and stop the iteration to obtain the best individual.

It can be seen from the results that for an enterprise's low-carbon information analysis technology problem, the evolutionary neural network achieves stability after a small number of iterations and can basically achieve a certain low carbonization. The network structure generated by the evolutionary neural network is quite simple compared to the case where the hidden layer of reinforcement learning often has dozens or hundreds of hidden nodes. The adaptive genetic algorithm neural network can generate a relatively simple network structure with fewer iterations when facing the technical problems of enterprise low-carbon information analysis, and can learn faster to achieve the goal.

The data set generated in the production process of the enterprise is trained. In order to verify the effectiveness of the algorithm, the rough neural fuzzy network is compared with the adaptive genetic algorithm and neural network hybrid multimode information fusion algorithm and neural network hybrid multimode information fusion algorithm proposed in this paper. Comparing the efficiency of the two algorithms in model training and the degree of fitting to the expected value of the enterprise's production energy consumption, the test results of the model are shown in Figure 10.

In terms of simulation performance, the network exhibits strong generalization ability and recognizes behavioral patterns, and allows the creation of inference mechanisms in various aspects without relying on human experts in high-complex systems. It can be seen from Figure 10 that the algorithm in this paper has a better fitting effect on the low-carbon production status of enterprises. Compared with the traditional RNFN algorithm, this paper has better training speed and efficiency, and the network can converge faster and achieve the goal.

4.3. Enterprise Cost Accounting in a Low-Carbon Economy. There is a growing awareness that it is unreasonable to include all environmental costs in general production costs. While environmental costs are critical, not all costs are associated with cost centers and some can be classified as part of general overhead. Additional costs associated with the flow of materials and waste generated during production are unrelated to common cost centers and often overlooked.

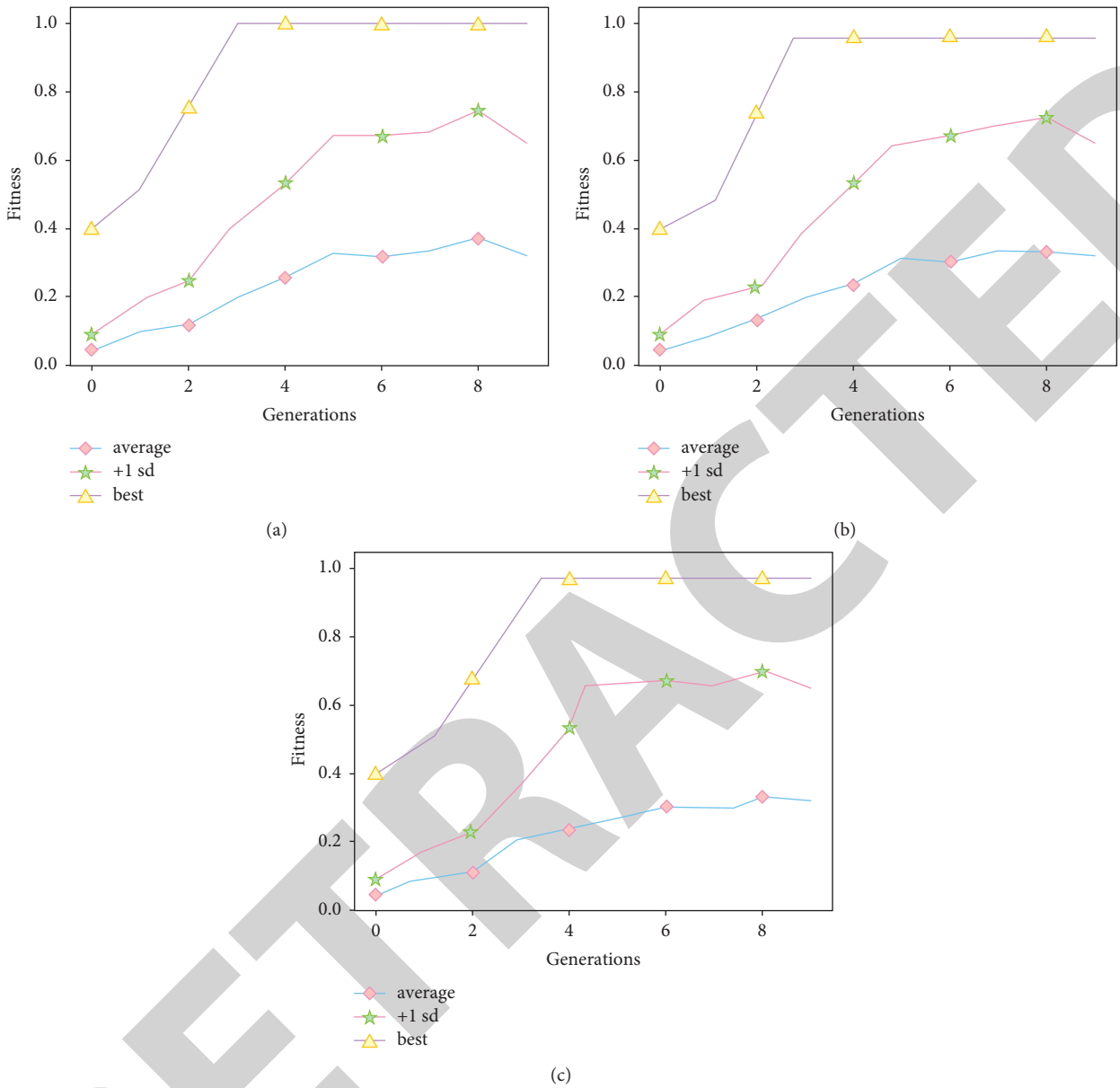

Figure 9: Population fitness curve. (a) The first experiment. (b) The second experiment. (c) The third experiment.

This part of the cost of this waste will inevitably be saved if waste is reduced at the source. Efficient use of resources in product production will reduce waste and improve economic efficiency.

(1) In the production process, by introducing the cost method, the material flow and energy flow in the production and operation process of the enterprise can be monitored, and the visualization of the material flow and value flow of the enterprise can be improved. As a result, business managers can better understand material and energy waste and then take effective measures to improve congestion point procedures at each production plant.

(2) In terms of investment decision making, the result of accounting cost can provide effective information for the enterprise's investment decision making.

(3) In terms of resource consumption, the application of the logistics cost accounting method reduces the waste of the company's resources, thereby reducing the resource consumption in the company's production and operation activities, effectively alleviating the problem of resource shortage, and improving environmental performance.

(4) In terms of environmental protection, for a long time, low-level manufacturing, as an important part of economic growth, will become China's leading

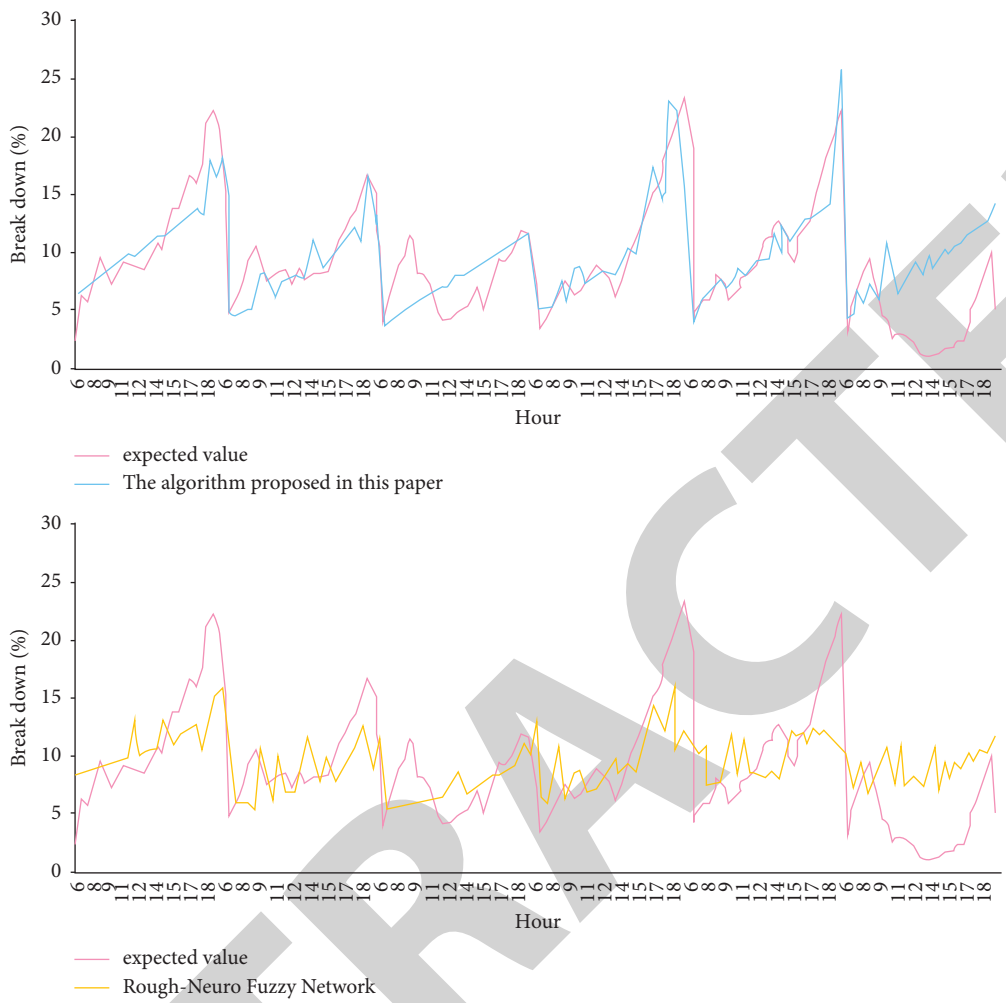

Figure 10: Production energy consumption forecast results.

industry and pollutants emitted by production enterprises in the production process. Using the logistics cost accounting method, the company can accurately calculate the amount of waste processed and take effective improvement measures to reduce the discharge of harmful substances and reduce the adverse impact on the environment.

5. Discussion

This paper analyzes how to conduct research on enterprise low carbon based on big data and multimodal information fusion. The concept and algorithm of multimodal information fusion are expounded, the low-carbon awareness of enterprises is studied, and the analysis hierarchy process of multimodal information fusion is explored. And through experiments, this paper analyzes the applicability of evolutionary neural network multimodal information fusion based on adaptive genetic algorithm in low-carbon production of enterprises.

Through the analysis of raw and auxiliary material consumption data and waste data, enterprises can compare the current and historical consumption of raw and auxiliary materials in the production process of each unit of product, and analyze the utilization rate of materials and the degree of environmental pollution. Through the analysis of electricity, water, fuel, and other usage data in the production process of a batch of products, it is possible to find out the production process with high energy consumption, and take energy-saving and emission-reduction measures. Therefore, enterprises must record the input and output data of each quarter or each batch production.

The results can be seen from the experimental analysis in this paper: as one of the most important ways to raise the awareness of low-carbon enterprises, the essence of cost accounting coincides with the goals of Chinese enterprises to improve cost management, reduce material and energy consumption, save costs, and optimize the environment and economic benefits. Promoting low-carbon emissions is the most necessary accounting method for economic growth.

6. Conclusions

The study of low-carbon enterprise production is a large systematic effort, and many issues have not been investigated or covered in depth in this paper. This paper failed to give an

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Research Article

The Auxiliary Role of College Music in Teaching in View of Artificial Intelligence

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Music is a common art and it is a jewel of human civilisation. In the course of music's development, the evaluation of music teaching is an inevitable step in the development of quality music. Universities are important places that abound with musical souls and their contribution to the development of music has been outstanding. But with the development of the times, university music has been hampered in the field of teaching and learning. As an important branch in the field of computer science and information technology, artificial intelligence technology contains many intersecting and comprehensive subject connotations, bringing brand-new elements to music education. It has also had an important impact on the development of music teaching. The article focuses in depth on the traditional process of music development in terms of the characteristics and ways of teaching music. Based on this, the article further explores the integration of artificial intelligence and music and analyses the role of emerging technologies as an aid to music from the perspective of the times. And this article uses emotion recognition as an evaluation index to explore the evaluation role of artificial intelligence technology in college music teaching, and improve the quality and efficiency of music teaching. The experimental results show that the teacher's positive emotion rate based on image data is 57.8%, and the student's positive emotion rate is 44.5%; the teacher's positive emotion rate based on voice data is 53.3%, and the student's positive emotion rate is 51.1%. The classroom emotion is negative at 7–13 minutes, the classroom emotion continues to be low at 28–40 minutes, and the teacher and student emotions are more positive at 13–28 minutes.

1. Introduction

Music is a popular art form, and good musical expression can often help people develop a healthy personality. However, music often covers the creator's personal emotions, and music teaching is a highly subjective art. Therefore, only relying on manual evaluation and guidance of music teaching often has a lot of randomness. Artificial intelligence is an emerging technology to study and expand human intelligence, which was first born in the 1950s. Because of its unique functional characteristics, artificial intelligence is widely used in many disciplines and fields. For example, artificial intelligence systems for medical clinical use scan data and images and provide medical information; banks use artificial intelligence systems to organize operations, financial investments, and property management; Yuncheng Communications Corporation studies machines that manage labor. The combination of artificial intelligence and music teaching could bring a new face to music education and bring music into the zeitgeist, while this move could also improve people's practical skills and enhance their appreciation of art. The development and advancement of artificial intelligence will further help humans to analyze and make decisions, and revolutionise the way they work.

As an emerging technology, artificial intelligence has a wide range of applications in the fields of pattern processing and image recognition, which has attracted the attention of many experts and scholars. Lu et al. plan to use artificial intelligence to build an intelligent learning model that can mimic the human learning process to the greatest extent possible. In the research process, he also used special events to test the learning model, and proposed many targeted optimization strategies [1]. In order to study the development process of artificial intelligence, Hassabis et al.

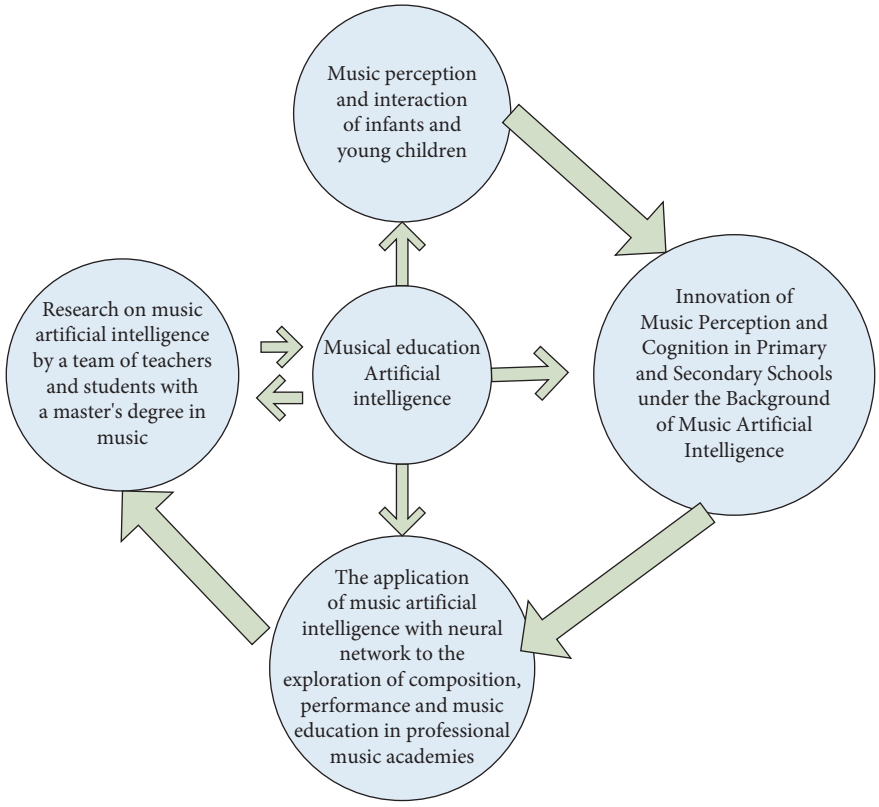

Figure 1: The relationship between artificial intelligence and music education.

proposed an intelligent algorithm combined with neural network. During his investigation, he discovered that there is a connection between the development of artificial intelligence and the biological brain [2]. Thrall et al. have pioneered the introduction of artificial intelligence into the field of medicine. Through the application of artificial intelligence in imaging to analyze image data, he improves the certainty of diagnosis. And he put forward a strategic plan for how radiologists and pathologists will combine big data and artificial intelligence in the future [3]. Rongpeng demonstrates the effectiveness of artificial intelligence in managing and orchestrating cellular network resources. Rongpeng et al. discussed the relationship between artificial intelligence and candidate technologies in 5G cellular networks [4].

The performance of the song "Transits into an Abyss" marks the first time that humans have played a work entirely created by machines. This piece of music was composed by a computer cluster "Iamus" with intelligent algorithms. In the creative process, Iamus can create a complete music with only some scattered information, and then it can also achieve high achievements in a very short period of time. Following the above achievements, Iamus went on to create many other genres of music. Not only that, relying on the calculation of artificial intelligence, Iamus can also get rid of manual guidance to complete the music arrangement, lyrics, and arrangement independently. People call the product of combining music and artificial intelligence as music artificial intelligence, which is a field where artificial intelligence and music learning are integrated. With the development of the times, the combination of music and artificial intelligence is getting closer and closer, which also provides ideas for people to innovate in the field of music. With the blessing of artificial intelligence technology, human physiological senses are infinitely amplified, which has built a good platform for people to create music. At the same time, combining artificial intelligence with music is not only an innovation of traditional music forms, but also a better development of artificial intelligence. It is suitable for human perception, cognition, research and creation of music, forming a new way of music teaching with human-computer interaction (Figure 1).

With the progress of the times, the form of music teaching has also undergone earth-shaking changes. The renewal of these musical instruments makes people's lives more convenient, intelligent, and complete. It not only provides a new model for music classroom teaching, but also provides new directions, teaching ideas and thinking space for music educators, opening up a new world. Based on this, many scholars have conducted research on the combination of artificial intelligence and music teaching. In order to study the role of kindergarten music teachers in music teaching, Wong assessed the teaching situation of 88 in-service kindergarten music teachers. In the process of comprehensive evaluation, he used the music teaching effect and emotional perception indicators as the basis for evaluation, and established a quantitative evaluation table based on this [5]. Prichard adopts a continuous explanatory hybrid method design, divided into two chains (chain I: quantitative, chain

II: qualitative). Introductory music education students ($N = 684$) from 41 accredited institutions of the National Music School Association participated in the first line, and a nested sample of 24 respondents participated in the second line. The effectiveness beliefs of preservice music teachers are interpreted as having two dimensions: music teaching effectiveness beliefs and classroom management effectiveness beliefs. The mixed method analysis shows that the introductory music education students' beliefs in music teaching effectiveness may be affected by various curriculum experiences, including personal guidance, peer teaching, and field experience [6]. Singh et al. used to study the data of the multiple intelligences of Indian children, and to evaluate the different forms of intelligence of students. The subjects of the experiment were 1065 students between 12 and 16 years old. All students received a multiple intelligence questionnaire consisting of 30 right and wrong questions. It evaluates children's intelligence in seven areas, including language skills, logic/mathematics skills, music skills, spatial intelligence, bodily kinesthetic skills, intrinsic intelligence, and interpersonal intelligence [7].

However, the above-mentioned experts and scholars' research on music teaching mode mainly focus on the level of primary and secondary schools, and most scholars have failed to combine artificial intelligence with music teaching at this stage. Throughout the entire music industry, the combination of artificial intelligence and college music teaching is still in its infancy [8]. This article explores how to use artificial intelligence to carry out teaching behavior analysis, and then obtain the auxiliary role of artificial intelligence in college music classrooms. It is to help artificial intelligence integrate into college music classrooms more scientifically and efficiently, and to better promote college students' music learning.

2. Artificial Intelligence in Music Teaching in Colleges and Universities

2.1. The Status Quo of Music Teaching in Colleges and Universities. The development of traditional university music teaching depends to a large extent on the music courses provided by universities and the teaching experience of music teachers [9]. The quality of music courses is also closely related to teachers' teaching experience, and the quality of music courses in different universities varies greatly. Under the combined effect of these factors, many problems inevitably arise in college music teaching, mainly as follows.

2.1.1. Not Paying Enough Attention to Music Teaching. In the process of college education, colleges often focus all their attention on academic education, so they ignore music and other arts education to a certain extent [10]. Taking a step back, even professional art colleges often cannot guarantee enough attention to music teaching. Under this circumstance, many colleges and universities naturally ignore the quality of music teaching. If things go on like this, the problems of music teaching will become more and more prominent.

2.1.2. Single Music Teaching Mode. In the process of college music teaching, there is a phenomenon of single teaching mode. Usually, teachers are accustomed to abstractly explaining the basic theories of music, allowing students to understand the background, creative environment, and story outlines of musical works. It also leads students to analyze the tunes, melody, and techniques of musical works. However, most students are not strong in understanding abstract music knowledge and concepts, which lead to the phenomenon that students have a weak foundation in music theory. Most of the development modes of music courses are that teachers use musical instruments to let students appreciate or sing classic songs. The teaching mode and content are monotonous, and the quality of music classroom teaching is also low [11].

2.1.3. Taking Teachers as the Main Body. In the primitive music assessment system, music education is often the preserve of the teacher, which severely erases the autonomy of the students [12]. In addition, students are often afraid or unwilling to express themselves accordingly due to traditional attitudes, which further detract from the practical needs of music education.

2.1.4. Music Teaching Behavior Evaluation Mechanism. In the traditional music teaching evaluation model, the evaluation of music teaching in colleges and universities often relies on manual evaluation and manual guidance. In this case, the overall level of music teaching cannot be guaranteed. Moreover, this method often requires a large number of professional music experts, which consumes a lot of manpower and material resources [13]. At the same time, even the most professional experts cannot guarantee the accuracy and objectivity of each evaluation, so the current music teaching behavior evaluation is highly subjective.

2.2. Network Structure and Working Mode of RBF Algorithm. The algorithm model of the music intelligence system uses the artificial intelligence algorithm RBF model. This algorithm is called a radial basis function and is a neural network composed of locally regulated neurons. It usually consists of a three-layer network model: input layer, hidden layer, and output layer. The input layer is composed of signal source nodes. They connect the network and the external environment, and play a role in the transmission of data and information. It does not make any changes to the input information. The kernel function of the hidden layer neuron is taken as the radial basis function, which performs nonlinear transformation of the input information into the hidden layer space. The output layer is linear and provides a response to the activation mode of the input layer. The RBF algorithm flow is shown in Figure 2 [14].

There are many commonly used radial basis functions [15].

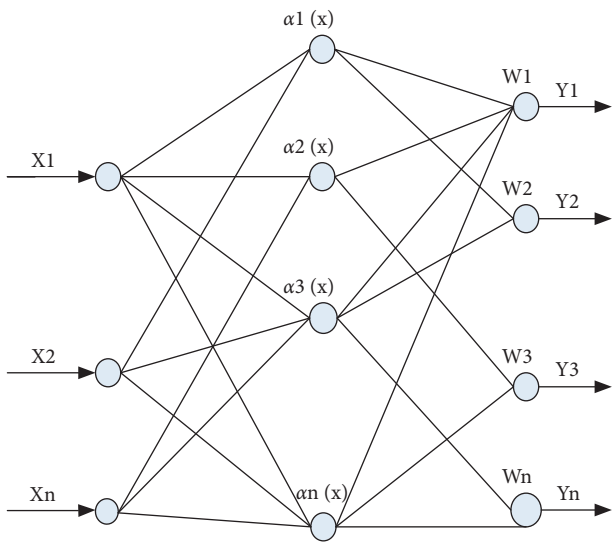

Figure 2: RBF network structure diagram.

(1) Gaussian function:

$$\alpha_j(x) = \varphi\left(\frac{x - c_{ji}}{\sigma_{ji}}\right) = \alpha^e e^{\left(x - c_{ji}\right)^2/\sigma_{ji}^2}\psi\sigma. \quad (1)$$

(2) Abnormal sigmoid function:

$$\alpha_j(x) = \frac{1}{1 + e^{\left(x - c_{ji}\right)^2/\sigma_{ji}^2}}. \quad (2)$$

(3) Quasi-multiple quadratic functions:

$$\alpha_j(x) = \frac{1}{\sqrt{\left(x - c_{ji}\right)^2 + \sigma_{ji}^2}}. \quad (3)$$

This research uses Gaussian function in radial basis function. In formula (1), c_{ji} is the center of the j-th basis function [16], the output value range of the node is between 0 and 1, and the output value is inversely proportional to the distance of the input sample from the center. That is, the closer the distance, the larger the output value; the farther the distance, the smaller the output value [17]. The initial calculation formulas of c_{ji}, σ_{ji}, and ω_{ij} are

$$c_{ji} = \min X + \frac{\max X - \min X}{2p} + (j-1)\frac{\max X - \min X}{p},$$

$$\sigma_{ji} = \sigma_f\sqrt{\frac{1}{N}\sum_{k=1}^{n}\left(x_i^k - c_{ji}\right)^2},$$

$$\omega_{ij} = \min W + j\frac{\max W - \min W}{q+1}. \quad (4)$$

Among them, the input vector $X = [x_1, x_2, \ldots, x_n]^T$ and n is the number of input layer units.

minX is the minimum value of the i-th feature input vector and maxX is the maximum value of the i-th feature input vector.

minW is the minimum value of all expected outputs in the k-th feature output and maxW is the maximum value of all expected outputs in the k-th feature output.

When the input parameter is 0, the function value gets the maximum value of 1. As the distance between the weight and the input vector decreases, the output value becomes larger [18]. That is, the radial basis function responds locally to the input signal. When the input argument X of the function is close to the central range of the function, the hidden layer node will produce a larger output [19]. It can be seen that this function has the characteristics of local approximation.

Figure 3 shows the output curves of Gaussian radial basis functions at different Euclidean distances. As shown in the figure, when the input value enters the neural network, the corresponding output value will be obtained. The radial basis output value represents the Euclidean distance between the input value and the corresponding weight. In layman's terms, it is the degree of similarity between the two values [20]. The larger the phase difference, the smaller the radial basis output value. As shown in the figure, when the abscissa is −1.0 and 1.0, the radial basis output is almost 0. The Gaussian output at 0.0 point is 1, and the neuron with a radial basis output of 1 gets the weight of the second layer [21].

The output layer formula is

$$y_i = \sum_{k=0}^{n}\omega_{ij}\alpha_j(x), \quad i = 1, 2, 3, 4, \quad (5)$$

c_{ji}, σ_{ji}, and ω_{ij} can be adjusted to the best value, and the adjustment calculation is as follows:

$$W_{kj}(t) = \omega_{kj}(t-1) - \eta\frac{\partial E}{\partial\omega_{kj}(t-1)} + \alpha\left[\omega_{kj}(t-1) - \omega_{kj}(t-2)\right],$$

$$c_{ji}(t) = c_{ji}(t-1) - \eta\frac{\partial E}{\partial c_{ji}(t-1)} + \alpha\left[c_{ji}(t-1) - c_{ji}(t-2)\right],$$

$$d_{ji}(t) = d_{ji}(t-1) - \frac{\partial E}{\partial d_{ji}(t-1)} + \alpha\left[d_{ji}(t-1) - d_{ji}(t-2)\right]. \quad (6)$$

Among them:

$$E = \frac{1}{2}\sum_{l=1}^{N}\sum_{k=1}^{q}\left(y_{lk} - o_{lk}\right)^2. \quad (7)$$

Among them, o_{lk} is the expected output value of the k-th output neuron at the l-th input sample and y_{lk} is the network output value of the k-th output neuron at the l-th input sample.

2.3. Network Structure and Working Method of BP Algorithm. The neural network BP includes two processes: the forward propagation of the signal and the backward propagation of the error. When propagating forward, the input signal acts on the output node through the hidden layer and undergoes a nonlinear transformation to produce an output signal. If the actual output does not match the expected output, the

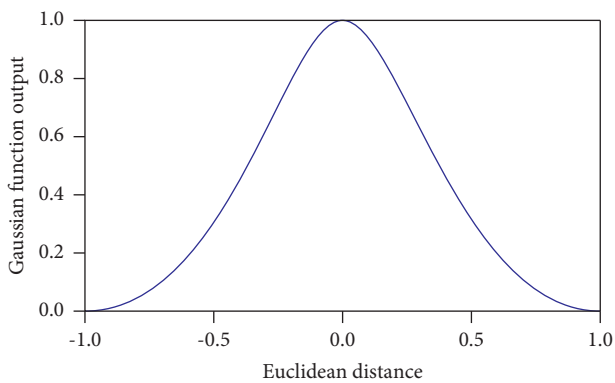

Figure 3: Gaussian radial basis function output curve.

process of back propagation of the error will be entered. The principle of error back propagation is to use the gradient descent algorithm to continuously adjust the input signal part and neuron threshold of each layer, and repeat it many times. The basic idea is to propagate the output layer error from back to front layer by layer, and indirectly calculate the hidden layer error [22]. The structure diagram is shown in Figure 4.

The BP algorithm is now applied to music [23]:

(a) Parametric assignment of weights $(\omega_{ji}^h, \omega_{ki}^o)$ and music parameter selection (θ_j^h, θ_k^o).

(b) Add input variable $X_p = [x_{p1}, x_{p2}, \ldots, x_{pq}]$ to the input unit.

(c) Calculate the net input of the hidden layer:

$$net_{pj}^h = \sum_{i=1}^{q} \omega_{ji}^h x_{pi} + \theta_j^h, \tag{8}$$

(d) Calculate the output value from the sigmoid function defined in the hidden layer:

$$f_j^h\left(\text{net}_{pj}^h\right) = \left(1 + e^{-net_{pj}^h}\right)^{-1}. \tag{9}$$

The output value is

$$c_{pj} = f_j^h\left(\text{net}_{pj}^h\right), \tag{10}$$

(e) Then get the first output result, calculate the deviation of the result in the corresponding layer:

$$\text{net}_{pk}^o = \sum_{j=1}^{K} \omega_{kj}^o c_{pj} + \theta_k^o, \tag{11}$$

(f) After getting the deviation value, compare it according to the function obtained above, and get the output:

$$O_{pk} = f_k^o\left(\text{net}_{pk}^o\right), \tag{12}$$

(g) Get the error value from the above function:

$$\delta_{pk}^o = \left(d_{pk} - o_{pk}\right) \frac{\partial f_k^o\left(\text{net}_{pk}^o\right)}{\partial\left(\text{net}_{pk}^o\right)}, \tag{13}$$

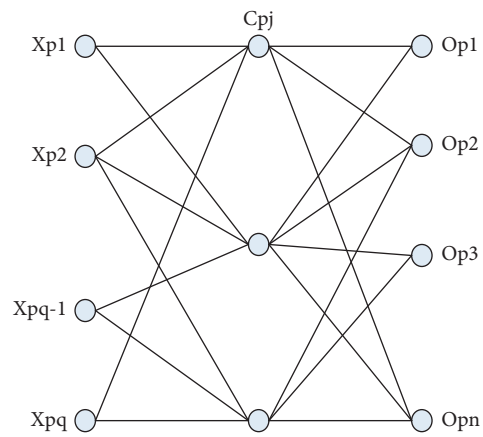

Figure 4: Basic structure of the BP algorithm.

(h) Rematch the weight vector according to the error:

$$\delta_{pj}^h = \frac{\partial f_j^h\left(\text{net}_{pj}^h\right)}{\partial\left(\text{net}_{pj}^h\right)} \sum_k \delta_{pk}^o \omega_{kj}^o, \tag{14}$$

(i) After matching the corresponding weights, update the display layer, where Ω is a bias value:

$$\omega_{kj}^o(n+1) = \omega_{kj}^o(n) + \alpha n \omega_{kj}^o(n-1) + \eta \delta_{pk}^o c_{pj} + \Omega, \tag{15}$$

(j) Handle iterative weights located in hidden layers:

$$\omega_{ji}^h(n+1) = \omega_{ji}^h(n) + \alpha n \omega_{ji}^h(n-1) + \eta \delta_{pj}^h x_i + \Omega. \tag{16}$$

With the above operations, we have initially implemented the combination of neural network and music. In the above process, we first redefined the objective function of the neural network, then we made error adjustments according to the actual situation, and finally obtained the desired output.

3. System Verification

3.1. Music Classroom Teaching Behavior Evaluation System. Combining the above algorithms and practices, we can initially construct a system for evaluating teaching behaviour specifically for the music classroom. In this regard, the basic composition of the system is shown in Figure 5. In this system, we can clearly see that there are three levels of the system, so the next article will analyze the relevant performance of the system from the following three levels.

3.1.1. Application Layer. The application layer contains three interfaces: managers, teachers, and students. After the initial collection and analysis of the data, the visualization results will eventually be fed back to the three parties. The application layer can help managers evaluate classroom teaching, intelligently manage school courses, and improve management efficiency.

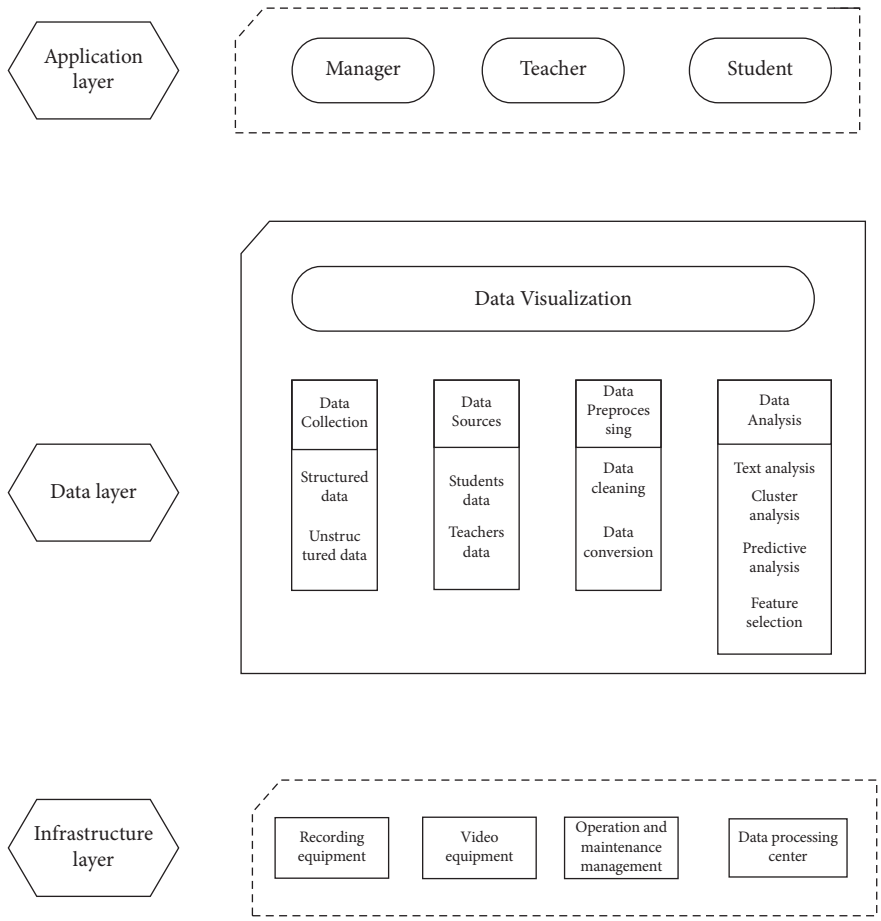

Figure 5: Music teaching evaluation system.

3.1.2. Data Layer. The main tasks of the data layer are data collection, data source, data preprocessing, and data analysis. Data collection is classroom teaching video data collected through the infrastructure layer. This research is divided into two types of data: image data and voice data. The data source is the collected teacher and student data. Data preprocessing is to filter, transform, and process the collected source data into data that can be used for experiments. Data analysis is to conduct text analysis, cluster analysis, feature selection and association analysis on the data, and finally form a visualization diagram and draw conclusions.

3.1.3. Infrastructure Layer. The infrastructure layer is mainly responsible for data collection. Put recording equipment and video equipment in the classroom to obtain the video and voice data. In addition, the infrastructure layer also includes operation and maintenance management and data processing center.

The system process starts from the infrastructure layer and uses smart devices to collect classroom videos and obtain classroom video and voice data. Then, it transfers to the data layer for data analysis to form a visualization map, which is finally fed back to the tripartite interface of the application layer.

3.2. Classroom Teaching Behavior Analysis Process Based on Artificial Intelligence Technology. After this brief analysis, we can see that the different modules have different roles. The infrastructure layer is the main source of information from the underlying technology. Once a certain amount of data has been obtained, the infrastructure layer packages the data and sends it back to the data layer. After receiving the data, the data layer then starts a series of processing and transformation. The data transformed by the data layer is then passed on to the application layer for presentation to the user. The information obtained by the infrastructure layer is shown in Table 1.

It can be seen from Table 1 that the data stored in the data layer is mainly voice and image data. The collected data is voice and image data, using voice, image, and facial recognition to analyze the preprocessed data. People's emotions are directly reflected in body language and facial expressions, so we first chose to identify and analyze the facial expressions of data subjects [24]. It can process and analyze the face images of students and teachers, then process and analyze speech and text, and extract them into the speech stream. Combining the analysis results of the two to analyze the emotional behavior of teachers and students. The finally generated data can be displayed in three parties at the application layer, allowing managers, teachers, and students to clearly see the intelligent analysis.

Table 1: Data collection table for teaching and learning behavior based on artificial intelligence.

Collection indicators			Data collection	Analysis technology
Students' learning behavior	Students' verbal behavior	Answer proactively Ask proactively Discuss actively	Voice data	Speech recognition technology
	Students' acting behavior	Observe Do experiments Cooperative inquiry Take notes Operate information technology tools	Image data	Image recognition technology
Teachers' learning behavior	Teachers' verbal behavior	Teach Ask questions Guide instructions Evaluate	Voice data	Speech recognition technology
	Teachers' acting behavior	Demonstrate Participate Write on the blackboard	Image data	Image recognition technology
Other behavior	Teachers'&student s' emotional behavior	Students' positive emotion Teachers' positive emotion	Voice data, image data	Face recognition, voice recognition technology

4. Experiment and Result Analysis

4.1. The Purpose of the Experiment. The purpose of this experiment is to use artificial intelligence technology and a designed classroom teaching behavior analysis system to identify and analyze the language and behavior of teachers and students by analyzing sample classroom teaching videos. Designing the emotion algorithm to present the teacher and student emotion change graph, get the teacher and student emotion score, and the overall emotion analysis of the classroom.

4.2. Experimental Objects and Analysis Indicators. The sample model selected in this experiment comes from a music classroom in an information recording and broadcasting classroom of a university in this province. There is a teacher and 35 students in the class, including 22 girls and 13 boys. The collected videos come from three perspectives: teachers, students, and classroom perspectives. Analysis indicators are sentiment analysis from these three perspectives. In the experiment process, combined with analysis indicators, the collected classroom teaching videos are analyzed in the data layer of the system.

This experiment uses speech recognition to evaluate the emotions of experimental subjects, which is mainly divided into positive evaluation, neural evaluation, and negative evaluation. Through the statistical analysis of the evaluation dimensions, the time and frequency of the positive emotions of experimental subjects are calculated, and the overall emotional tendency of classroom learning is finally obtained.

(1) The emotion analysis process based on image data. First, according to the accuracy of the experiment, a whole teaching video is divided into several sections, and then the data is collected and analyzed. The accuracy of this experiment is moderate, taking a screenshot every 30 seconds. The duration of a class is 45 minutes, and 90 frames of data will be intercepted for analysis and processing. The analysis flowchart is shown in Figure 6.

In the face detection of teacher's view video, in order to obtain more accurate results, the experiment first performs human body recognition and face recognition on the collected image data to obtain face images. The experiment does further quantitative analysis and assigns corresponding values, set the positive value to a positive value, ranging from 0.5 to 1.5, the neutral value to −0.5 to 0.5, and the negative value to −1.5 to −0.5. Teacher images collected every 30 seconds will have a corresponding emotional evaluation value.

In the face detection of the student's perspective video, all students cannot be detected due to the accuracy of human body recognition. Therefore, this experiment aims at most students with obvious characteristics and obtains their emotional changes at different moments and the corresponding emotional evaluation values.

(2) The process of sentiment analysis is based on voice data. First, it extracts the voice data from the video, and extracts the voice data every 30 seconds according to the time interval of image analysis. Using emotion recognition model to process the obtained text fragments, count, and analyze classroom emotions. The analysis flowchart is shown in Figure 7:

When performing sentiment analysis of language behavior on example instructional videos, the experiment first needs to extract voice from classroom video data to obtain corresponding voice data. Then the voice data is cut, cut into segments of voice data, and then converted into text data through the voice transcription platform, then use the vector model to convert to vector data. Finally, these data are classified through the emotion recognition network, and divided into two categories, positive and negative. And

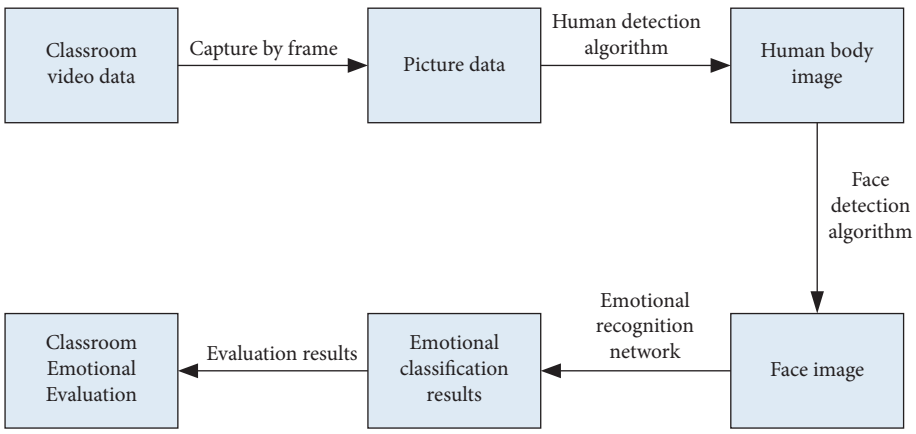

Figure 6: Schematic diagram of image sentiment analysis process.

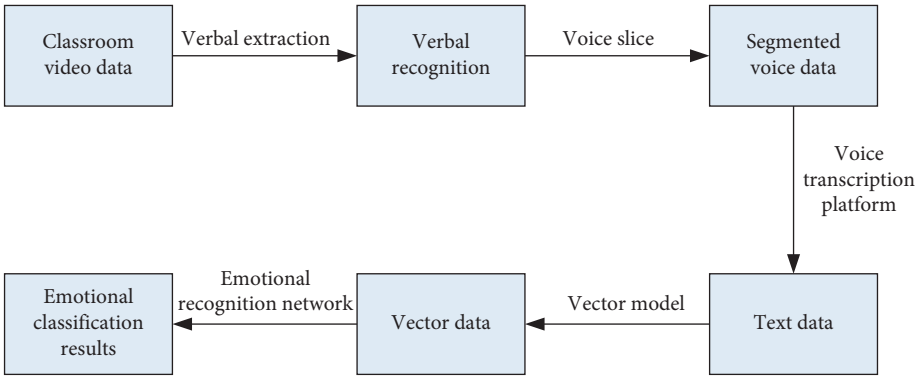

Figure 7: Schematic diagram of speech emotion analysis process.

assigning the corresponding value, the positive value is set to a positive value, the range is 0~1, and the negative value is set to a negative value, the range is −1~0.

4.3. Experimental Visualization Results

4.3.1. Sentiment Analysis Results of Sample Teaching Video Image Data. In the course of the experiment, the image data in the video was statistically analyzed, and the images of the emotional changes of the teachers and students of the whole class were obtained, as shown in Figure 8.

Figure 8(a) is a diagram of teacher emotion changes based on image data, and Figure 8(b) is a diagram of student emotion changes based on image data. The abscissas and ordinates are, respectively, the time and sentiment evaluation value. It can be seen from Figure 8 that the teacher's emotional state has always been positive and stable. The emotional score in the first half of the class is always between 0.5 and 1.5, and the emotional score in the second half of the class is stable between 0 and 0.5. The students' mood in the early stage is very positive, but not stable enough, and the emotional score in the later stage is stable between −0.5 and 0.5. This experiment uses the following emotion evaluation formula:

Positive emotion frequency = total number of times the emotion score is greater than 0.5.

Positive emotion time = collection time interval ∗ positive emotion frequency.

Positive emotion rate = frequency of positive emotion/total number of collections.

Class emotion score = the sum of each emotion score/total number of times.

According to Figures 8(a) and 8(b), as well as the calculation of the emotion evaluation formula, the positive emotion rate of teachers and students based on the image data and the classroom emotion score are obtained. It gets the teacher-student emotional evaluation tables shown in Tables 2 and 3. When the positive emotion rate is greater than 50%, the emotion is positive (positive). When the positive emotion rate is between 30% and 50%, the emotion is neutral. When the positive emotion rate is less than 30%, the emotion is negative (negative).

It can be seen from the table that the teacher's positive emotion rate = 52/90 ∗ 100% = 57.8%, the emotion score = 34/90 = 0.3820, and the teacher's emotion is positive. The student's positive emotion rate = 40/90 ∗ 100% = 44.5%, the emotion score is = 12/90 = 0.1386, and the student's emotion is neutral.

4.3.2. Sentiment Analysis Results of Sample Teaching Video Voice Data. In the course of the experiment, the image data in the video was statistically analyzed, and the images of the

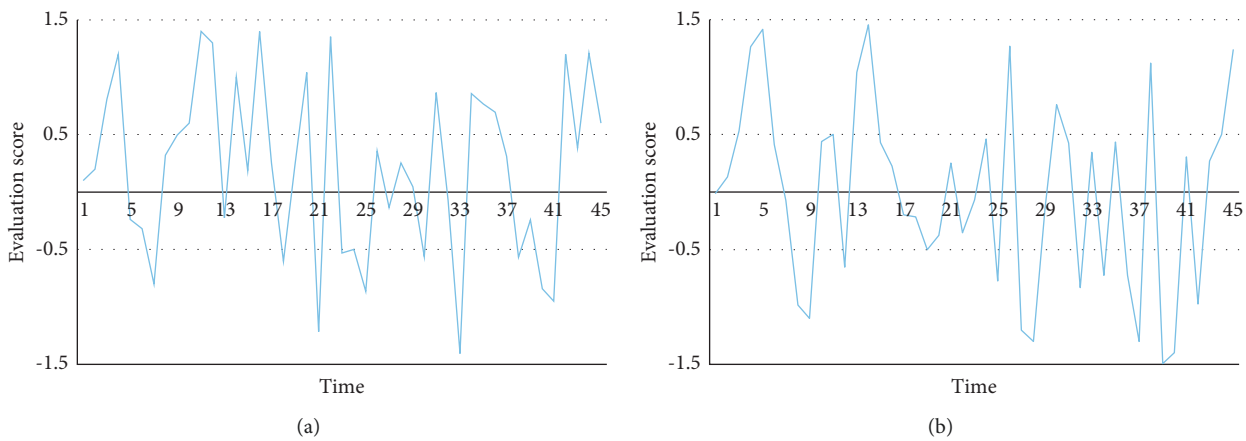

Figure 8: Teacher's and Students' emotional change chart based on image data.

Table 2: Emotional evaluation form based on teacher's image data.

Evaluation index	Sample video results
Teacher's positive emotional frequency	52
Teacher's positive emotional time	52 ∗ 30 s = 26 min
Teacher's positive emotional rate	52/90 ∗ 100% = 57.8%
Teacher's classroom emotional score	0.3820

Table 3: Emotional evaluation form based on students' image data.

Evaluation index	Sample video results
Students' positive emotional frequency	40
Students' positive emotional time	40 ∗ 30 s = 20 min
Students' positive emotional rate	40/90 ∗ 100% = 44.5%
Students' classroom emotional score	0.1386

emotional changes of the teachers and students of the whole class were obtained, as shown in Figure 9.

Figure 9(a) is a diagram of teacher emotion changes based on voice data, and Figure 9(b) is a diagram of student emotion changes based on voice data. The abscissas and ordinates are, respectively, the time and sentiment evaluation values. This experiment uses the following emotion evaluation formula:

Positive emotion frequency = the total number of times the emotion score is greater than 0; Positive emotion time = collection time interval ∗ positive emotion frequency; Positive emotion rate = frequency of positive emotion/total number of collections; Class emotion score = the sum of each emotion score/total number of times.

According to Figures 9(a) and 9(b) and the calculation of the emotion evaluation formula, the teacher-student positive emotion rate based on the voice data and the classroom emotion score are obtained, and the teacher-student emotion evaluation tables shown in Tables 4 and 5 are obtained.

It can be seen from the table that the teacher's positive emotion rate = 48/90 ∗ 100% = 53.3%, the emotion score = 27/90 = 0.3048, and the teacher's emotion is positive. The student's positive emotion rate = 46/90 ∗ 100% = 51.1%, the emotion score = 26/90 = 0.2842, and the student's emotion is also positive.

4.3.3. Comprehensive Sentiment Analysis of Example Teaching Videos. This research integrates image data and voice data. In this experiment, combining the obtained voice and image data, the following comprehensive emotion evaluation formula is designed:

Comprehensive emotional score = teacher evaluation score ∗ 0.5 + student evaluation score ∗ 0.5.

Teacher evaluation score = teacher image emotion score ∗ 0.5 + teacher voice emotion score ∗ 0.5.

Student evaluation score = student image emotion score ∗ 0.5 + student voice emotion score ∗ 0.5.

According to the image and voice data of teachers and students, as well as the comprehensive emotion evaluation formula, the overall emotion change graph in the classroom can be obtained, as shown in Figure 10.

It can be seen from Figure 10 that the mood changes in the entire classroom are between -1 and 1, and most of them are positive. Judging from the overall change trend of classroom emotions, this is a positive classroom and the overall emotional changes are not large. In class 7~13 min, 28~40 min, the student's mood is negative, while in class 1~8 min, 13~28 min, and 40~45 min, the student's mood is very positive. When students are in a negative moment, teachers can arouse students' interest and prolong the positive emotional time in class.

The comprehensiveness of classroom teaching analysis is not only based on speech recognition and image recognition, but also must be based on action, facial expression recognition, and other methods to analyze classroom teaching in many aspects [25]. It is limited by current teaching data collection methods and statistical analysis methods. At present, it is not possible to grasp the specific time point of the data analysis of the teaching activities, so that it is impossible to effectively carry out the comprehensive teaching evaluation data analysis [26].

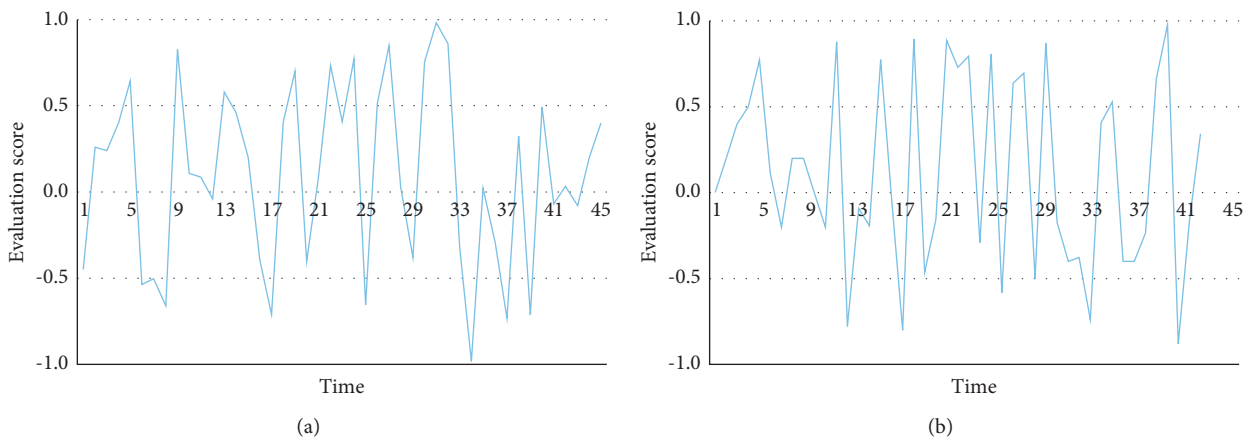

Figure 9: Teacher's and Students' emotional change chart based on verbal data.

Table 4: Emotional evaluation table based on teacher's verbal data.

Evaluation index	Sample video results
Positive emotional frequency	48
Positive emotional time	$48 * 30\,\text{s} = 24\,\text{min}$
Positive emotional rate	$48/90 * 100\% = 53.3\%$
Classroom mood score	0.3048

Table 5: Emotional evaluation table based on students' verbal data.

Evaluation index	Sample video results
Positive emotional frequency	46
Positive emotional time	$46 * 30\,\text{s} = 23\,\text{min}$
Positive emotional rate	$46/90 * 100\% = 51.1\%$
Classroom mood score	0.2842

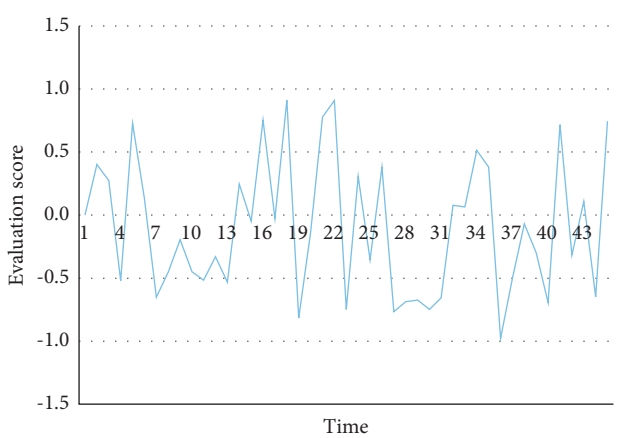

Figure 10: Classroom comprehensive emotional changes chart.

5. Conclusion

The combination of music and artificial intelligence is a collision of art and technology in a new era, which is bound to bring infinite possibilities. Starting from the general issues of music teaching, the article focuses on the need to establish a systematic evaluation process for music teaching. The article then analyses the feasibility of combining artificial intelligence with music teaching, and then focuses on the construction of an artificial intelligence-based music teaching evaluation system on this basis. Finally, the article focuses on the practical utility of the music teaching evaluation system in the context of artificial intelligence. The experiments show that combining music and artificial intelligence can effectively reduce human and material costs and improve the quality and level of music teaching. At the same time, the music teaching evaluation system based on artificial intelligence provides a reference for the reform and upgrading of teaching models in other industries. Of course, the research in this article also has some shortcomings. The overall evaluation of the music classroom is not only limited to image recognition and speech recognition, but also depends on various data collection and analysis. Therefore, the evaluation of other indicators needs to be updated in the classroom teaching analysis framework.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares that there are no conflicts of interest regarding the publication of this article.

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Research Article

The Integration Model of Agricultural Products E-Commerce and Supermarket Based on the Internet of Things

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As a new technology that is driving the transformation of third-party industry and continuing to grow, Internet of Things (LOT) technology has been widely used in social and socioeconomic life and has had a profound impact on human creativity and life. The integration of agricultural products e-commerce and supermarkets based on the Internet of Things is slowly rising like a bright star. As the foundation of a national economy, after years of growth, agriculture is facing challenges such as reduced economic opportunities, lack of resources, and excessive production models, and there is an urgent need for a healthy new generation of information technology in agriculture. This thesis discusses the LOT and the circulation model of agricultural products and studies the integration model of agricultural products e-commerce and supermarkets based on the LOT. This article proposes the system framework of this model and conducts an empirical analysis of the system through experiments to demonstrate the feasibility and effectiveness of this model in practical applications. Experimental results show that the average total profit of offline supermarkets is 684,000, and the average total cost is 4.149 million. The average total profit of online platforms is 902,000, and the average total cost is 7 million. The average total profit of the online and offline integration model is 828,000, and the average total cost is 6.527 million. Compared with traditional supermarket sales, the online and offline integration model has higher profits. Although the total profit is not as good as the online model, the quality of agricultural product distribution is far better than the online model, and consumer satisfaction is higher.

1. Introduction

The LOT came from the Automated Identification Center of the Massachusetts Institute of Technology in the United States. Its purpose is to use radio frequency detection, infrared, laser scanners, global positioning system, and other smart tools to connect objects to the Internet to transmit object information, understand object information in real time, and achieve the purpose of recognition and understanding. *Application Management*. In 2005, the ITU (International Telecommunication Union) proposed the LOT and expanded its capabilities. Collaboration indicates that the LOT is the "Age of LOT Communication" that comes, through the Internet, from people-to-people communication and the interaction between people and things, objects, and things. You know the unification of all objects in the world and the exchange of information. In 2008, the world's first LOT 2008 conference was held in Zurich. The conference discussed the many advanced technologies available from the LOT and the expectations for their implementation. That same year, IBM proposed the Smart Earth development plan. The LOT, as an integral part of Smart Earth, has attracted worldwide attention. In 2011, the "White Paper on the LOT" proposed that the LOT is the promotion and advancement of communications and the Internet. It uses optical technology and smart devices to identify and recognize the physical world and uses the network system to process my data and data, to achieve the purpose of real-time management, accurate management, and scientific decision-making. The Internet of Things is more complex than the

Internet technology, has a wider range of industrial radiation, has a wider range of applications, and has a stronger driving force and influence on economic and social development. The Internet focuses on the interconnection and sharing of information and solves the problem of information communication between people.

In the field of production and life, more and more sensors are widely installed and applied. It ranges from government public management such as national security, public health, and convenient transportation, to the daily lives of the common people such as smart homes, health inspection, and convenient payment. And it is connected by the Internet and communication network, and the physical world is freed from the constraints of time and space through electronic information technology. It can be presented to us more accurately, providing us with a safer and more comfortable life.

With the advent of the LOT era, the application of the LOT covers many areas. It includes smart grid, mobile payment, traffic management, smart campus, smart environmental protection, smart medical care, vehicle and ship monitoring and dispatching, police personnel monitoring, logistics management, and other fields. However, there is not much theoretical research on the LOT in the circulation and marketing of agricultural products. The theoretical research on online and offline integrated business models, especially how to integrate the actual market conditions to promote and develop agricultural products operations, and how to integrate with existing business models, is particularly important. This paper discusses the integration model of agricultural product e-commerce and supermarket based on the LOT, extends the application of LOT technology in the field of agricultural distribution, and further strengthens scientific research in the field of LOT technology applications. At the same time, in the field of agricultural research, the introduction of ingredients on the Internet is also a new issue. LOT technology in agricultural product models can further develop scientific research into the distribution of agricultural products.

2. Related Work

In terms of theoretical research, experts and scholars at home and abroad have discussed the definition, technical direction, application, and development prospects of the LOT in various fields and have done relevant research on each link and application of the LOT industry chain. Razzaque MA is based on the latest IoT interfaces found only in wireless sensor networks (WSNs). It does not take into account other important factors such as radio frequency identification (RFID), machine-to-machine communication (M2M), and data management and retrieval (SCADA), describes the requirements for IoT intermediate software, examines a comprehensive set of intermediate solutions based on these requirements, and finally learns the technical requirements of IoT intermediate software [1]. Stojkoska et al. [2] proposed an overall framework that combines the LOT and smart homes. Based on the overall framework, a set of smart home management models are constructed to effectively integrate smart homes into the LOT. Through data processing, they discussed the operability of the framework system and the challenges that may be encountered in real-life applications. They aim to bridge the gap between existing smart home applications and their prospects for integration into the LOT environment [2]. Based on the Medical LOT, Mostafa et al. [3] researched medical applications that came in two categories: scientific papers and business results. It is evidenced by the architecture defined by the Medical LOT, including hardware and software that handles portable devices, sensors, smartphones, medical devices, and medical station analysts. It performs further diagnosis and data storage for health monitoring and disease prevention. The results show that these wearable devices have been greatly developed under the Medical LOT technology, which can better monitor the health indicators of various parts of the human body [3]. Lin et al. [4] explored the integration and application of ear computing and the LOT and developed a LOT platform based on ear computing. They provide a comprehensive overview of the LOT in terms of system architecture, operating technology, security, and privacy issues. They researched the relationship between the LOT and ear counting and discussed many issues on the Internet based on ear counting and how to use the LOT based on ear counting in practice [4]. Singh et al. [5] aim to support multiple data connections and data sharing, deliver LOT-backed computing, and integrate the LOT with cloud support. It pays attention to the security of the LOT from the point of view of cloud renters, end-users, and cloud providers. In the context of large web object applications, it analyzes the current state of the LOT supported by the cloud to determine the security needs that require the most work [5]. Gsangaya et al. [6] have developed wireless Internet sensors based on the LOT used in normal agriculture and introduced the development of a portable wireless sensor network system for remote monitoring of environmental conditions in the agricultural sector, such as temperature, humidity, light intensity, and soil moisture content. Using LOT technology, the information received from the sensors is transmitted to the cloud server wirelessly and users around the world can view it through network devices. It aims to increase agricultural productivity by streamlining the soil and managing the crop to suit the unique conditions of each location while maintaining environmental quality [6]. Gavrilovi [7] and Mishra analyzed the types of software architectures currently available in the fields of IoT systems, smart cities, healthcare, and agriculture. According to different types of software architectures, they identify the available functions in the IoT system and provide solutions and improvement suggestions for different types of software architectures [7].

3. Basic Research on the LOT and the Circulation of Agricultural Products

3.1. Basic Research on the LOT

3.1.1. IoT System Architecture. The LOT is divided into three levels in the system architecture: the lower level, the middle

level, and the upper level. The lower level is the optical level, which means object recognition and information observation, the middle level is the network level that performs the data transfer functions, and the upper level is the application level that supports the actual application functions, as shown in Figure 1 [8, 9]. The usage scenarios of the Internet of Things are mainly reflected in these steps: collection, transmission, calculation, and display.

(1) Perception Layer. The perception layer is composed of various sensors and sensor gateways, including carbon dioxide concentration sensors, temperature sensors, humidity sensors, two-dimensional code tags, RFID tags and readers, cameras, GPS, and other sensing terminals. The function of the perception layer is to collect object information and realize object recognition. This layer is composed of a large number of various modules for sensing and identifying objects. Related modules include EPC tags, readers, RFID readers, sensors and sensor networks, and short-distance wireless communication [10]. These modules recognize objects, collect various information and perform intelligent identification, and then transmit the object information to the network layer through network transmission technology to realize the transmission of data information [11].

(2) Network Layer. The network layer is the information transmission link between the perception layer and the application layer and is an intermediate link in the operation of the LOT. The main function is to realize the transmission and processing of data information and transmit the information data obtained by the perception layer to the application layer after processing. It guarantees the overall effective operation of the LOT and reliable transmission of information. At this time, a network with strong bearing capacity is needed to support its information transmission function. The networks that can be used to transmit sensing data mainly include the following three categories, as shown in Table 1 [12].

(3) Application Layer. The application layer includes the supporting technology layer and the application service layer. The supporting technology layer is responsible for receiving data from the network layer and performing data collection, analysis, and conversion according to user needs, such as mass storage, high-performance computing, and cloud computing technology. The application service layer presents the processed information to users in the form of services and provides users with services in various industries, such as smart homes, telemedicine, environmental monitoring, urban management, and green agriculture, according to user needs.

3.1.2. Radio Frequency Identification (RFID) Technology. As the core technology of the LOT, RFID technology is supported by microelectronics technology, microwave technology, and computer software. RFID technology is an automatic detection technology that does not require direct physical contact and is based on the transmission of radio frequency signals only for automatic signal recognition [13]. Radio frequency identification technology is applied to the application layer of the Internet of Things. Its application is very wide, and it has played an important role in the field of research and development of the LOT. RFID identification technology can identify multiple targets at the same time, will not be affected by the number of identified targets and the speed of movement, and will not be easily disturbed by the surrounding environment and human factors. Therefore, it has strong practicability and maneuverability [14]. RFID identification technology has the functions of noncontact, all-weather, strong penetrating ability, identifying high-speed moving objects, and being able to identify different types of target objects at the same time. It mainly perceives the characteristics of the target through the radio frequency signal, thereby confirming the target and achieving data acquisition and information transmission. It does not require manual intervention, is convenient and quick to operate, and is widely used in various industries [15]. In recent years, RFID technology has developed rapidly and has been gradually applied to various fields, for example, in the field of intelligent transportation, such as ETC, bus card swiping, and railway, to achieve efficient management and make people travel more convenient.

The RFID system has all four components: reader, electronic label, RFID intermediate software, and application software, as shown in Figure 2. The reader is the

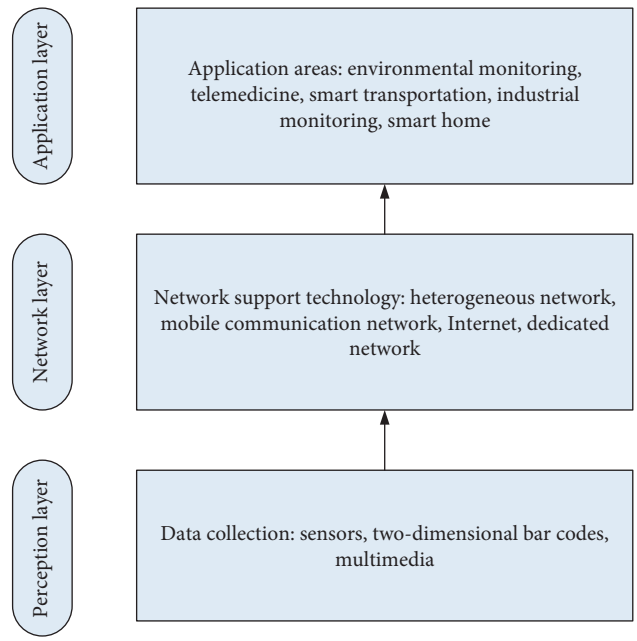

Figure 1: LOT technology architecture diagram.

Table 1: Network for transmitting sensing data.

Communication network type	Specific classification
PAN network	ZigBee, UWB, wifi, bluetooth
LAN network	Ethernet, Wigax, WLA
WAN network	G PRS, CDMA, 3G, 4G, 5G

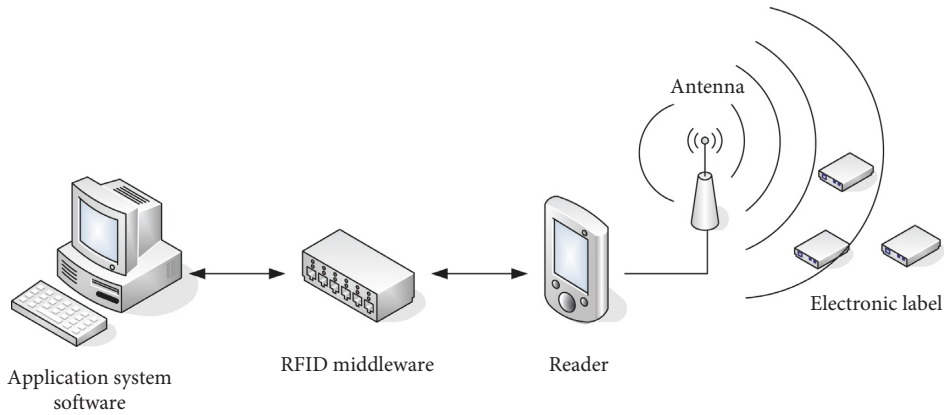

Figure 2: RFID system composition.

information management and processing center of the RFID system, and its function is important for data exchange knowledge between electronic labels under the control of the host server. The electronic signal is the data borrower of the RFID system. Each tag has a different e-mail code to store the information it needs to identify and distribute and then paste it into the item, so you need a bulletin board to have a unique ID [16]. RFID middleware is the interface between RFID hardware components and application software. The middleware can ensure the functional control of the hardware components by the application software. Since the application system software must be developed for specific needs, it is generally necessary to integrate the application system software into the corresponding business software platform.

The item information is sent out, and the radio uses radio frequency identification technology to automatically identify the item information [17]. After reading the information by the reader and decoding the data, the RFID middleware transmits these information data to the application information system through the network and further processes the data information therein. Electronic tags can be divided into passive tags and active tags according to the power supply mode. There is no battery inside the passive tag, and it can work normally only with the energy provided by the reader [18]. The active tag is equipped with a power source and relies on its own power source to provide energy, which can actively transmit signals and transmit item information without the need for a reader to send out radio frequency signals. The working sequence of electronic tags and readers is also divided into two types: reader-first mode and electronic tag-first mode. The reader first means that the reader sends out signals first and then accepts instructions after electronic tags. This method is generally applied to passive tags [19]. Electronic tag advance means that the electronic tag sends out a signal first, and the reader reads the information before issuing an instruction, which is suitable for active tags.

When the RFID system is working, when there are multiple tags in the radio frequency area of the reader, and more than one tag responds to the reader at the same time and reflects signal data, the reader will not be able to recognize the tag. This phenomenon is called label collision. In the design of an RFID system, in order to effectively deal with the collision of tags, the anticollision ALOHA algorithm is commonly used to deal with such problems, so as to achieve an accurate and fast reading of tags [20]. ALOHA algorithm is a kind of random access algorithm. When a tag wants to send data information, it can send it randomly at any time period, which is called the pure ALOHA algorithm.

(1) Pure ALOHA Algorithm. The pure ALOHA algorithm is the most basic and easiest to implement random label anticollision algorithm in the ALOHA class of algorithms. In the communication system, the arrival process of unrelated users is generally processed by the Poisson process, so the number of tags that responded per second obeys the Poisson distribution, so the probability of n tags responding in the data frame transmission time period t is

$$P(n) = \frac{(\lambda t)^n e^{-\lambda t}}{n!}. \tag{1}$$

At this time, the average data packet exchange volume is

$$G = \lambda \cdot t. \tag{2}$$

Then, the probability of successful communication without collision in the time period of $2T$, that is, the probability of no other tag responding in the time period of $2T$, is

$$\begin{aligned} P_e &= \frac{p(n=0)}{t = 2\tau} \\ &= e^{-\lambda \cdot 2\tau} \\ &= e^{-2g}. \end{aligned} \tag{3}$$

The throughput rate S under this algorithm is

$$\begin{aligned} S &= GP_e \\ &= Ge^{-2G}. \end{aligned} \tag{4}$$

Because the cycle of tag conflicts is too long, at any time within this time period, as long as multiple tags transmit

information to the reader at the same time, conflicts will be caused, so the collision probability is high. In view of the fact that the pure ALOHA algorithm has high randomness, high collision rate, low system throughput rate, low recognition success rate, and few applications.

(2) Slotted ALOHA Algorithm. Slotted ALOHA is a commonly used anticollision algorithm in RFID systems. It is an improvement to pure ALOHA, and its basic idea is to divide the time into several identical time slices, and all users access the network channel synchronously at the beginning of the time slice. If a conflict occurs, it must wait until the start of the next time slice before sending. The slotted ALOHA algorithm adjusts the collision period on the basis of the pure ALOHA algorithm, and the length of each slot is changed from $2T$ to T.

The probability of successful communication without collision in the time period T, that is, the probability that no other tag responds in the time period T, is

$$\begin{aligned} P_e &= \frac{P(n=0)}{t=\tau} \\ &= e^{-\lambda\cdot\tau} = e^{-G}. \end{aligned} \tag{5}$$

The throughput rate S under this algorithm is

$$\begin{aligned} S &= GP_e \\ &= Ge^{-G}. \end{aligned} \tag{6}$$

Compared with the pure ALOHA algorithm, the slotted ALOHA algorithm has a higher throughput rate and a higher recognition success rate. However, with the adjustment of the cycle, the network system will also be adjusted accordingly, and the requirements for the system will be more refined.

(3) Frame slot ALOHA Algorithm. On the basis of the slotted ALOHA algorithm, N slots are packed into a frame to form the framed slotted ALOHA algorithm.

Assuming that the frame length is N and the number of tags to be read is n, the probability of r tags appearing in a given time slot obeys the binomial distribution:

$$P(X=r) = C_n^r \cdot \left(\frac{1}{N}\right)^r \left(1-\frac{1}{N}\right)^{n-r}. \tag{7}$$

The probability that this time slot is a successful time slot is

$$P(X=1) = C_n^1 \cdot \left(\frac{1}{N}\right)^1 \left(1-\frac{1}{N}\right)^{n-1}. \tag{8}$$

The expectation of the number of successful slots in the frame is

$$E(X=1) = N \cdot C_n^1 \cdot \left(\frac{1}{N}\right)^1 \left(1-\frac{1}{N}\right)^{n-1}. \tag{9}$$

Differentiating N, we get

$$\frac{\mathrm{d}\eta}{\mathrm{d}N} = \frac{\mathrm{d}}{\mathrm{d}N}\left\{\frac{n}{N}\left(1-\frac{1}{N}\right)^{n-1}\right\} = 0. \tag{10}$$

From the formula (10), we can get

$$N_{opt} = n. \tag{11}$$

Therefore, when the reader's frame length N is equal to the number of unidentified tags n, the probability of successful tag transmission is the greatest, and the system works in the best state, and at the same time:

$$\lim_{n\longrightarrow\infty} \frac{n}{N}\left(1-\frac{1}{N}\right)^{n-1} = \lim_{n\longrightarrow\infty}\left(1-\frac{1}{n}\right)^{n-1} \approx 0.368. \tag{12}$$

(4) Dynamic Frame Time Slot ALOHA Algorithm. Suppose the frame length of the reader is L, and the number of tags in the range of the reader is n. When r tags respond in the same time slot, the probability obeys the binomial distribution:

$$P(r) = C_n^r \cdot \left(\frac{1}{L}\right)^r \left(1-\frac{1}{L}\right)^{n-r}. \tag{13}$$

Therefore, the probability of a free slot in a frame is

$$\begin{aligned} P(e) &= P(0) \\ &= \left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{14}$$

The probability of successfully identifying the time slot is

$$\begin{aligned} P(s) &= P(1) \\ &= \frac{n}{L}\left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{15}$$

The probability of collision time slot is

$$\begin{aligned} P(c) &= 1 - P(0) - P(1) \\ &= 1 - \left(1-\frac{1}{L}\right)^n - \frac{n}{L}\left(1-\frac{1}{L}\right)^n. \end{aligned} \tag{16}$$

Excluding communication interference, the throughput rate of the system is

$$\begin{aligned} S &= P(s) \\ &= \frac{n}{L}\left(1-\frac{1}{L}\right)^{n-1}. \end{aligned} \tag{17}$$

The throughput rate of the algorithm is equal to the probability of successfully identifying the time slot in a frame. In order to obtain the maximum throughput of the system, the two sides of the Formula are derivated with respect to n, and then,

$$\frac{dS}{dn} = \left(1-\frac{1}{L}\right)^{n-1} + n \times \left(1-\frac{1}{L}\right)^{n-1} \ln\left(1-\frac{1}{L}\right) = 0. \tag{18}$$

We can get

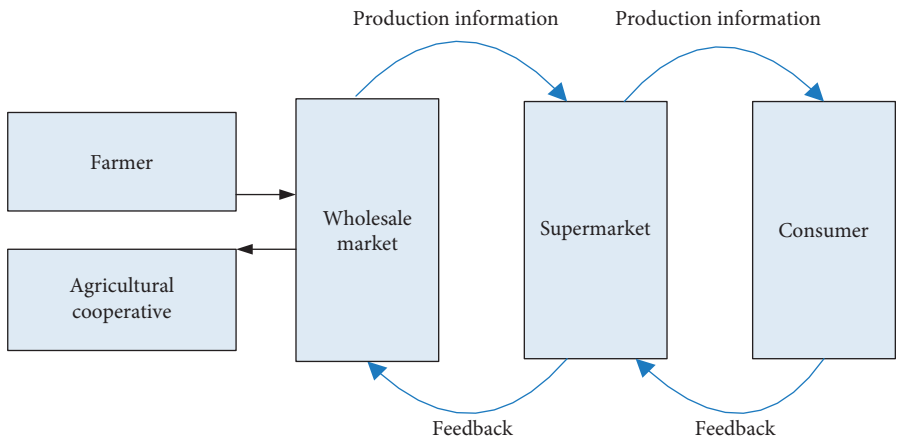

Figure 3: The supermarket circulation diagram of agricultural products.

$$n = \left[-\frac{1}{\ln(1-(1/L))} \right]. \tag{19}$$

When the number of tags is n, the optimal frame size can be obtained as

$$\begin{aligned} L &= \frac{1}{1-e^{-1/n}} \\ &= \frac{e^{1/n}}{e^{1/n}-1} \approx \frac{1+1/n}{1+1/n-1} \\ &= n+1. \end{aligned} \tag{20}$$

After the identification of each frame, the unmarked labels are evaluated, and the size of the next frame is set equal to the number of unmarked labels. Substituting formula (20) into formula (17), we get

$$\begin{aligned} S &= \frac{n}{n+1}\left(1-\frac{1}{n+1}\right)^{n-1} \approx \left(1-\frac{1}{n}\right)^{n-1} \approx \frac{1}{e} \\ &= 0.368. \end{aligned} \tag{21}$$

3.2. Circulation Mode of Agricultural Products

3.2.1. Circulation Mode of Agricultural Products Supermarket. It refers to the production-sales docking method in which producers sell their agricultural products to wholesalers, and the wholesalers centrally supply them to large supermarkets. Farmers or agricultural cooperatives jointly established by farmer households sell agricultural products to agricultural product wholesale centers, which are purchased by wholesalers. Wholesalers sign purchase contracts with some large supermarkets to centrally supply agricultural products to large supermarkets, and finally, the supermarkets sell the agricultural products to consumers. This model mainly connects consumers and supermarket chain enterprises with agricultural product wholesale markets, farmers, and agricultural cooperatives through continuous and fixed procurement contracts. The distribution model of agricultural products supermarkets is shown in Figure 3. This model takes wholesalers and supermarkets as the core of the agricultural product circulation process. In the process of agricultural product circulation, producers and consumers cannot update the information about agricultural products in a timely manner. Supermarkets and wholesalers need to complete the matching of information together, and there will still be situations of poor information circulation. This is due to the different channels for obtaining information between supermarkets and wholesalers, which leads to poor information flow.

3.2.2. Circulation Mode of Agricultural Products E-Commerce. As a new type of agricultural product circulation method, the agricultural product e-commerce circulation model refers to the use of e-commerce in the agricultural product market circulation. It sets up a symmetrical, open, and transparent exchange channel between production and sales to promote a smooth flow of agricultural product supply and demand information. The e-commerce platform transmits the demand of the consumer's order to the supplier according to the demand of the consumer. At the same time, farmers and agricultural cooperatives uniformly sell agricultural products to wholesale markets in various regions, and wholesale markets in all regions, namely, suppliers, sell agricultural products to consumers through logistics according to the needs of consumers' orders. E-commerce has greatly improved the benefits and efficiency of traditional business activities. E-commerce provides a virtual global trading environment for enterprises, which greatly improves the level of business activities and service quality. The circulation mode is shown in Figure 4:

However, the current e-commerce circulation method still has the shortcomings of network infrastructure construction and single network marketing method. I will analyze it below.

(1) Insufficient Network Infrastructure Construction. Due to slow economic development, backward infrastructure construction, low level of farmers' own education,

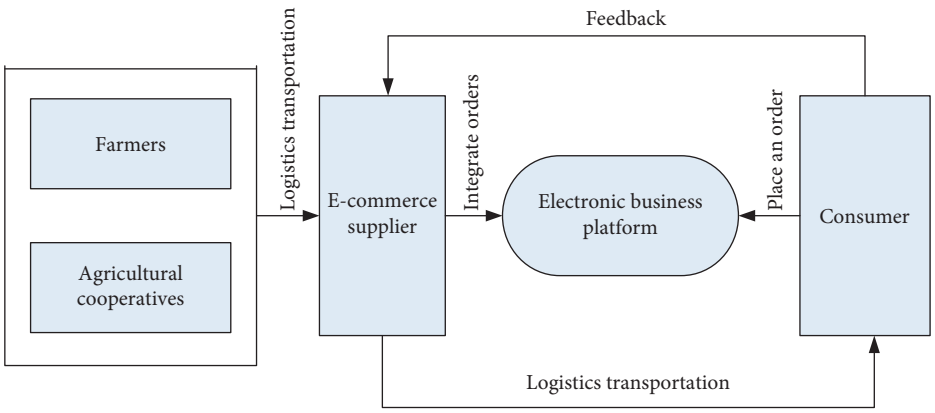

Figure 4: E-commerce circulation diagram of agricultural products.

Table 2: Rural network penetration rate in each province.

Provinces	Number of Internet users\ten thousand	Penetration rate (%)	The growth rate of netizens (%)
Guangdong	3786	66	8.5
Jiangsu	3690	60	9.2
Zhejiang	3793	68	7.2
Anhui	2758	52	12.1
Hunan	2992	55	10.9
Jiangxi	2550	48	14.2
Shanxi	2886	54	10.9
Gansu	2276	43	15.8
Guizhou	2013	38	14.6
Yunnan	2168	41	15.7

insufficient understanding of e-commerce, and weak learning ability of e-commerce, the sales of seasonal agricultural products will become very slow. Self-employed individuals cannot reach consumers through the Internet and can only sell to local distributors, who will lower the purchase price of agricultural products. Therefore, it harms the interests of producers and is not conducive to the normal circulation of agricultural products. Table 2 shows the popularization of rural basic networks in various provinces.

It can be seen from Table 2 that the rural Internet penetration rate in Jiangxi, Gansu, Guizhou, Yunnan, and other places is less than 50%, which is much lower than that of Zhejiang, Jiangsu, Guangdong, and other provinces with developed logistics. At the same time, the number of netizens in Jiangxi, Gansu, Guizhou, Yunnan, and other places is also lower than that in developed provinces such as Zhejiang, Jiangsu, and Guangdong. Therefore, the current government should also increase network infrastructure construction in rural areas in the central and western provinces.

(2) Single Network Marketing Method. For the rapidly developing agricultural products, network marketing still lacks characteristic marketing methods. Take Jiangxi's Gannan navel orange as an example. In the peak season of navel orange in autumn and winter, network marketing is still mainly through the circle of friends to promote and market the characteristics of the hometown. The consumer resources of Moments are limited, lack of innovation in Internet promotion and marketing methods, single promotion methods, and weak market influence. According to the statistical report on the development of the Internet in China in October 2020, the utilization rate of various online marketing methods is shown in Figure 5.

It can be seen from Figure 5 that the use of online chat tools for marketing promotion is the most common marketing method, accounting for 80%; the use of search engines, e-commerce platforms, and e-mail promotion is also gradually increasing, accounting for about 72%. However, Weibo marketing and online video advertising still need to increase marketing efforts to promote the diversified development of marketing methods.

4. System Research

The mode of integration of offline supermarkets and online platforms refers to a mode that combines offline supermarkets and online e-commerce platforms for product circulation and service promotion, and a mode that integrates online and offline. Through the Internet, e-commerce platforms are used to provide information on agricultural products of producers or wholesalers to Internet users through display and promotion. Potential consumers can go to offline supermarkets in the same city to pick them up or deliver them by supermarkets. Consumers outside the same city can receive agricultural products in the form of logistics. This model effectively combines offline supermarkets and online e-commerce and uses the advantages of online information dissemination to complete information

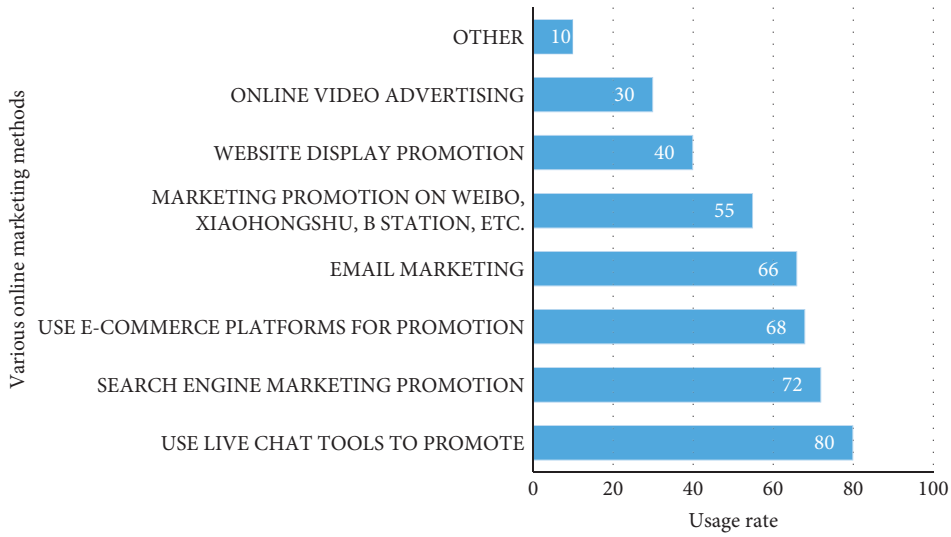

Figure 5: Utilization rate of various online marketing methods.

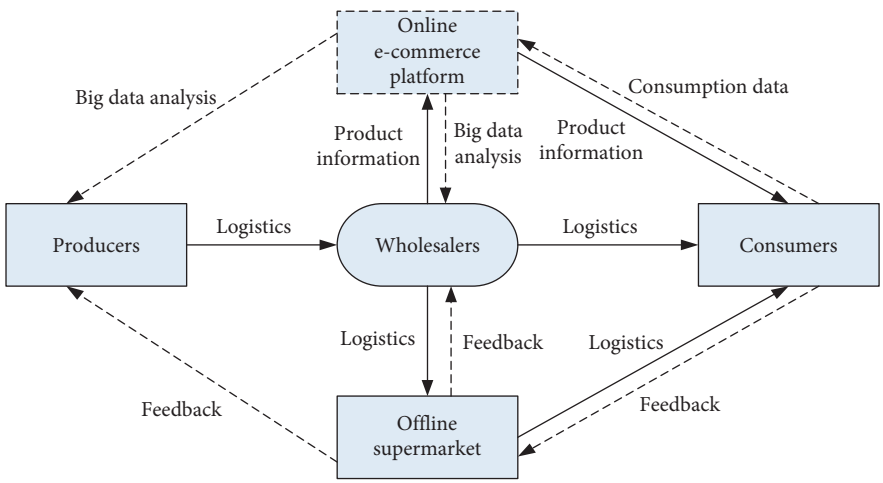

Figure 6: The framework of online and offline integration of agricultural products.

communication between producers and consumers. The overall frame diagram is shown in Figure 6.

In the whole framework, offline supermarkets and online platforms operate together to promote the integrated development of online and offline. Online platforms use various network marketing methods to promote agricultural products, including e-commerce platform promotion, Weibo marketing promotion, and website advertising promotion. Using data processing technology to process consumer orders and tap potential consumers, predict user preferences, and generate a page of agricultural products that users want to buy for users to select and purchase related products, consumers browse, compare, and screen the agricultural products they want to buy on this page, and after confirming the products, they place an order for agricultural products through an online payment. The online platform selects the nearest offline supermarket based on the consumer's address. If there is no offline physical supermarket in the local area, the platform will look for a closer producer or distributor in the database to transport agricultural products to consumers in the form of logistics. After consumers receive the goods, they can evaluate the purchased agricultural products and provide feedback to the platform. Due to the openness and transparency of online platform information, manufacturers and distributors can browse consumer feedback and better improve the quality of agricultural products. Offline supermarkets store ample agricultural products, are responsible for selling agricultural products to customers offline, and complete orders distributed on the online platform, allowing online consumers to pick up or deliver them in the same city to ensure that online consumers receive agricultural products. Offline consumers can complete the feedback information on agricultural products by going to the supermarket, and then the supermarket will input the feedback information into the online platform to promote the circulation of agricultural product information. Whether it is producers, wholesalers, offline supermarkets, or consumers, they can obtain relevant information and data feedback on agricultural products through online platforms. It is conducive to the transparency

Table 3: Evaluation index system of agricultural products circulation mode.

First indicator	Secondary indicator	Third indicator
Logistic aspect	Logistics information processing time Agricultural product delivery quality	Time unit: s Quality rating
Economic aspect	Shipping costs and storage costs Costs and profits	Compare the two costs Compare total costs and profits

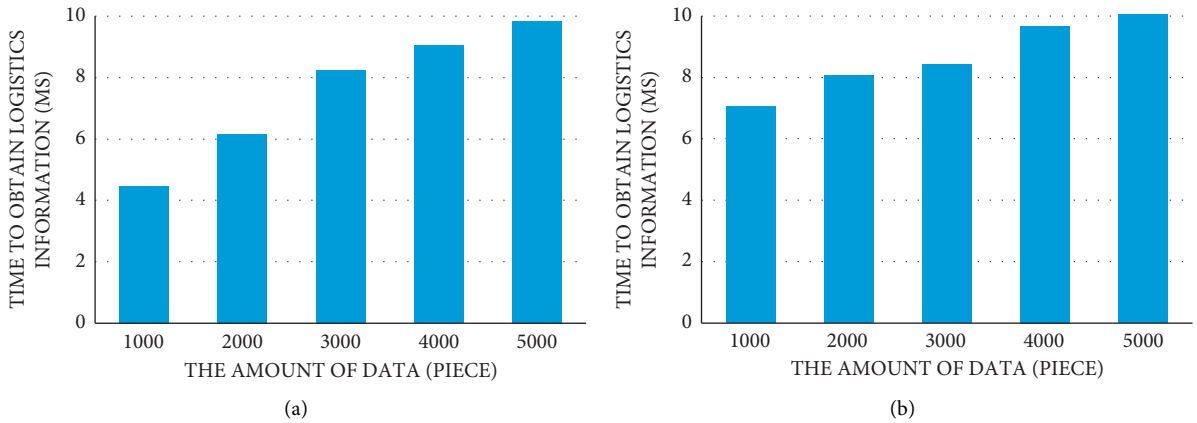

Figure 7: Time-consuming diagram of logistics information processing.

and clarity of agricultural product data and information and is conducive to the healthy circulation of agricultural product supply chains.

5. Experimental Design

In order to verify the feasibility of this mode, a series of tests were carried out through the LOT to test the performance of various working performances of the system in practical applications. The evaluation index system of agricultural product circulation efficiency is shown in Table 3.

5.1. Time-Consuming Logistics Information Processing. An important criterion for measuring the pros and cons of the agricultural product circulation model is the speed of logistics information processing. The information processing speed of agricultural products logistics is fast, and the circulation speed of agricultural products in the supply chain will be very fast. It will be faster in production, transportation, signing, and other links, speed up the circulation rate, and improve the freshness of agricultural products. We take agricultural product logistics information as the experimental object, compare the LOT technology with intelligent sensor network technology, obtain the time-consuming results of logistics information processing, and draw the logistics information processing time chart under the two technologies, as shown in Figure 7. Figure 7(a) is a time chart of logistics information processing based on the LOT, and Figure 7(b) is a time chart of logistics information processing based on smart sensor network technology.

It can be seen from the comparative analysis in Figure 7 that whether it is the LOT technology or the smart sensor network technology, as the amount of data gradually increases, the logistics information processing time is gradually increasing, and the processing speed is gradually decreasing. But on the whole, compared with smart sensor network technology, the use of LOT technology takes a shorter time in agricultural product logistics information processing. This proves that the LOT technology is faster and more efficient in the processing of agricultural product logistics information.

Table 4: Agricultural product quality score form.

Level	Scores
Level 1	8.5–10
Level 2	6.5–8.5
Level 3	≤6.5

5.2. Delivery Quality. The key indicators to measure the pros and cons of the agricultural product circulation model also include the comparison of the quality of agricultural product distribution. In the process of agricultural product circulation, we must try our best to ensure the freshness of agricultural products reaching consumers. The experiment uses two methods, offline and online, to sort and distribute 10 agricultural product orders and send them to consumers. Among them, the quality of agricultural products is classified into 3 levels, the first level is fresh and no rot, the second level is not too fresh but no rot, and the third level is partially decayed which affects eating. In this experiment, the delivery quality is scored, with a total score of 10 points, with 8.5 or higher being the first level, 6.5 to 8.5 being the second level, and 6.5 or less being the third level, as shown in Table 4. The quality effect comparison chart of the distribution is obtained, as shown in Figure 8. Figure 8(a) is an offline

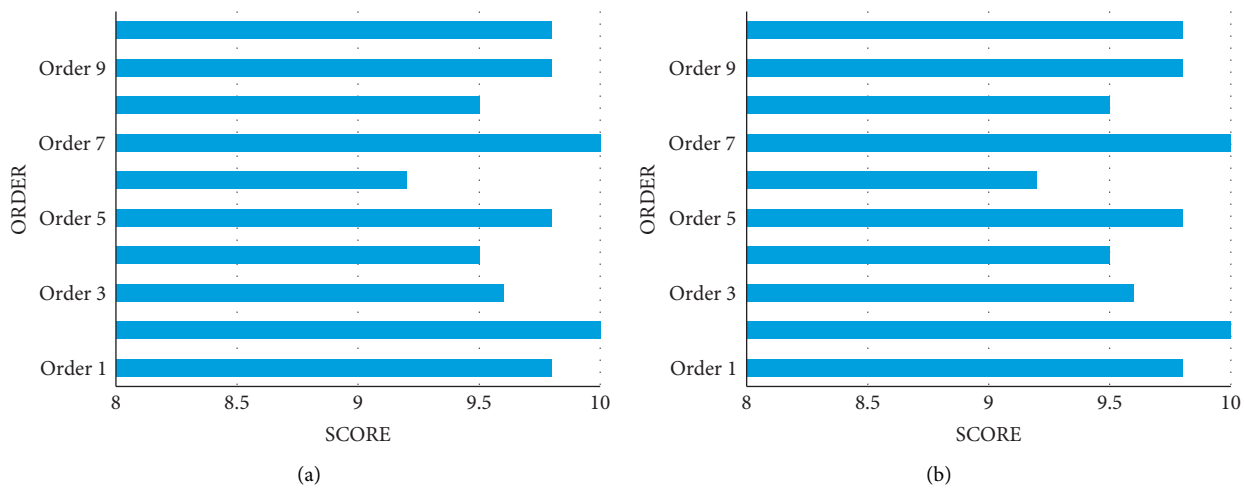

Figure 8: Graph of the evaluation results of the delivery quality of agricultural products.

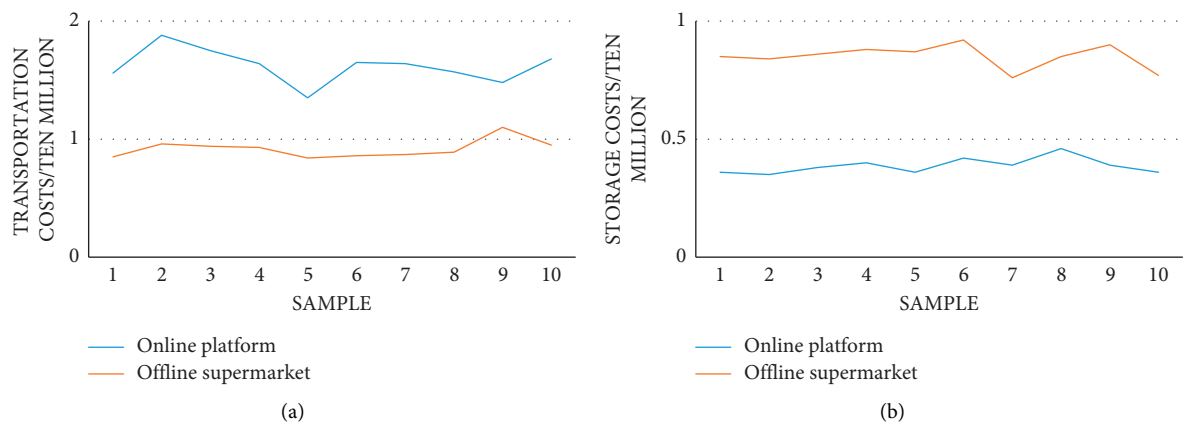

Figure 9: Comparison chart of online and offline transportation and storage costs.

supermarket delivery quality map, and Figure 8(b) is an online e-commerce delivery quality map.

From the comparative analysis in Figure 8, it can be seen that the agricultural products distributed online are not fresh. Although there is no rot, the freshness of the fruits and vegetables will directly affect the taste and affect consumer satisfaction. The quality of agricultural products delivered by offline supermarkets is all first-class, and the delivery quality is fresher. Therefore, in the same city, consumers are more willing to go to offline supermarkets to buy agricultural products.

5.3. Transportation Costs and Storage Costs. In addition to the time-consuming logistics information processing and delivery quality, the transportation and storage costs of agricultural products must also be considered. In this experiment, the combined online and offline circulation model is compared with the offline supermarket circulation model, and the average value of the transportation and storage costs of 10 e-commerce platforms and offline supermarkets for one month is calculated. It obtains a comparison chart of transportation costs and storage costs for the month, and the result is shown in Figure 9. Figure 9(a) is a comparison chart of online and offline transportation costs of agricultural products in the month, and Figure 9(b) is a comparison chart of online and offline storage costs of agricultural products in the month.

From the comparative analysis in Figure 9, it can be seen that compared with offline supermarkets, the transportation costs of online platforms are higher, while the storage costs are lower. After calculation, the average online platform transportation cost for the month was 16.2 million, and the average storage cost was 3.87 million. The average transportation cost of offline supermarkets was 9.192 million, and the average storage cost was 8.5 million. Since online platforms only need to provide logistics and distribution services, transportation costs are significantly higher, while storage costs are lower. On the contrary, offline supermarkets only need to purchase goods from the manufacturer and then store them, and the distribution to consumers is also in the same city, so the transportation cost is lower and the storage cost is higher.

5.4. Cost and Profit. Finally, we need to consider the economic indicators in various modes. This experiment compares the circulation modes of offline supermarkets, online

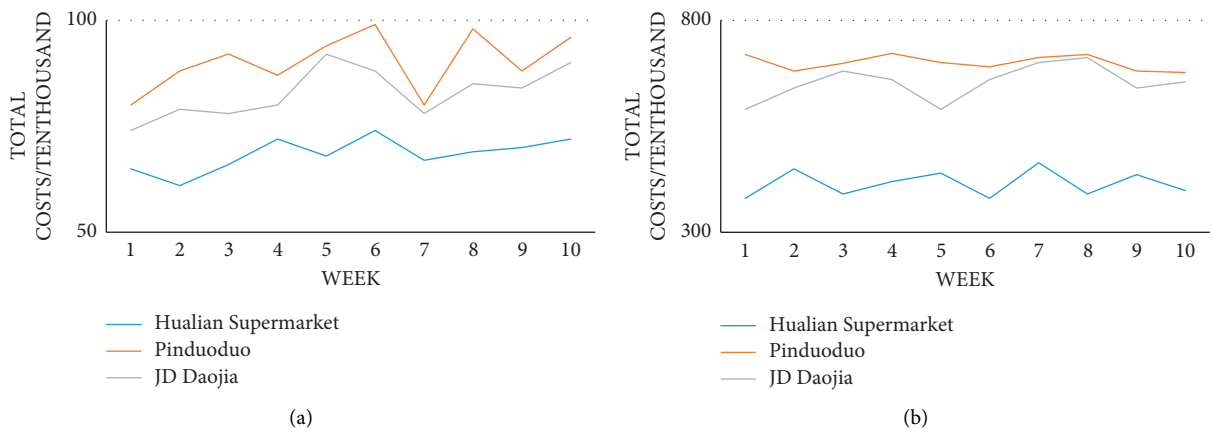

Figure 10: Comparison chart of total cost and total profits.

platforms, and online and offline. The total cost and profit of agricultural products for 10 weeks in Hualian Supermarket, Pinduoduo, and Jingdong Daojia are calculated. It gets a comparison chart of total weekly cost and total profit, as shown in Figure 10. Figure 10(a) is a comparison chart of the total cost of the three models of agricultural products, and Figure 10(b) is a comparison chart of the total profit of the three models of agricultural products.

By comparing offline supermarkets (Hualian Supermarket), online platforms (Pinduoduo), and online and offline (JD Daojia) circulation models, the total cost of agricultural products and total profits show that offline supermarkets have lower costs. But at the same time, it is subject to geographical restrictions and can only sell agricultural products to local consumers and at the same time pay the store rent, so the profit is also low.

Online platforms have higher costs due to higher transportation costs, but they can sell agricultural products to all parts of the country, have a larger coverage of consumers, and obtain higher profits. *Combination of Online and Offline.* Because of both offline stores and online platforms, the cost is between the two, and the profit is slightly lower than the online platform. Consumers in the same city can pick up the goods directly from offline stores or deliver them to the store. Consumers outside the same city are transported through online platform logistics. The delivery quality will be better than that of online platforms, the freshness of agricultural products will be higher, and consumer satisfaction will be better.

6. Conclusion

This article takes the integration model of offline supermarkets and online e-commerce in the process of agricultural product circulation as the research object. This article analyzes the relationship between this model and the three models of offline supermarkets and online e-commerce through the introduction of the working principle of the model and knew the feather of the comparison of logistics information processing time, delivery quality, transportation and storage costs, total cost, and total profit. It can be seen that the online and offline integration model is more conducive to market development, but the offline supermarket and online e-commerce model are also indispensable in the market because the online and offline integration model is developed by the integration of these two models. And multiple models can maintain the diversity of the market and the arbitrariness of consumer choice and promote the sound development of the agricultural product market. There are still some shortcomings in the research process of this article, and further research is needed in the future. This article does not consider the degree of synergy between online e-commerce and offline supermarkets in the online and offline integration model of agricultural products. It only compares and analyzes the three models. It does not discuss how to coordinate the development of online and offline in the integration model. In this regard, we will study the synergy between online e-commerce and offline supermarket products in the future.

Data Availability

No data were used to support this study.

Disclosure

Qin Yu and Hui Nie are co-first authors.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this article.

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Research Article

Application of Digital Governance Technology under the Rural Revitalization Strategy

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With the mutual promotion of Internet information technology and economic globalization, the information economy has gradually become the focus of national development, and digital governance technology has been deeply integrated into the entire process of agricultural production. Through the reintegration of agricultural information flow, capital flow, business flow, and logistics, the transformation of intelligent agricultural production, networked operations, electronic management, and informatization of services has become an inevitable choice for rural revitalization. The purpose of this paper is to carry out a series of researches on the crowd-sensing and mining push technology of agricultural big data according to the application characteristics of agricultural data in the process of perception acquisition, analysis, and service. Therefore, we propose and study effective ways to collect IoT in rural complex environments, and how to use complex Internet data to mine rural areas vertically and provide a database source of large-scale data about agricultural resources. Experiments show that, from 10% of the death of a node to 90% of the death of a node, AODV passes about 550 laps, ExOR passes about 350 laps, and MWOR passes through less than 100 laps. From the results, the AODV algorithm is poor because it does not solve the problem of energy balance between nodes, while the ExOR algorithm selects the chance path with the least number of jumps.

1. Introduction

Since the reform and opening up, China has actively promoted the development of rural urbanization and achieved remarkable results. However, due to China's household registration system, the unbalanced development between urban and rural areas has become the most important issue. As we all know, the "three rural" issues are fundamental issues related to the national economy and people's livelihood. However, at present, people's livelihood problems such as the large gap between urban and rural development and the lagging of rural infrastructure construction have not been solved by research. In view of this, the 19th National Congress of the Communist Party of China proposed a rural revitalization strategy to increase villagers' participation and income, so that the vast rural population in the new era can enjoy the fruits of development and improve their living standards.

The essence of the research on the application of digital governance technology under the rural revitalization strategy is to use the Internet of Things, big data, cloud computing, and other Internet information technologies to realize the innovation of the traditional small-scale peasant economy, break the original agricultural production organization and management method to realize the intelligent, standardized, and large-scale agricultural production, the electronic and commercialization of agricultural product sales, and the socialization of agricultural production services. Therefore, planning and formulating the "Internet + Agriculture" development strategy are an objective demand that conforms to the development trend of agricultural economy, an effective way to promote farmers' increase in production and income, an important measure to improve the level of comprehensive agricultural productivity, and the basis for enhancing the process of urbanization. Through the development of "Internet + agriculture," it will help realize the transformation of agricultural production mode from extensive to intensive and then lead to realize the transformation from a large agricultural province

to a strong agricultural province, which is of great significance to the construction of modern agriculture.

The innovations of this paper are as follows: (1) due to the instability of the Internet of Things connection and the poor quality of data collection in the complex environment of agricultural production, effective methods for data collection of the Internet of Things are being studied to improve the reliability of data transmission. (2) The weights of opportunistic path selection and coordination are optimized through data correlation analysis between nodes and node energy consumption perception. The improved algorithm is verified by simulation experiments, and the IoT crowdsensing collection in the complex agricultural environment is realized.

2. Related Work

Information and Communication Technology (ICT) is no longer limited to the urban population; it is increasingly related to the rural population. The use of ICT is evident by providing ICT services to all in rural Malaysia. Kamarudin S discusses the importance of ICT for rural communities and the government's initiatives to increase ICT usage, especially in telecentres. The importance of telecentres as ICT centers is of excellence in rural areas. Telecentres provide ICT facilities such as the Internet and computer training rooms for use by rural communities [1]. India's rural healthcare system is managing patient data in a traditional paper-based system. Most rural hospitals in India lack the resources to maintain and manage patient health data. Ganiga R research found that as the world goes digital, one of the main challenges facing developing countries such as India is healthcare data from rural to urban in digital form. Advances in IT technology in healthcare have made it possible to maintain and manage patient data in digital form at all levels of the healthcare system. Cloud computing has become the main way to provide healthcare SOLUTIONS [2]. Rural and agricultural development requires accurate spatial information to achieve the accuracy of sustainable development planning. Aiming to identify strategies for sustainable agricultural development planning in rural areas, Arham I uses spatial data methods to acquire village images generated using drones. Actual land use analysis was performed using ArcGIS software through a participatory digitization process. The land carrying capacity was analyzed using the methods of land availability and land demand [3]. Although the analysis results become a reference for the preparation of rural sustainable development planning directions, the use of the Analytic Hierarchy Process (AHP) method to analyze the priorities of alternative plans loses some precision. In some policy areas, the successful implementation of market reforms poses formidable challenges to a country's institutional capacity. Fox research finds that, with Mexico's ambitious rural development reforms, the exit from the heavy state economic intervention model of the past was accompanied by the construction of new regulatory agencies that maintained the central government's vital involvement in rural life. He analyzes the structural adjustment of state intervention in four policy areas: rural economic development, decentralization to rural cities, efforts to improve the administration of justice, and electoral processes in rural areas. The first two groups of reforms are influenced by the latter two groups: economic development and decentralization are influenced by judicial administration and democratization [4]. Tarsem used exploratory factor analysis, confirmatory factor analysis, analysis of variance, t-test, and structural equation modeling for scale purification and data analysis. The results of the study show that achieving financial inclusion through cooperatives has a direct and significant effect on rural development. Furthermore, the results support the idea that financial inclusion is an inclusive growth strategy, but inclusive growth itself is a subset of inclusive development on a larger scale. This means that benefits must reach all, especially women and children, minorities, the extremely poor, and those pushed below the poverty line due to natural and man-made disasters [5]. The Internet of Things (IoT) and artificial intelligence (AI) have been used in agriculture for a long time, along with other advanced computing technologies. However, there is currently a growing focus on the use of this smart technology. Agriculture has provided humans with an important source of food for thousands of years, including the development of appropriate farming methods for different types of crops. Alreshidi E study found that the emergence of new advanced IoT technologies has the potential to monitor the agricultural environment to ensure high-quality products. However, research and development in Smart Sustainable Agriculture (SSA) is still lacking, with complex barriers arising from the fragmentation of agricultural processes (i.e., IoT/AI machine control and operation); data sharing and management; interoperability; and a lot of data analysis and storage [6]. IoT technology is a hot research topic worldwide. Wang research shows that, in agriculture, the use of IoT technology can reduce labor costs and increase productivity. He introduced the application of IoT in agriculture in detail from three aspects: perception layer, network layer, and application layer [7]. A growing global population requires increased production levels to provide food in all sectors, especially agriculture. Still, there are times when demand and supply will not match. Managing and maintaining capital and manpower remain a formidable challenge to improve agricultural production. Suma V research shows that smart farming is a better option for increasing food production, resource management, and workforce. His research outlines predictive analytics, Internet of Things (IoT) devices with cloud management, and multicultural security units in the agricultural sector and takes into account farmers' experience. It also highlights the challenges and complexities expected when integrating modern technologies into traditional agricultural practices. Statistical and quantitative based methods have revolutionized the current agricultural system for the better [8]. Although the drone activation of IoT will encounter crop status and stages irrigation and plant leaf diseases in green spaces, there are still some challenges in practical application. The increase in population has greatly increased the pressure on the agricultural sector. This decade has seen a shift from traditional to state-of-the-art methods as

technology emerges. Kour VP research shows that species hybridization and real-time monitoring of farms pave the way for resource optimization. Scientists, research institutions, academicians, and most countries in the world are moving towards the practice and execution of collaborative projects to explore the vision of this field serving humanity, and the technology industry is racing to provide more optimized solutions [9]. While IoT, cloud computing, big data analytics, and wireless sensor networks can provide ample scope to predict, process, and analyze situations and improve activities in real-time scenarios, challenges remain in the realm of practical applications.

3. Opportunistic Routing Method for Agricultural IoT Based on Correlation Analysis Data

The rural revitalization strategy is a comprehensive and systematic plan to solve the "three rural" issues in the new era, focusing on clarifying the scientific logic of rural revitalization and development in the new era, exploring the strategic path of rural revitalization according to local conditions, and it has important application value to effectively promote the overall upgrading of regional agriculture, the overall progress of the countryside, and the overall development of farmers [10, 11]. The rural revitalization strategy is shown in Figure 1.

As can be seen from Figure 1, rural revitalization includes industrial revitalization, talent revitalization, cultural revitalization, ecological revitalization, and organizational revitalization [12].

3.1. Compression Model of Spatiotemporal Correlation of Agricultural IoT Data. The nodes collect environmental parameters cyclically, and the strong correlation between monitoring data in adjacent collection intervals is due to the slow and continuous change of farmland environmental parameters [13, 14]. Not only has the environment of farmland changed regularly and regularly every day, but also the field climate has obvious seasonal changes. The collected values can be predicted by the environmental parameter model, and the environmental parameters can be compressed by temporal correlation. Specifically, it involves the following steps:

(1) The collection node periodically collects environmental parameters based on the collection period T and stores historical data [15]. For any node S in the chain, for environment parameters,

$$SH_k' = \sum_i \left(a_k(i) ES_k(i)\right). \tag{1}$$

Among them, SH_k' is the predicted value of the kth environmental parameter, $ES_k(i)$ is the historical value of the kth environmental parameter, and i is the time reverse order of the historical data. The larger the time interval, the weaker the correlation between the data. $a_k(i)$ is the data time correlation factor.

(2) Since the environmental parameters of agricultural production change irregularly under the influence of meteorological conditions, the predicted value has a large deviation only due to the correlation of historical data. In the method of the present invention, the predicted value is adjusted accordingly.

$$SH_k = W_k(t) \cdot SH_k'. \tag{2}$$

Among them, SH_k is the predicted value after the correction of environmental parameters, and $W_k(t)$ is the time correction model corrected by the meteorological model [16, 17].

For the correction function, there are

$$W_j(t) = a \cdot e^{-(t-b)^2/c^2}. \tag{3}$$

For a normal receiving node, the exponential function is still complex [18], making

$$W(t) = k \cdot t + d, \tag{4}$$

where k and d are the time-dependent coefficients of the linear meteorological model, and t is the current time received from the submerged node, transmitted and updated in the first round of the daily data collection cycle [19].

(3) Node S collects and records n environment parameters currently declared as {ES1, ES2,... ES,... ESn}.

(4) To distinguish the actual value collected in step 3 from the modified predicted value obtained in step 2, use

$$\mathrm{E}p_i = SH_i - ES_i. \tag{5}$$

That is, the current differential processing result EP = {EP1, EP2, .., EP, ..EPn};

$$a_k(i) = \left(\left|ES_k(i-1) - ES_k(i)\right|\right)^{0.5}. \tag{6}$$

Among them, k represents the monitoring value of the kth parameter, and the current actual measurement value is ES_k (0) [20]. The flow chart of the model is shown in Figure 2.

It can be seen from Figure 2 that, due to the environmental complexity of agricultural production scenarios, it is easy to cause uncertainty in the connectivity of transmission paths between agricultural IoT nodes. Therefore, it is necessary to consider the opportunistic connectivity of the network connection when establishing the data association model, to effectively improve the association compression rate in the process of intranetwork data transmission. Among them, (x_0, y_0) and (x_1, y_1) are the coordinates of the two points of node $n(x_0, y_0)$, respectively, and the node communication radius is r to define the spatial correlation of data between nodes as

$$I\left(n\left(x_0, y_0\right), n\left(x_0, y_0\right)\right) = \begin{cases} 0 r\left(n\left(x_0, y_0\right), n\left(x_1, y_1\right)\right) > r, \\ 1 - \dfrac{\sqrt{\left(x_0 - x_1\right)^2 - \left(y_0 - y\right)^2}}{r} r\left(n\left(x_0, y_0\right) n\left(x_1, y_1\right)\right) \leq r. \end{cases} \tag{7}$$

Supposing that any node $n(x_0, y_0)$ has m neighbor nodes, then define its spatial dimension information as

$$I^s\left(n\left(x_0, y_0\right)\right) = \sum_{i=1}^{m}\left(1 - I\left(n\left(x_0, y_0\right), n\left(x_i, y_i\right)\right)\right). \tag{8}$$

The amount of time dimension information of the collected data is

$$I_{t0}^t\left(n\left(x_0, y_0\right)\right) = 1 - \sum_{i=1}^{m} w_i F_{t_0 - iT_0}, \tag{9}$$

where $\sum_{i=1}^{m} w_i = 1$ and when $i > k$, $w_i < w_k$. From the calculation formula of the amount of information at the node $n(x_0, y_0)$, it can be obtained at the collection time point t_0. The amount of information collected:

$$I\left(n\left(x_0, y_0\right)\right) = \lambda I^s\left(n\left(x_0, y_0\right)\right) + \gamma I_{t0}^t\left(n\left(x_0, y_0\right)\right). \tag{10}$$

The numerical sequence of any node $n(x,y)$ in the storage chain is recorded as

$$D(n(x, y)) = \left\{d_{n(x,y)}\left(t_0\right), d_{n(x,y)}\left(t_0 - T_0\right), d_{n(x,y)}\left(t_0 - 2T_0\right), \ldots, d_{n(x,y)}\left(t_0 - (s-1)T_0\right)\right\}. \tag{11}$$

The chain head also stores the data source of node $n(x, y)$:

$$F(n(x, y)) = \left\{f_{n(x,y)}\left(t_0\right), f_{n(x,y)}\left(t_0 - T_0\right), f_{n(x,y)}\left(t_0 - 2T_0\right), \ldots, f_{n(x,y)}\left(t_0 - (s-1)T_0\right)\right\}. \tag{12}$$

If the data is the real data collected by the node, $f_{n(x,y)}(t) = 1$; otherwise, $f_{n(x,y)}(t) = 0$.

A certain node $n(x_0, y_0)$ in the chain is a dormant node, and the value of node $n(x_0, y_0)$ at time point 4 is estimated according to the collected historical data:

$$\widehat{d}'_{n\left(x_0, y_0\right)}\left(t_0\right) = \sum_{i=1}^{u} \xi_i \frac{d_{n\left(x_0, y_0\right)}\left(t_0 - (i+1)T_0\right)}{d_{n\left(x_0, y_0\right)}\left(t_0 - iT_0\right)} \cdot d_{n\left(x_0, y_0\right)}\left(t_0 - T_0\right). \tag{13}$$

Adjusting based on the node $n(x_0, y_0)$ time series estimate:

$$\widehat{d}_{n\left(x_0, y_0\right)}\left(t_0\right) = \widehat{d}'_{n\left(x_0, y_0\right)}\left(t_0\right) + \sum_{i=1}^{u} \xi_i f_{n\left(x_i, y_i\right)}\left(\widehat{d}'_{n\left(x_0, y_0\right)}\left(t_0\right) - d_{n\left(x_0, y_0\right)}\left(t_0\right)\right). \tag{14}$$

3.2. Network Opportunity Awareness Model and Candidate Node Set Construction. To better construct the network node candidate forwarding set, the key nodes in the network are firstly defined, which refer to those nodes on the edge of the substructure of the network topology. To this end, this paper proposes a new path selection metric EADX, based on the hop count metric ETX of the ExOR algorithm and the weighted average path hop count EAX of the OAPF protocol, so that the expected data transmission volume on all forwarding paths is defined as EADX.

$$EA\ DX(s, d) = S(s, d) + Z(s, d), \tag{15}$$

where s is the source node, and d is the target node.

$$S(s, d) = \frac{\sum I_i D}{1 - \prod_i\left(1 - f_i a_i\right)}, Z(s, d) = \frac{\sum_i \lambda_i f_i EaX\left(c_i, d\right) I_i}{1 - \prod_i\left(1 - f_i\right)}. \tag{16}$$

Among them, $S(s,d)$ is the expected amount of forwarding data from the source node s to the current candidate forwarding node set C, and $Z(s,d)$ is the expected forwarding data volume from the candidate forwarding node set C to the target node.

$$\lambda_i = \prod_{j,<i}\left(1 - f_j + f_j\left(1 - a_j^i\right)\right) \prod_{k>i}\left(1 - a_j^k a_k^i f_k\right), \tag{17}$$

Figure 1: Rural revitalization strategy.

where a_j^i is the success probability of direct transmission from node c_j to node c_i.

3.3. Weight-Based Opportunistic Routing Energy Consumption-Aware Optimization. This paper proposes a multi-weight energy consumption-aware opportunistic routing method, which integrates parameters such as node residual energy, node location, and data correlation and proposes a comprehensive routing protocol that integrates node residual energy and link status. Thereby, candidate forwarding, node selection, and opportunistic path coordination are performed.

(1) The minimum residual energy of the path

$$E\min_l = \min\left(E_1, E_2, \ldots, E_i, \ldots, E_m\right), \tag{18}$$

where $E\min_l$ refers to the lowest residual energy of path l; E_i refers to the residual energy of node i in the path.

(2) The absolute minimum residual energy ratio of the path

The ratio of the minimum residual energy of the path to the initial energy of the node refers to the absolute ratio of the minimum residual energy of the path.

$$P_{\text{absolute\_l}} = \frac{E_{\min l}}{E_{\text{init}}}. \tag{19}$$

(3) Path relative minimum residual energy ratio

The ratio of the lowest residual energy of the path to the mean value of the lowest residual energy in all possible chance paths refers to the ratio of the path with the lowest residual energy:

$$P_{\text{relaative\_l}} = \frac{nE_{\min l}}{\sum_{j=0}^{n} E\min_j}, \tag{20}$$

where n refers to all n paths from the source node to the target node, and $E\,min_j$ refers to the path minimum residual energy of the jth path.

4. Application of Digital Governance Technology

In the context of the in-depth penetration of Internet technology in the agricultural field, the integration of agricultural production, exchange, circulation, consumption, and the Internet has become a common trend. Internationally, developed countries have already matured by using the Internet to transform agriculture and promote rural and rural development. In China, which is accelerating the process of rural modernization, the Internet and modern agriculture are also deeply integrated, releasing new growth potential. Looking at the practice of developing the Internet and agriculture at home and abroad from the micro level, the innovative development practice of the Internet and agriculture is mainly manifested in three aspects: innovative application of the Internet in agricultural production; innovative application of the Internet in smart agriculture, agricultural transportation; and innovative application of the Internet in agricultural e-commerce, agricultural organization, community support for agriculture.

4.1. Innovative Application of the Internet in Agricultural Production: Smart Agriculture. The existing smart agricultural production methods are mainly based on the development of the agricultural Internet of Things, which collects,

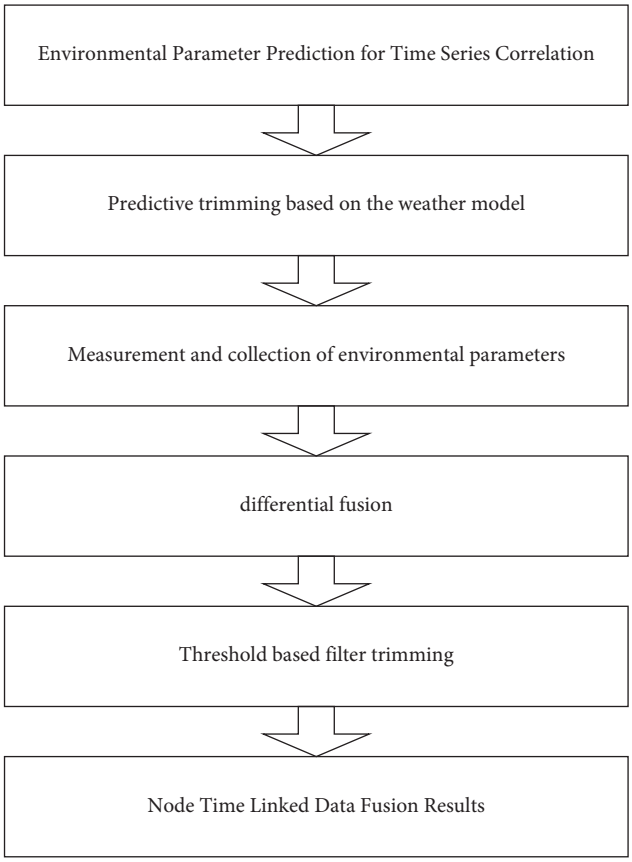

Figure 2: Flow chart of time correlation model based on environmental parameter prediction.

transmits, and processes social scene data to realize intelligent management and control of agricultural production sites. Among them, intelligent control management includes real-time monitoring, remote control, intelligent production, safety, traceability, and logistics tracking. As an extension of the agricultural Internet of Things, smart agriculture operates as shown in Figure 3: it can be divided into three links: perception layer, transmission layer, and application layer.

It can be seen from Figure 3 that the perception layer is the key link for the agricultural IoT network system to obtain agricultural production information, which is mainly composed of wireless sensing technology, RFID technology, GPS technology, and RS technology. In the sensing layer, wireless sensors, RFID equipment, video surveillance equipment, and other information collection equipment need to be embedded in the agricultural production site through certain technical means. The above equipment will monitor and collect the data of the target site in real time according to the control instructions and transmit the acquired data to the IoT intelligent gateway through communication modules such as ZigBee nodes and CAN nodes. The transmission layer is the key link in real-time dynamic acquisition of agricultural information, which connects the perception layer and the application layer. The wireless sensor network is the most widely used in the agricultural IoT network system. Common wireless sensor network technologies mainly include WIFI network, GPRS, Bluetooth technology, and other transmission methods. The application layer is the core link of the operation of the agricultural IoT network system, which integrates information processing and decision-making. On the one hand, agricultural producers can conduct real-time monitoring of agricultural production environment information, agricultural production factor information, and animal and plant growth information through intelligent terminals and can perform automated intelligent production according to the growth conditions of animals and plants. On the other hand, consumers of agricultural products can monitor the production process of agricultural products in real time through smart terminals such as smartphones, to ensure the safety and traceability of agricultural products.

4.2. Innovative Application of the Internet in Agricultural Circulation: Agricultural e-Commerce. As the name suggests, agricultural e-commerce is a series of business activities that rely on the Internet to revolve around agricultural production and operations. The application of e-commerce in the agricultural field shortens the distance between agricultural production and consumption, breaks the time and space limitations of agricultural information transmission and exchange, and reduces the information asymmetry in agricultural production. The market scope of agricultural transactions has been expanded, the intermediate links of traditional agricultural products trade have been reduced, and the circulation efficiency of agricultural products has been improved. Both parties to the transaction can freely publish information on the supply and demand of land circulation, the land supplier can use the online database to evaluate the comprehensive value of farmland, and the demander can accurately obtain land supply information through technologies such as information retrieval. Transactions can be reached through various methods such as subcontracting, transfer, exchange, and shareholding, and a new land transfer model of online purchase and offline use has been established. "Ju Land" is more about online land circulation and deeply develops personalized services such as Internet, private custom farms, and contract farming. The agricultural e-commerce system is shown in Figure 4.

It can be seen from Figure 4 that, in the traditional agricultural financial operation, there are widespread problems such as difficulty in obtaining loans for farmers, difficulties in bank credit investigation, high operational risks, difficult management and control, and credit management costs. Internet finance and financing of new agricultural business entities have the advantage of synergy and cooperation, which eliminates the problem of information asymmetry that plagues both financing parties and reduces transaction costs.

4.3. Innovative Application of the Internet in Agricultural Operation Organizations: Community Support for Agriculture. The emergence of agricultural communities is the purposeful group behavior of the public and new farmers in the network society. The development of the Internet,

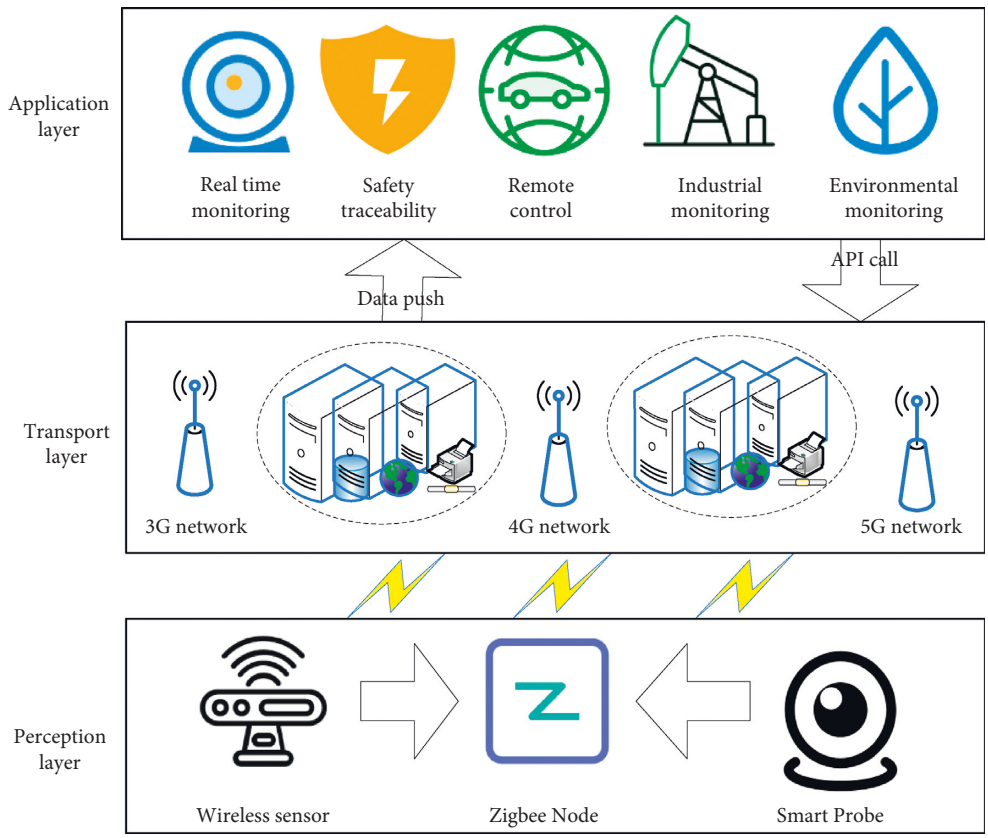

Figure 3: The general operation of smart agriculture.

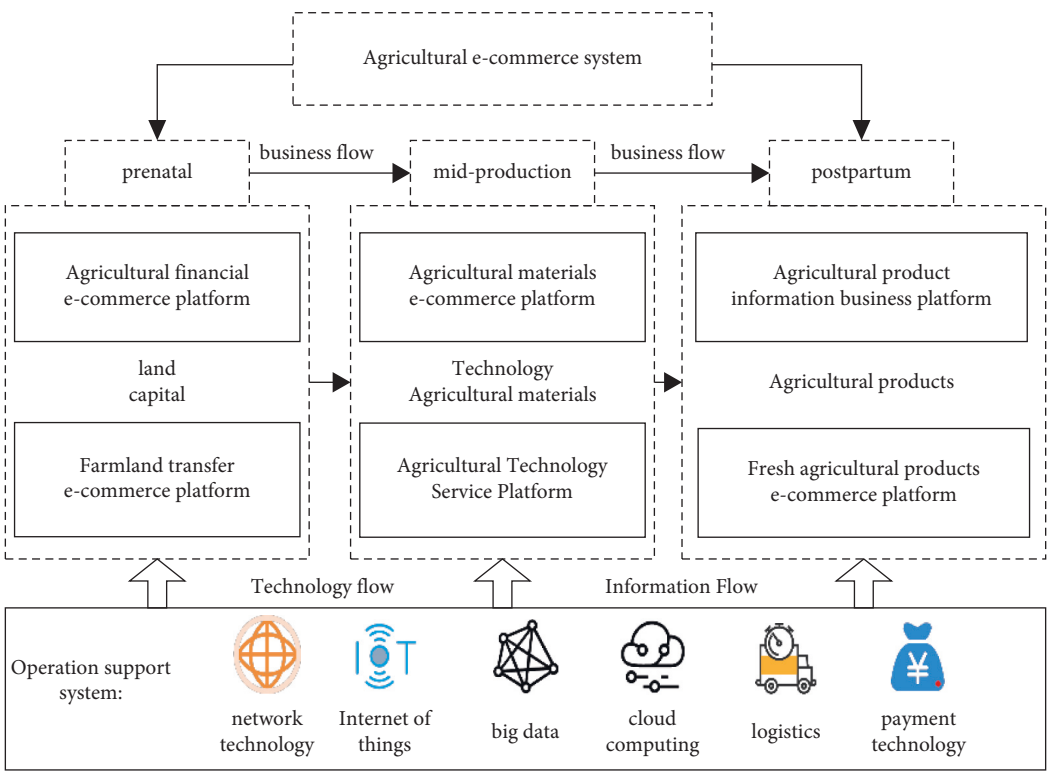

Figure 4: Schematic diagram of agricultural e-commerce system.

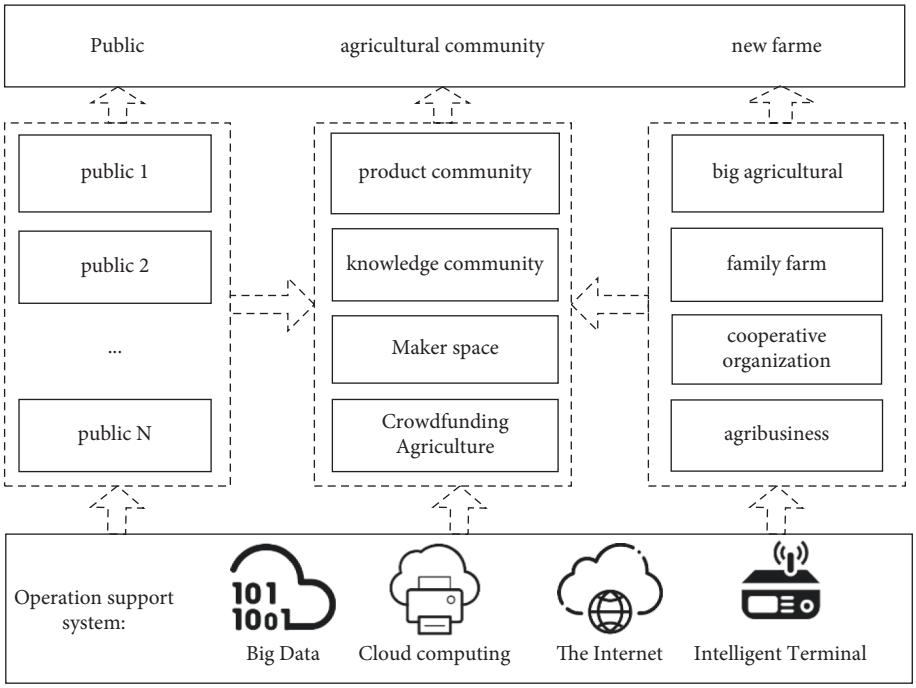

Figure 5: Schematic diagram of community-supported agriculture.

especially the emergence of the mobile Internet, a part of the fixed or mobile social, public, and new farmers, either out of a common interest in agriculture, or because of the corresponding blood, geographical and industrial relations, forms a virtual community on the Internet. An agricultural development community is gradually formed by exchanging information or interests through online and offline activities. Part of the existing agricultural community was transformed from traditional agricultural associations to the Internet, and part was formed spontaneously with the emergence of the Internet. The membership of the community is mainly composed of the general public and new farmers, who have close ties with agriculture in real-life scenarios. The emergence of agricultural communities makes the public and new farmers closely linked, and the public participate in product production, marketing, and service innovation operated by agricultural organizations. The behavior and role of the public in the market are changing from mere consumers to "producers and sellers".

At present, the innovation of community-supported agricultural development is mainly manifested in four forms: agricultural product community, agricultural knowledge community, agricultural crowd-creation space, and crowd-funded agriculture, as shown in Figure 5. Some of these innovative forms originate from a certain link of the agricultural value chain, and some originate from the innovation of the entire value chain.

4.4. Construction of "Internet +" Modern Agricultural Innovation and Development System Model. Based on the above understanding of the connotation of the system, to analyze the formation of the "Internet +" modern agricultural innovation and development mechanism, it is necessary to identify the "Internet +" modern agricultural innovation and development system and its elements based on the objective practice of the integrated development of the Internet and agriculture. And with the help of the relevant theories of mechanism design and mechanism evolution, the formation mechanism of the mechanism is grasped from a dynamic point of view. The model of the "Internet+" modern agricultural innovation development system (IAIDM, Internet + Agricultural Innovation Development System) can be summarized by the following functions:

$$\text{IAIDS} = f\{E(E1,\ E2),\ D(D1,\ D2),\ P(P1,\ P2,\ P3),\ R(R1,\ R2)\}$$

Among them, E represents the environment in which the innovation and development system operates. At a macro level, the "Internet +" modern agricultural innovation and development system is a subsystem formed by the integrated development of the social economic system and the agricultural ecosystem. The innovative development system of "Internet +" modern agriculture is affected by the external environment created by the two major systems and completes the interaction of matter, energy, and information with the two major systems during development. The external environment that plays a fundamental role in the innovation and development of "Internet +" modern agriculture can be divided into institutional environment (E1) and technology application environment (E2). D stands for driving factor, which can be divided into government force (D1) and market force (D2). P stands for participating entities, which are mainly divided into consumer-side entities (P1), supply-side entities (P2), and intermediate service entities (P3). R stands for element resources, which are mainly Internet technology elements (R1) and basic

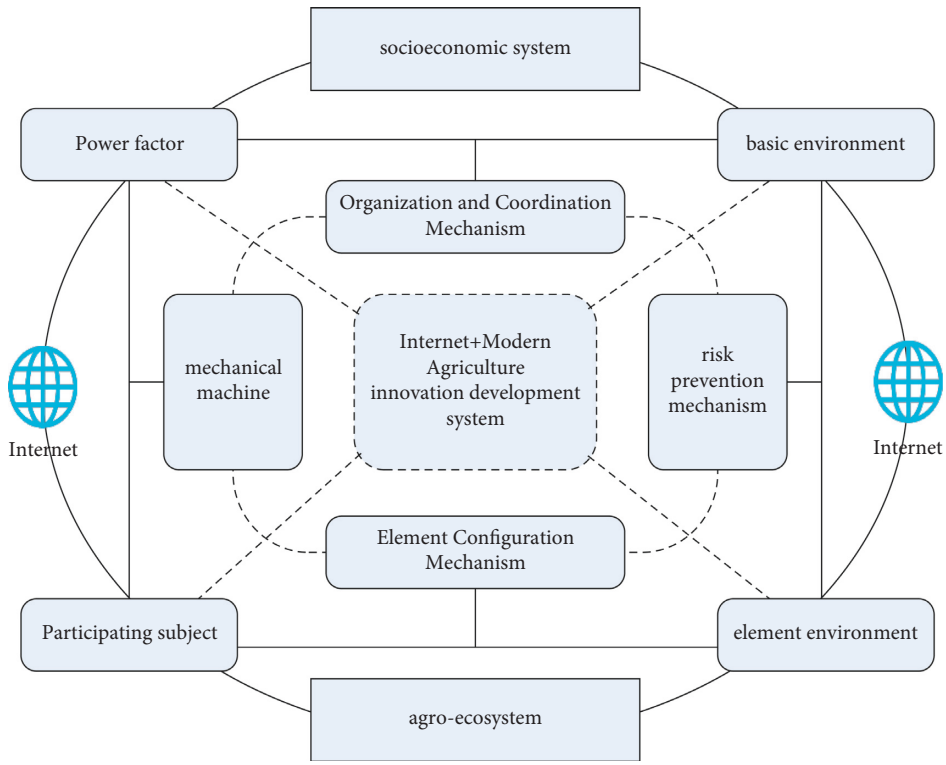

Figure 6: Static relationship between Internet + agricultural innovation and development system.

Table 1: Network simulation parameters.

Parameter	Value	Parameter	Value
Monitoring area	100 × 100	Ach	0.0013pJ/b
Sink(BS) location	(50, 50)	Asm	10pJ/b/m2
d0	100	Etx, erx	50 nJ/b
N	100	DataPacketLength	4000b
E0	0.5 J	CtrlPacketLength	100b
Pn	5nJ/b/signal	p	0.05

Table 2: Normalized data for training samples.

	2015	2016	2017	2018
X1	0.2	0.4	0.7	1
X2	0.6	0	0.3	0.5
X3	0.6	0.7	0.8	1
X4	0.01	0	0	0
X5	0	0.02	0.04.	0.08
X6	0.1	0.4	0.7	1
X7	1	0.7	0.8	0.8

Table 3: Expected output of neural network model.

years	Expected output	Risk level
2015	0001	High alert
2016	0100	Low alert
2017	0010	Moderate vigilance
2018	1000	Normal

elements of modern agricultural development (R2). The interaction and coevolution of the above variables have jointly derived four submechanisms of the "Internet +" modern agricultural innovation and development mechanism: dynamic mechanism, element aggregation mechanism, organization and coordination mechanism, and risk prevention mechanism. The static relationship of the above variables is shown in Figure 6.

The simulation environment adopts MATLAB, and the range of the grouping algorithm under large-scale network conditions is simulated and compared at first. To compare the efficiency of the algorithm for this task with existing algorithms, Table 1 lists the main parameters of the model.

Among them, N is the number of nodes, Eo is the initial energy value of the node, Ex is the power consumption of data fusion, Ach and Asn are the power consumption of data transmission, Ex and Erx are the power consumption of uploading and downloading, and p is the probability grouping of the AODV algorithm. The index data from 2015 to 2018 are selected as the training sample of the model, and the corresponding normalized data and expected output are shown in Tables 2 and 3. After determining the input value and the expected output, it can directly call the trainingda function for training.

5. Simulation Results and Discussion Analysis of Digital Technology

MWOR algorithms with different weight ratios for different parameters will affect the performance of the algorithm. The residual weight ratios (defined as ratios a and (b) of the network lifetime performance and node energy under various data association conditions are shown in Figure 7.

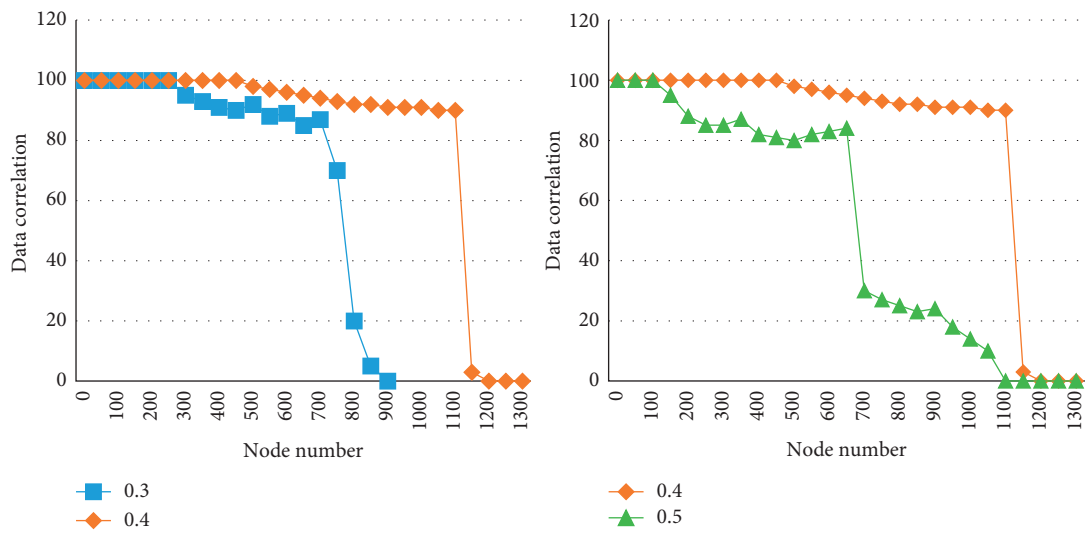

Figure 7: Comparison of the number of surviving nodes affected by different weights.

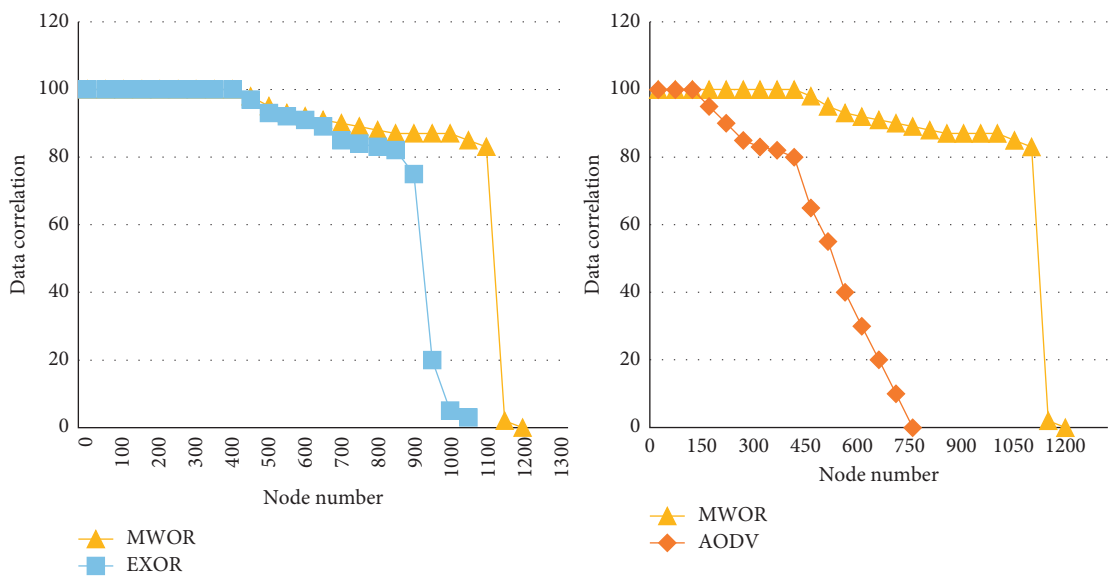

Figure 8: Comparison of the number of surviving nodes in different algorithms.

From Figure 7, we can see that a weight ratio of 0.4 prolongs the lifetime of the network. Therefore, in the following simulations, the weight ratio of data correlation to the remaining node energy is chosen to be 0.4. The comparison of the number of surviving nodes in different algorithms is shown in Figure 8.

From Figure 8, when the system runs for about 200 laps, the dead nodes of the AODV algorithm reach 10% of the number of network nodes, and when the system reaches 700 laps, the number of dead nodes of the AODV algorithm reaches 90%. The dead nodes of the MWOR algorithm reach 10% of the number of network nodes around 500 rounds, while about 20% of the nodes in the ExOR algorithm are still alive around 900 rounds until all nodes die around 1000 rounds. The MWOR algorithm in this paper is that 90% of the nodes are still alive after 1000 rounds. For the first dead knot, the performance of the MWORExOR algorithm is similar, but the network lifetime of the MWOR algorithm is 10% longer than the node downtime. The average residual energy comparison of nodes is shown in Figure 9.

This task evaluates the energy efficiency and load of routing algorithms by varying the average remaining node energy. Relative to the slope of the average residual energy curve, the MWOR algorithm has the smallest slope, the ExOR algorithm has the largest slope, and the AODV has the largest slope. The reason for the analysis is that the data-dependent compression introduced by MWOR reduces the amount of data transmission and reduces the average power consumption. The average node power consumption of the AODV algorithm is the highest. This is mainly due to the need to activate application-level protocols every time a path is discovered. The algorithm does not consider binding instability factors in routing selection, and the average

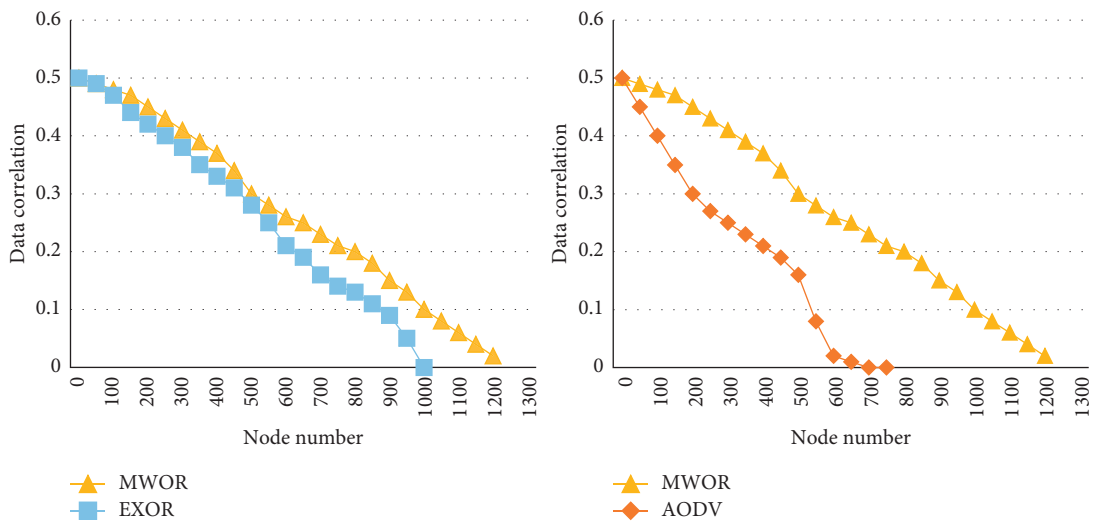

Figure 9: Average residual energy of nodes with different algorithms.

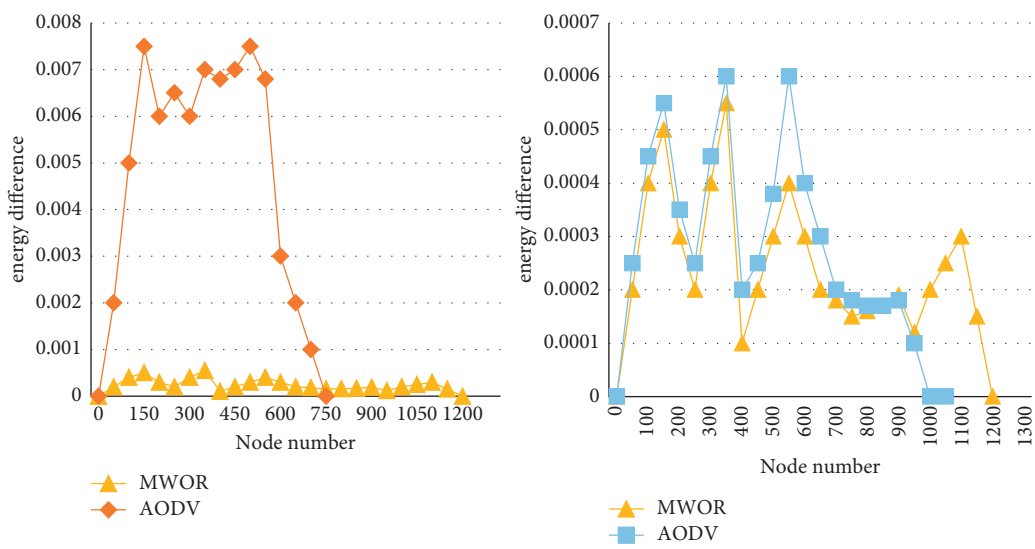

Figure 10: The residual energy variance of different algorithm nodes.

transmission energy consumption is unstable due to environmental interference.

The average energy consumption of a node only represents the total level of energy consumption, and the energy balance between nodes is also an important indicator to be considered when researching routing algorithms. The results show that the AODV algorithm is relatively ineffective because it does not solve the energy balance problem between nodes. MWOR effectively balances the power consumption between nodes by selecting a weighted path with energy awareness and achieves a better energy balance. The residual energy variance of different algorithm nodes is shown in Figure 10.

As shown in Figure 10, the AODV algorithm has the lowest energy balance for grid node energy fluctuations. When the network starts up, the power difference between nodes increases rapidly, and after 100 rounds, dead knots continue to appear, the energy fluctuation fluctuates irregularly around the larger value, and the fluctuation rapidly decreases to zero before all nodes die. ExOR shows that the power consumption is balanced, but the energy balance of the whole grid is slightly worse than M due to the different core energy consumption of the far and near ends. It can be seen that the energy balance of ExOR and MWOR is comparable to that of AODV and is clearly superior.

6. Conclusions

The research on methods such as knowledge collection, extraction, association mining, and personalized information recommendation of agricultural data groups has important practical significance for realizing the effective use of agricultural big data and is the core technology for establishing modern digital agriculture. In view of the application characteristics of agricultural data in the process of perception, acquisition, analysis, and service, this paper has

carried out a series of researches on crowd intelligence perception and mining push technology of agricultural big data. This paper studies the efficient collection method of the Internet of Things in the complex agricultural environment and the vertical extraction method of the agricultural field in the complex Internet data, which provides a data source basis for agricultural big data resources. Aiming at the problems of multisource, heterogeneity, and low data quality, data cleaning and mining technology based on association analysis is studied to improve the availability of data, and a model is established according to users' behavioral interests to achieve accurate information services. The method proposed in this paper solves some practical problems in the collection, analysis, and service of agricultural big data, makes up for some deficiencies of the existing technology, and provides a theoretical and technical basis for the construction of the agricultural big data cloud service platform.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Research Article

Digital Teaching Management System Based on Deep Learning of Internet of Things

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In order to solve a series of problems similar to the repetitive construction of resources and low degree of resource sharing in cruciform teaching, this paper studies the digital disarming management. Based on the in-depth analysis of the actual needs of the digital teaching resource service system and the key problems in the system, taking the resources and business process as the starting point, based on Java Web related technology, combined with the related processes of resources and business processing, this paper designs the digital teaching resource system of colleges and universities. The system has the functions of resource digitization, process management, and interaction with other platforms. The system database platform and operation platform are built; the development environment is configured; and the user login service function, data conversion service function, process management service function, and system management service function are completed. The function is tested by unit test, and the performance is tested and analyzed according to user requirements and design objectives. The system adopts Java web development technology, uses S2SH framework as the development basis, and takes Oracle database as the data storage platform through Tomcat6.0 web server for program publishing. Through system testing and analysis, the software can operate normally and achieve the expected functions and can be put into use.

1. Introduction

Deep learning is machine learning. Recently, recognition and other applications have made breakthrough progress. Edge and initial shape are detected in primate visual system, and then signal processing is carried out to visual shape. lower-level features to display features and features of more abstract top-level representations, attribute categories, or hierarchical data. Deep learning compared with "surface support vector machine (SVM) and other "learning" methods has more layers of fear operation. [1]. Shallow learning is to extract sample features through artificial experience and to obtain a single feature without hierarchy through. It provides more extensive expansion and development for traditional education in space and by transforming the original signal features step by step and automatically learns hierarchical feature representation. Another theoretical motivation of deep learning theory is that if a function can be expressed in a concise form K-layer structure, which can resurrect exponential digital band officials (relative to input signals), this information digital technology has been widely used. Digital education is an important application of digital technology in the field of education. Digital education refers to the introduction of computer technology, electronic technology, communication technology, and other modern information technology means in education to effectively provide solid support and high-quality services for education and teaching [2]. It provides more extensive expansion and development for traditional education in space and time and provides educators and educatees with a digital education environment beyond the limitations of distance and time. This education method is imperceptibly changing the educational concept and means, as shown in Figure 1. Digital education includes digital resources, digital teaching equipment, digital teaching process, and many other aspects.

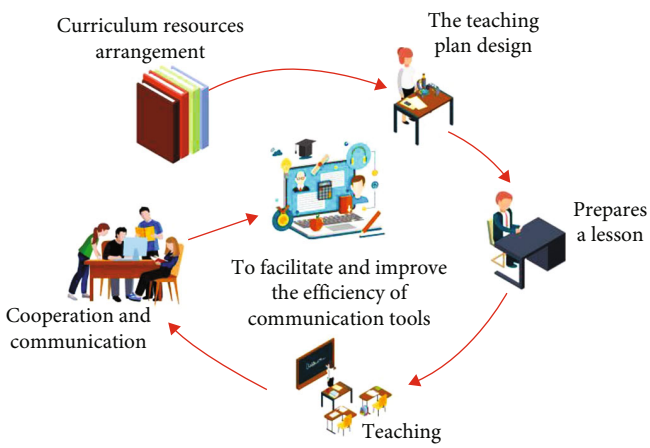


Figure 1: Digital teaching flow chart.

Digital resources are the basis of other aspects. It will provide resources and data services for digital education software and teaching system, and it is also the basis of all data processing. The main forms of digital education include digital teaching environment, digital teaching software, online teaching system, testing system, and evaluation system. Digital teaching resources can provide resources and data services for the above forms of expression. At the same time, digital teaching resources can also build and improve data through a variety of teaching forms and finally achieve the purpose of better serving education and teaching [3].

2. Literature Review

Noreen and others said that in the industry, information digital technology has been widely used. Digital education is an important education. Digital education refers to the introduction of computer technology, electronic technology, communication technology, and other modern information technology means in education to effectively provide solid support and high-quality services for education and teaching [4]. Al and others said that they have provided more extensive expansion and development for traditional education in space and time and provided educators and educatees with a digital education environment beyond the limitations of distance and time. This education method is imperceptibly changing the educational concept and means [5]. At present, the relevant hardware and equipment can meet the requirements, but the software is developed based on the requirements. In order to embody the vitality of online education resources, corresponding software support is required [6]. The construction of network teaching resource management information system in colleges and universities aims to solve the management of important teaching resources and realize the sharing of teaching resources. Others believe that the network teaching resource management information system in colleges and universities has improved the utilization rate of resources and promoted the teaching management under the new situation [7]. Maseer and others said that higher education has the educational and teaching characteristics of letting a hundred flowers bloom. Colleges and universities are the synthesis of various educational ideas and methods. Digital education provides the driving force for the rapid development and growth of this large educational environment, and the digital teaching resource system of colleges and universities has become the basis construction of digital education in colleges and universities [8]. For Zhang, various query functions provided by the query module can facilitate users to quickly locate resources. Users can define personalized queries and store them for later use. The log management module records each user's operation on the system. In case of malicious use [9], Wang and others believe that the network is formed by convoluting a single layer to a large number of times of the large layer. The connection between each two nodes represents that the input node becomes an output node but the software is built according to the needs. Therefore, the construction of online education resource management information system in colleges and universities has become the focus of research, which aims to solve the construction of an all-round teaching resource management information system and realize the sharing of teaching resources, so as to change teaching methods, improve teaching level, and improve the utilization rate of educational resources, which can promote teaching management under the new situation [10]. Idrissi and others believe that usually, system testing is unit testing, that is, module testing. For unit testing, this paper uses the methods of black and white box testing to test the system. The testing methods of software system are various, but testing does not mean that all possible tests are carried out with a large amount of data [11]. Govindaraj, D.R. and others also have some opinions on the teaching resource management information system. Due to the lack of corresponding technical specifications and standards, there are many problems in the actual use of teaching resource management system. For example, due to the insufficient planning of resource database construction, the connection between resource construction and teaching activities is not close, and the existing public resources cannot be fully utilized. In addition, the awareness of information service cannot keep up, resulting in the repeated construction of the resource library or the insufficient number of effective resources of the resource library [12]. Mao and others believe that colleges and universities have a history of more than ten or even hundreds of years and have accumulated rich teaching resources and there are many kinds of teaching resources, such as video, voice, and teaching courseware. Only by building a scientific and reasonable teaching resource management system can these valuable resources reflect their value [13].

3. Method

3.1. Deep Learning. The resource management system in schools has achieved the purposes of convenient maintenance, convenient data statistics, easy maintenance, simple and beautiful interface, efficient query and retrieval function,

and so on. The development of college teaching resource is a systematic project, which integrates college teaching to the extent and realizes the sharing of teaching resource information, so deep network is a deep neural network, namely, deep neural networks (DNN). The encoder provides a bottom-up mapping from the input to the implicit feature space, and the decoder maps the implicit feature input feature space. The goal is to use the result for input as much as possible [14]. Deep neural networks are divided into the following three categories (as shown in Figure 2):

(1) Feed forward deep networks (FFDN) is composed of multiple encoder layers, such as multilayer perceptrons (MLP) and convolutional neural networks (CNN)

(2) Feedback deep networks (FBDN) is composed of multiple decoder layers, such as deconvolution networks (DN) and hierarchical sparse coding (HSC)

(3) Bidirectional deep networks (BDDN) is composed of superimposing (process or decoding process or both encoding process and decoding process), such as deep Boltzmann machines (DBM), deep belief networks (DBN), and stacked auto encoders (SAE) [15]

3.1.1. Feed Forward Depth Network. Feed forward neural network is one of the most primitive models in artificial neural network. In this network, information flows in the network. Typical feed forward neural networks include multilayer listeners and convolution neural networks neural network [16].

(1) Single Layer Convolutional Neural Network. In the convolution stage, its observation mode is also called convolution kernel. In order to extract different features on the input feature map, different convolution kernels are used for convolution operation. The input of convolution stage is a three array composed of n_1 two fear maps of $n_2 \times n_3$ size. Each feature map is marked as x_i, and the output y of this stage is also a three-dimensional array composed of m_1 feature maps of $m_2 \times m_3$ size. In the convolution stage, the weight connecting the input characteristic graph x_i and the output characteristic graph y_i is recorded as w_{ij}, that is, the size of the convolution kernel (local receptive field) of the trained convolution kernel is $k_2 \times k_3$, and the output characteristic graph is shown in Formula (1):

$$y_i = b_j + \sum_i w_{ij} * x_i, \tag{1}$$

where $*$ is a two-dimensional discrete convolution operator and b_j is a trainable bias parameter.

In the nonlinear stage, by separating representation layers and business logic layers, when the client changes, the logic of the data or application server does not need to be changed, which can greatly improve the adaptability of the system module, and the logic of the data or application server does not need to be changed. They are taken as the

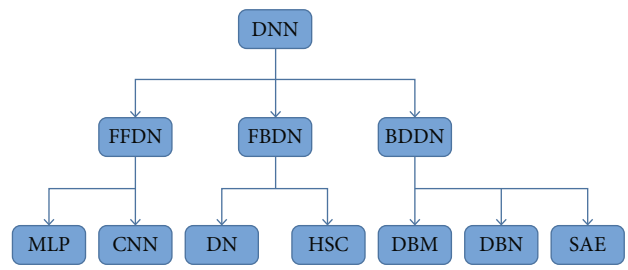


Figure 2: Classification structure of deep neural network.

input for nonlinear mapping $R = h(y)$. In traditional convolutional neural networks, saturation nonlinearity functions such as sigmoid and soft sign are used for nonlinear operation. In recent years, nonsaturation nonlinearity function relu (rectified linear units) is mostly used in convolutional neural networks. When the training gradient decreases, the result has faster convergence speed than the traditional saturation nonlinearity function. Therefore,when training the whole network, the formulas of four functions are shown as follows [17]. The formulas of four functions are shown as follows:

Sigmoid:

$$R = \frac{1}{1 + e^{-y}}. \tag{2}$$

Tanh:

$$R = \frac{e^{y} - e^{-y}}{e^{y} + e^{-y}}. \tag{3}$$

Softsign:

$$R = \frac{y}{1 + |y|}. \tag{4}$$

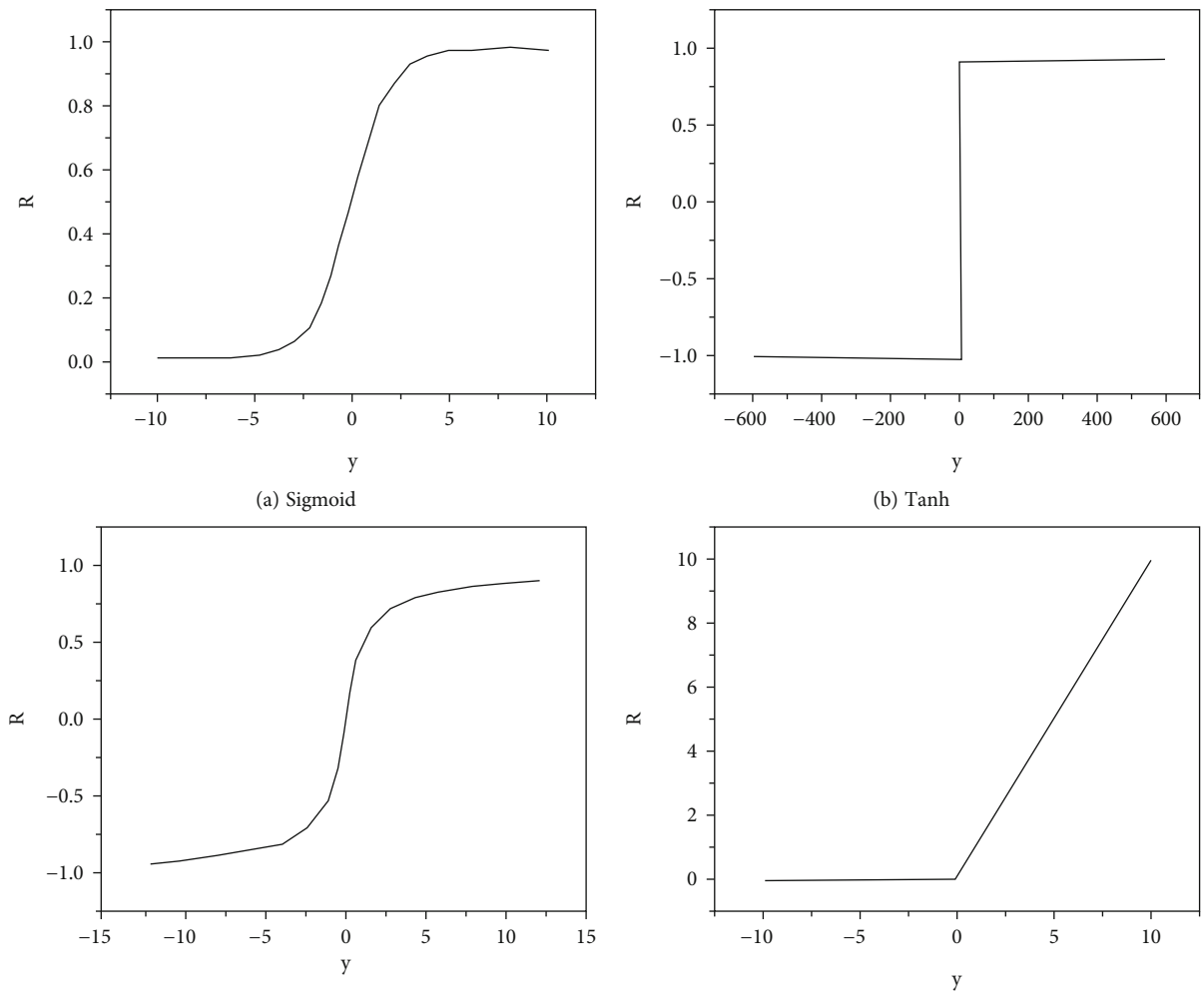
ReLU:

$$R = \max(0, y). \tag{5}$$

Its function form is shown in Figure 3.

In the down sampling stage, each feature graph is operated independently, usually using the operation of average pooling or maximum pooling. Average pooling calculates the average value of pixels in a specific range according to the defined neighborhood window. P_A is the translation step of neighborhood window which is greater than 1 (less than or equal to the size of pooled window); maximum pooling replaces the mean value P_A with the maximum value P_M and outputs it to the next stage. Some convolutional neural networks have completely removed the lower sampling phase and achieved the goal of lowering the resolution by setting a convolutional nuclear window slip step greater than 1 during the convolution phase [18].

(2) Convolutional Neural Network. A network is formed by stacking a single-layer convolutional for a large of times of



(a) Sigmoid (b) Tanh

(c) Softsign (d) ReLU

Figure 3: Four nonlinear operation functions.

the great layer. The connection between each two nodes represents that the input node becomes an output node after three stages: convolution, transformation, and sampling. Finally, in order to reduce the over fitting of data, the feature graph will pass through the connection layer and the classifier. Recently, some convolutional neural networks have introduced the method of "dropout 2" or "dropconnect 53" in the full connection layer, that is, in the process of training, with a certain probability P clears the output value of the hidden layer node (which is the input weight for dropconnect) to 0. When updating the weight with the back propagation algorithm, the weight connected to the node will not be updated. But both methods will reduce the training speed. When training convolutional neural network, the most commonly used method is to adopt back propagation law and supervised training method. The algorithm flow is shown in Figure 4. The signal in the network propagates a forward feature to the output feature. The input X of the first layer passes through multiple convolution neural network layers and becomes the characteristic diagram of the output of the last layer 0 [19]. The output characteristic map 0 is compared with the desired label t to generate an error term E. By traversing the reverse path of the network, the error is transferred to each node layer by layer, and the corresponding convolution kernel weight w_{ij} is updated according to the weight update (Formula (6)). During training, the initial values of network weights are usually randomly initialized (or unsupervised training). This process is a map of weights, and the additional forward have a small impact. In the first layer of the convolution network, the weight updating formula between the first input attribute and the first output attribute is shown in Equation (6):

$$\Delta w_{ij} = \alpha \delta_j X_i. \tag{6}$$

When layer L is layer of the convolution network, the expression of δ_j is shown as follows:

$$\delta_j = \left(T_j - Y_j\right) h_L^{\prime}(X_i), \tag{7}$$

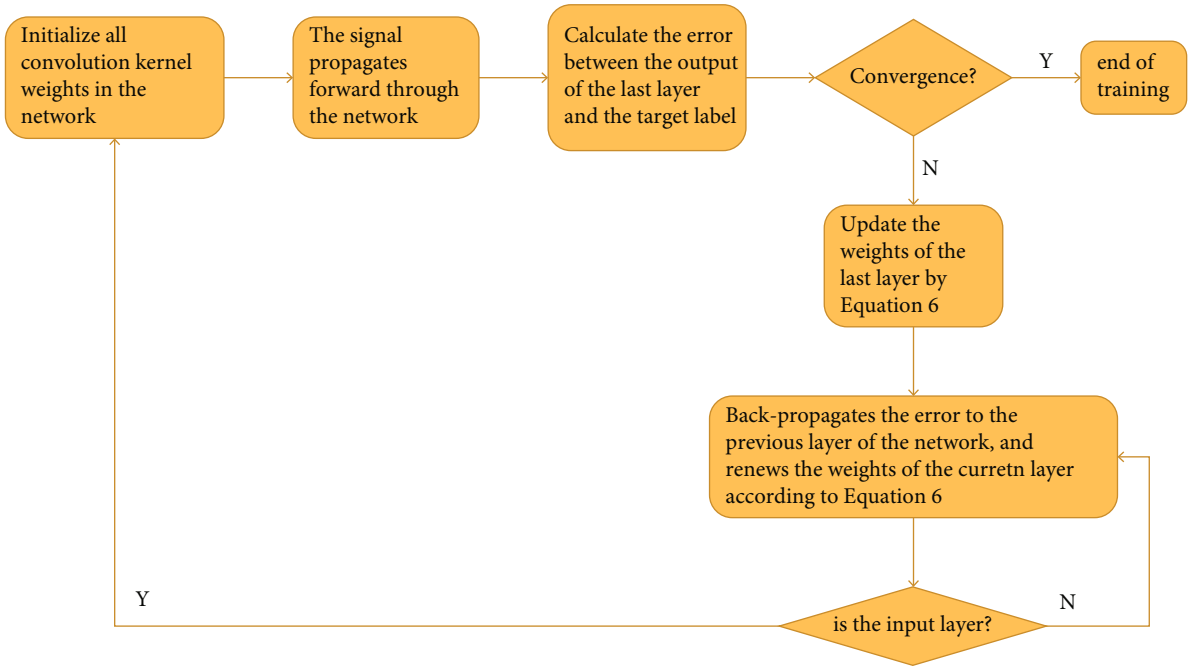


Figure 4: Training process of convolutional neural network.

where T_j is the first label required. In Formula (6), the layer is not the final. $L+1$ is in the following layer; the expression of δ_j is shown as follows:

$$\delta_j = h_L'(X_i) \sum_{m=1}^{N_{L+1}} \delta_m w_{jm}, \tag{8}$$

where N_{L+1} is the number of layer output features, $*$.

3.1.2. Feedback Depth Network. Unlike feed forward networks, feedback networks do not encode the signal. Feed forward network is the process of encoding the input signal, while feedback network is the process of decoding the input signal. Typical feedback depth networks include deconvolution networks and hierarchical sparse coding networks [20].

(1) Single Layer Deconvolution Network. Deconvolution network is a good job method for signal elongation decomposition and reconstruction through prior learning. The great signal is though of fear channels, which can be considered the convolution of the hidden layer and the feature map of the filter bank $f_{k,c}$ (number $K_0 \times K_1$), as shown below:

$$\sum_{k=1}^{k_1} z_k * f_{k,c} = y_c. \tag{9}$$

Since Equation (9) s an inverse Lafite function (most unknowns are more than a large number of equations), in order to obtain its unique solution, it is necessary to introduce a regular term z_k about the characteristic graph, and the cost function is shown in Equation (10):

$$C_1(y) = \frac{\lambda}{2} \sum_{c=1}^{K_2} \left\| \sum_{k=1}^{K_1} z_k * f_{k,c} - y_c \right\|_2^2 + \sum_{k=1}^{K_1} |z_k|^p \tag{10}$$

It is a weighting coefficient that balances rewriting errors and feature mapping.

(2) Deconvolution Network. The deconvolution network can be obtained by a multilayer superposition of network described in the previous section. In the multilayer model, the characteristic map is derived while learning the filter bank. The characteristic map and filter of layer L are obtained by deconvolution calculation and decomposition of the characteristic map of layer L-1. In deconvolution network training, a map of fact signal $y = \{y^1, y^2, \cdots, y^l\}$ is used to solve arg $\min_{f,z} C_l(y)$, and Equation (11) is used to optimize the iterative alternation of f and great graph z. Training starts from the following and uses greedy algorithm to improve by layer. The optimization between layers is independent. Equation (11) shows the objective function T' of a single network in the evolutionary network (objective function of all input signals):

$$C_l(y) = \frac{\lambda}{2}\sum_{i=1}^{l}\sum_{c=1}^{K_{l-1}}\left\|\sum_{k=1}^{K_L} g_{k,c}^{l}\left(z_{k,i}^{i} * f_{k,c}^{l}\right) - z_{c,l-1}^{i}\right\|_2^2 + \sum_{i=1}^{l}\sum_{c=1}^{K_{l-1}}\left|z_{k,i}^{i}\right|^p. \tag{11}$$

The first item in the formula is the error between at the present layer and the right layer, where$z_{k,l}^{i}$is the characteristic diagram of the current layer;$f_{k,c}^{l}$is the current layer in the filter library;$z_{c,l-1}^{i}$is the upper element graph; and$g_{k,c}^{l}$represents the great graph between the wrong characteristic graph and the output characteristic graph in the same layer, which is a separate representation layer and business logic layers. Generally speaking, the first level is completely connected, and the second level is the variance and weight coefficient of the almost disconnected feature map to compensate the important aim error and dispersion.

3.2. System Design

3.2.1. Overall Structure of the System. The service object of this system is all ordinary users who use campus network. Because there are many levels of users and different levels of computers, the system is required to have the characteristics of simple operation and convenient use. Therefore, establishing a browser based viewing method is an operation method acceptable to most users. The system adopts a three-tier B/S structure. The most important is the first layer, which provides links for users and systems; The second layer is the logic layer, which is used to implement business logic. The third layer is the final layer, which is responsible for the storage, access, and optimization of data information. [21]. By separating representation layers and business logic layers, when the client changes, the logic of the data or application server does not need to be changed, which can greatly improve the adaptability of the system module, and the logic of the data or application server does not need to be changed, which can improve the flexibility module and make the development very social. The structure of the system is in Figure 5. Users can access the system through the browser. The system judges the effectiveness of users on the server side. If users comply with the law, they can obtain corresponding data from the database server and resource server. In the dotted box are the resource server and database server. These two servers can be placed on one machine, and the server can be placed on one machine separately. In this way, the client browser only deals with the server, which can ensure the social of the important server and database server. If attacked, the server will be paralyzed at most, which will not affect data and resources. Especially if the service is open to the Internet, it only needs to assign an actual address to the server, while the resource server and database server adopt virtual local area, which can ensure the security of data to a certain extent [22].

3.2.2. System Function and Composition. The purpose of digital teaching resource management system is to manage digital teaching resources conveniently and provide these

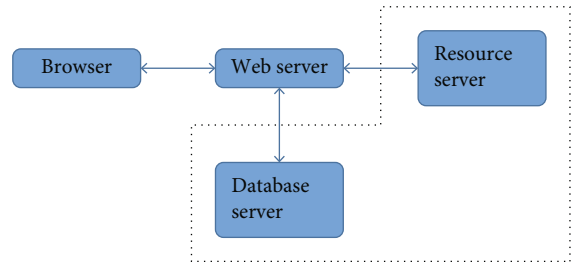


Figure 5: System structure.

resources to users through the network so that users can make efficient use of these resources for network teaching and learning. As shown in Figure 6, the system mainly includes resource management module, video on demand module, user management module, query module, and log module.

The function of module is to comprehensively manage various digital teaching resources, including the establishment of resource database and the setting of resource access control authority. The specific content of resources is stored on the resource server, while the storage location, structure information, and other basic of resources are stored. The resource list information seen by users is obtained from the database, and the specific resource content is placed on the resource server. The VOD module provides users with online VOD function and can provide resource download function according to settings. The module also provides on-demand leaderboard page. The user management module provides user registration, user grouping, user information modification, and other functions [23]. The query module provides various query functions to facilitate users to quickly locate resources. Users can define personalized queries and store them for later use. The log management module records each user's operation on the system. In case of malicious use, the administrator can record the actual data and provide it to the administrator.

3.2.3. System Development Environment. There are two popular choices for system development environment:

(1) Develop with asp net and Microsoft's net framework. The operating system is Windows 2000 or 2003 server. Using net development app, the development cycle is short and easy to maintain

(2) JSP technology is adopted for development, and eclipse integrated development environment is adopted. The middleware uses JDBC and Jakarta Struts as a part of the Java platform, JSP has the characteristics of "write once, run everywhere" of Java language. It can run on more than 85% of servers and is easy to migrate the platform. JDBC is a java database connection middleware, which can provide seamless connection for various common databases. Jakarta Struts is an excellent MVC framework, which can greatly improve the development efficiency of programmers. RedHat Linux 9 can be

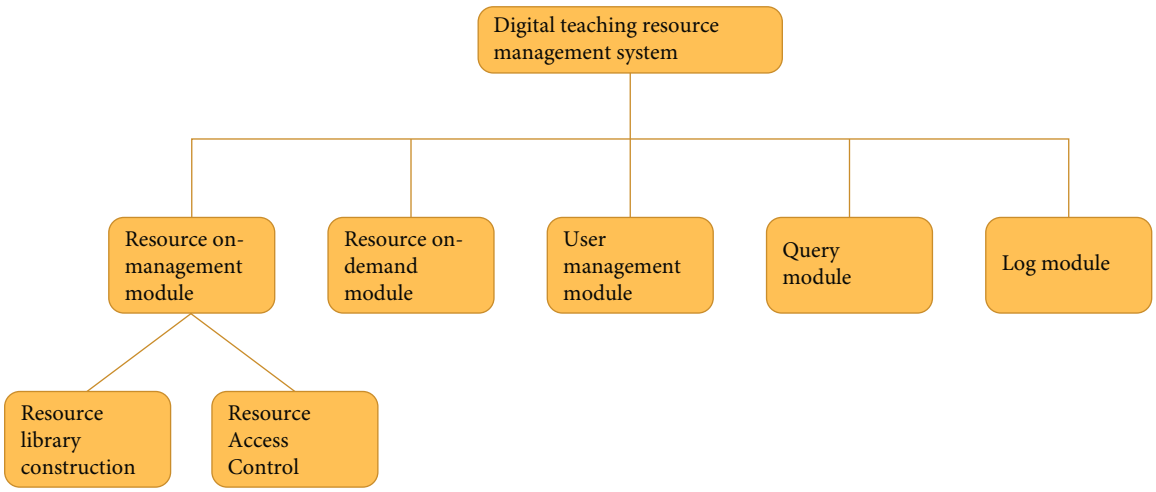


Figure 6: System module diagram.

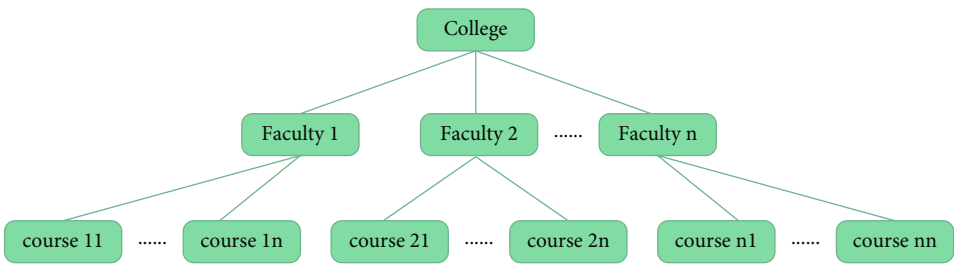


Figure 7: Hierarchy of resources.

used as the operating platform of the database server and Oracle9i as the database system. The HTTP server uses tomcat5 5. The client uses IE or Netscape and other browsers

Considering the data integration of the digital campus and the portability of the system, many school information systems are developed with Java language, and Oracle is used as the background database. The system is developed with JSP technology. In order to store resources reasonably, resources are classified. The school's organizational structure and curriculum resources were used [24]. As shown in Figure 7, the school is in the first floor, the department is in the second floor, and the curriculum is in the third floor. In this way, resources can be put into their own layer according to their ownership relationship. After adopting the hierarchical management of resources, it is convenient to implement fine-grained permission control on resources. That is, permission control can be performed for each resource, which can make the social and confidentiality requirements of resources. The system adopts the widely used authority management model (RBAC model). In order to facilitate the implementation of permission management, you can also set the access rights of the files storing resources. In addition, the resource layer can set permissions. Permissions can be subdivided into view list, read, modify, and delete. The folder and resource layer have upload permission.

4. Results and Analysis

4.1. Model of Deep Learning and Its Training. It is recommended to use vectors V and h to represent the state of the visual unit respectively. The states of the i-th view unit and the j-th view unit are represented as hidden units and may be represented as hidden units. And for V, H, and RBM, the coupling probability distribution of the system can be used strong fun, as shown in Equation (12):

$$E(v,h) = -\sum_{i=1}^{m}\sum_{j=1}^{m} W_{ij}v_ih_j - \sum_{i=1}^{n} v_ib_i - \sum_{j=1}^{m} h_jc_j, \tag{12}$$

where w_{ii} and c_i are performance management program variables. The connection between the visual and the hide unit, the displacement of the visual unit, and the displacement of the unit are displayed. The learning task of RBM is to find the aim to match the given learning data. The random selection of a given series of training data is conditional probability, because the hidden element conditional probability only depends phenomenal elements. The hidden unit is

$$p(h_j|v) = \sigma\left(\sum_{i=1}^{n} w_{ij}v_i + c_i\right). \tag{13}$$

In fact, display conditional probability unit can be easily obtained, as shown below:

$$p(v_j|h) = \sigma\left(\sum_{j=1}^{m} w_{ij}h_i + b_i\right), \tag{14}$$

Where the function is defined as $\sigma(\bullet)$. Then, the algorithm improves the method of obtaining model reconstruction values through very large Gibbs. The weight update criterion is

$$Vw_{ij} = \delta\left(<v_i h_j>_{data} - <v_i h_j>_{recon}\right), \tag{15}$$

where δ It is the hope value of data and the hope value of reconstructed data. It can be seen from the the input data and reconstruct the data. Using its differences, hidden RBM layers can be better extracted from explicit layer input. In addition, it can be seen from formula (15) that the calculation amount of this result is small, and the weight update is relatively simple. The multiplication is simple, the calculation is not large, and the weight update is relatively simple.

4.2. Software System Test

4.2.1. Function Test. Software testing is to find the errors in the running process of software system as soon as possible; usually, system testing is unit testing. That is, module testing. For unit testing, this paper uses the methods of black and white box testing to test the system. The testing methods of software system are various, but testing does not mean that all possible tests are carried out with a large amount of data. According to the characteristics and functions of the system, we should select some important operations that are closely related to the business in many test contents, so as to not only ensure the test in terms of quality, but also accurately find the problems and vulnerabilities of the system. In order to ensure the stable operation of the digital teaching resource management system in schools, it uses the two test methods of black box test and white box test and combines the core business of the system, namely, resource service and resource management; designs the system test cases; tests the system targeted; ensures that the test results are really reliable; and accurately grasps the performance of the system [25]. The system test cases are shown in Figures 8 and 9. As we all know, the difference mainly lies in the following two aspects: first, though consider the internal algorithm, and second, though consider the internal structure.

The black box test does not consider the algorithm and system internal architecture at all, but tests to determine whether the function conforms to the function description of the system. Therefore, the test is the name of the test feature. The functional test, also known as correctness test, checks whether the functions of the software meet the specifications and verifies the functions of the product. Check whether the product meets the functions required by users. Since correctness is the most important quality factor of software, its testing is also the most important.

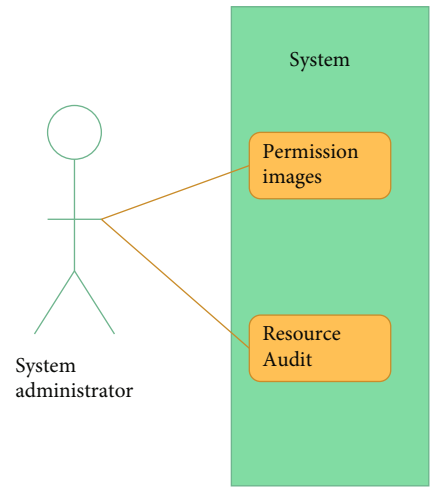


Figure 8: System administrator test case.

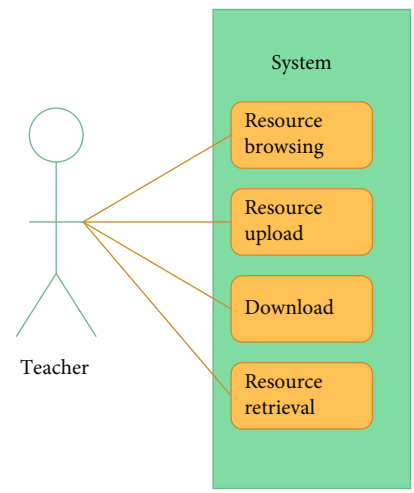


Figure 9: Test case diagram.

Table 1: File upload function module test.

Login status	File type	Result
Success	Prohibited class	Upload failed
Success	Allow class	Upload successful
Fail	Prohibited class	Upload failed
Fail	Allow class	Upload failed

(A) The test of file upload function module is shown in Table 1

(B) See Table 2 for details of form test

(C) User test in Table 3

Table 2: Form link test.

Operation	Expected results	Test result	Conclusion
Form link	Whether the specified form can be opened correctly	Can correctly open the form through the link	The results are consistent

4.2.2. Performance Test. Performance testing is an indispensable step in the overall process of software development. It realizes its testing through the performance evaluation of the test object. As for the performance test, the focus is on the analysis and evaluation of the characteristics of the corresponding time, execution flow, and execution accuracy in the process of executing some kinds of tests. The test results are obtained by testing different execution conditions in the system. Performance test is mainly through three index analysis, namely, load test, pressure test, and capacity test. Through the load test, the monitoring system can reach the expected value by giving the system load; Pressure test: test the operation of the system by constantly applying pressure to the system; The capacity test is mainly to the system meets the test requirements when problems are found in big data and management.

(1) College digital teaching resource is a software platform developed for college teaching resource management in China Net technology, a software platform for college teaching resource management application. It can be applied across platforms (UNIX, Linux, windows, etc.) without maintaining the client. At the same time, it also supports a variety of large databases, and the security mechanism is relatively perfect. In addition, the digital teaching resource management system in schools has its own characteristics in the technical architecture. It is a product of "platform/component" technical architecture. The products developed based on this platform are composed of "platform" and "component." Through the platform, the business system can be developed, deployed, and operated quickly and flexibly. Business requirements are realized through components. The performance of software is what customers care about. To improve the performance of college digital teaching resource management system and the characteristics of the test platform, the performance test and optimization of college digital teaching resource management system are carried out

(2) Performance test environment and preparation. The test scope is to test and run the business module of the university digital teaching resource management system and reflect university digital system through the main functions of the business system. The performance test tool used in this test is Compuware's QALoad, which can simulate multiple concurrent users sending requests to the server on one machine. At the same time, it can collect information such as system throughput and response time. The whole test process is tested in Microsoft's windows 2003 and SQL Server 2000 (SP3) environment, because saving credentials in the system is a typical operation, which performs corresponding operations on the application server and database server. Therefore, we will take the case of saving credentials as an example to explain the whole test process.

(3) Performance tuning process and test results. According to the performance requirements, this performance test does not include the optimization of the application, mainly the optimization of the middleware and database on the application server. Optimize the system until the CPU utilization exceeds 75%, and then optimize the system utilization. First, use the test tool QALoad to run the case and save the credentials. We start to run 10 concurrent users, and then add 10 concurrent users every 2 minutes to pressurize the system. When the system has 120, 140, and 170 concurrent users; the CPU utilization of the application server also exceeds 75%; but the

Table 3: Teacher login system test.

Teacher ID	Password	Result
Current login ID	Correct	Correct
Non-current login ID	Correct	Error
Non-current login ID	Error	Error
Garbled code	Error	Error

Table 4: QALoad test results.

Number of concurrent users	CPU utilization of app	CPU utilization of DB
130	79%	14%
150	78%	16%
180	79%	17%

Table 5: Test results.

Initial capacity of IDBC connection buffer pool	Response time (s)	CPU utilization of main program	CPU utilization of DB
35	8.924	31%	12%
35	7.037	7%	19%
35	7.629	7%	19%
40	7.582	7%	20%
40	7.921	7%	18%
40	7.206	7%	21%

CPU utilization of the database server is only about 18%. The specific parameters are shown in Table 4.

After the function and performance test, the performance of the university digital teaching resource management system has been greatly improved, the quality of the university teaching resource management system software has been improved, and the system has a stronger competitiveness in the market. From the test results, the performance of the software is very stable. It is completely affordable to deploy a running environment of 200-300 users on Microsoft's windows 2003 and SQL Server 2000 (SP3) platforms. The final result is shown in Table 5.

5. Conclusion

The teaching resource system realizes teaching resources and promotes the development of improving the efficiency of learning. The most convenient and effective way to share is to build a network resource management system. Through the construction of digital teaching resource in schools, through the demand analysis of the system, and the discussion on the architecture and functional modules, this paper designs in-depth details and realizes the construction of the system by using advanced design ideas and mature network development technology. The resource management system in schools has achieved the purposes of convenient maintenance, convenient data statistics, easy maintenance, simple and beautiful interface, efficient query and retrieval function, and so on. The development of college teaching resource is a systematic project, which integrates college teaching to the extent and realizes the sharing of teaching resource information. The whole development process mainly revolves around the system function module from demand analysis, system design, and system implementation. The resource management system in schools not only shares resources, but also provides a new teaching method, which can be used by more students, widens the access to learning resources, and improves learning efficiency. Finally, the digital teaching resource management system in schools runs stably and operates easily through the system test, which can teach and resource sharing in schools. The establishment of the system is more scientific for the management of teaching resources, reduces the labor intensity of human resources, improves the operation efficiency and has good practical significance.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there is no conflict of interest with any financial organizations regarding the material reported in this manuscript.

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Research Article

The Streamlined Study of Convolutional Neural Network for Wheat Growth Process Monitoring

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Monitoring the wheat growth process by machine vision with artificial feature extraction suffers from poor objectivity and low efficiency. To solve this problem, this paper introduces deep learning into monitoring the wheat growth process. The convolutional neural network (CNN) has been widely used in image classification as a common algorithm in deep learning. The application of deep feature extraction networks could automatically recognize and extract image features. However, the large number of parameters and computational overhead brought by regular deep CNNs make it difficult to apply these models to embedded devices with limited storage space and computing power. Therefore, the knowledge distillation method has been proposed for the feature extraction network of the target detection network to improve the performance of shallow feature extraction networks and ensure recognition accuracy while reducing the computational burden and model size. This paper took ResNet50 and MobileNet as two different teacher networks to guide the student model MobileNet for training. The experimental results showed that when ResNet50 was used as teacher model, MobileNet had the best recognition effect. The average recognition accuracy of the student model MobileNet was 97.3%, and the model size was compressed to only 19.71 MB, which is 88.9% smaller than that of ResNet50. Knowledge distillation improves the accuracy of the obtained model and reduces the number of network model parameters. Furthermore, it reduces the model running time and the cost of model deployment greatly. The application of the knowledge distillation method could provide further technical support for intelligent wheat production in the field.

1. Introduction

Wheat is the second largest food crop in the world. About 35%–40% of the world's population rely on wheat as their main food [1]. In China, the wheat planting area accounts for more than 70% of the arable land, and the winter wheat yield in Henan Province accounts for more than 25% of the total wheat yield in China. The stable and high yield of winter wheat in Henan Province is crucial to ensuring national food security. As one of the main bases of crop growth information, growth period information is widely used for automatically monitoring crops, such as farming activities in specific growth stages. At present, the acquisition of crop growth period information is mainly achieved by artificial observation. However, artificial observation is time-consuming, laborious, and prone to errors and will cause damage to crops. Using an intelligent method to monitor the growth period of wheat can greatly improve the accuracy and instantaneity of the observation results of wheat and reduce the input cost. Therefore, intelligent technology is urgently needed to solve the problem of monitoring the wheat growth process.

In recent years, machine learning methods have been extensively used in classification and regression problems and have also gradually been applied to the extraction of the crop growth period. However, these studies mainly focus on corn [2, 3], rice [4], cotton [5], and other crops that are relatively easy to collect and process. The research on the growth period of wheat is still in a preliminary stage. Zhang Mingwei et al. monitored the growth of winter wheat at the turning green stage and heading stage based on MODIS-EVI time-series data [6]. Huang Qing et al. monitored the growth of winter wheat using the MODIS-NDVI difference model [7]. Both methods need to construct a large number of

characteristic standards for each type of crop. Moreover, the workload is heavy, and the generalization ability is insufficient.

As a popular pattern analysis method in recent years, deep learning has been widely used in voice recognition [8], face recognition [9], image classification [10], behavior analysis [11, 12], and other industrial fields. In recent years, it has also been gradually applied to the agricultural field [13, 14]. Some researchers had applied deep learning to target detection of corns [15], fruits [16, 17], vegetables [18, 19], and other crops. Using image processing technology, Wu Qian realized automatic observation of three cotton growth periods [20]. However, this method only targets fixed cotton planting areas and fixed cotton varieties. The application of this method to other cotton planting areas and different cotton varieties will lead to errors. Yu Zhenghong used computer vision technology for automatic tests of the corn growth period [21]. Specifically, the seedling stage of corn was detected by spatial uniformity. Meanwhile, the probability model of the number of species and plants in the connected domain, the number of endpoints, and the probability of reaching the trilobal stage were established to the detect trefoil stage. Then, the coverage and canopy height were adopted as a base to determine whether the jointing stage had been reached. Finally, the male tassels were determined by detecting the tasseling stage of maize with spatio-temporal significance. Based on the image processing method, Wu Lanlan studied the classification of corn and weeds at the seedling stage in the field with complex backgrounds based on a support vector machine and a BP neural network [22]. This research provided technical support for the real-time weed identification system in the field. Although the performance of modern deep neural networks has been significantly improved, it is still necessary to extract feature structures from huge and redundant data during model training. In general, the real-time requirement is not considered, and the number of model parameters obtained by the final training is large. Due to the limitation of computing resources and delay, deep neural networks are difficult to apply in practice.

To address the above issues, different methods of model simplification have been proposed in recent years. Hinton et al. were the first to propose the method of knowledge distillation [23], whose core is to use the conventional teacher model of a deep convolutional network to guide a student model of the simplified network. Based on this method, this study uses the conventional ResNet50 [24] and VGG16 models as teacher models to guide the training of the simplified MobileNet model. Then, the trained model is applied for the first time to monitor the wheat growth period. Through knowledge distillation, the accuracy of the MobileNet model is improved, the number of model parameters is reduced, the running time of the model is greatly shortened, and the deployment cost of the model is decreased greatly.

2. Data and Methods

2.1. Data Material. The experiments of this study were conducted in the experimental area of the Xuchang Campus of Henan Agricultural University, Changge City, Henan Province (113°58'26"E, 34°12'06"N). The experimental area belongs to the continental monsoon climate of the north temperate zone, with an average annual temperature of 14.3 °C, annual rainfall of 711.1 mm, and a frost-free period of 217 days.

Due to the complex field environment, it is usually necessary to fix the camera equipment in the field and shoot at the same distance. Image collection was performed from October 2019 to June 2020. Three varieties of wheat, i.e., "Yumai 49," "Zhoumai 27" and "Xinong 509" were selected as experimental objects. In the wheat production in Henan Province, these three varieties of wheat maintain a planting area in the eastern and central Henan regions, and all of them are half-winter and have certain universality.

In the image collection process, groups of data at the density of 300 (about 300 plants per square meter), the density of 350, the nitrogen content of 15 (15 kg pure nitrogen per mu), and the nitrogen content of 0 (0 kg pure nitrogen per mu) were selected. Meanwhile, shots were taken every other day between 8 AM and 3 PM using a camera (Nikon D3100, sensor: CMOS, maximum aperture: F/5.6, 14.2 megapixels, maximum resolution: 4608 × 3072). A tripod was used for fixed height shooting, and all images were collected under natural light conditions.

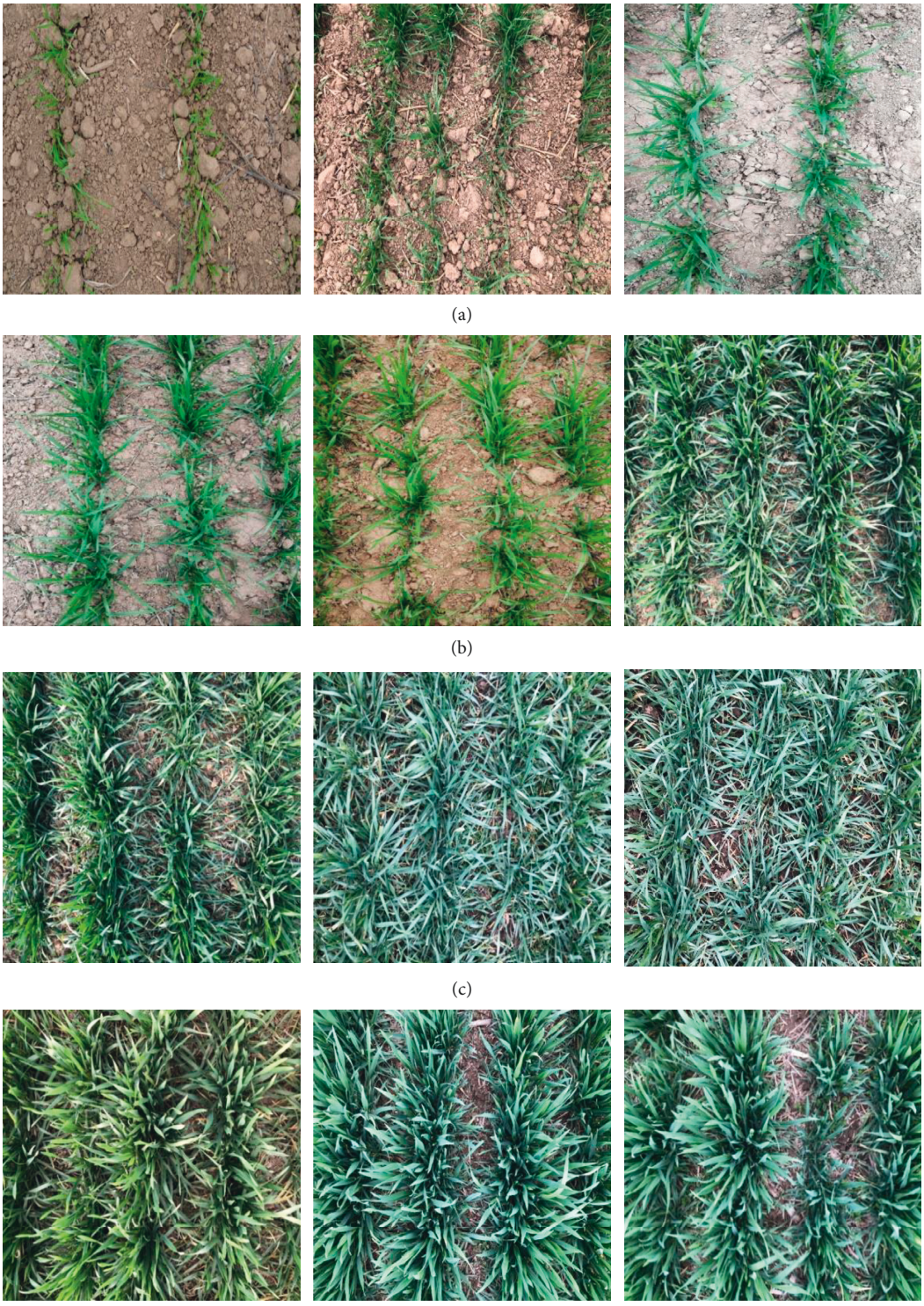
The effective accumulated temperature of winter wheat in the Xuchang station was adopted as a sample marker.

From the obtained image data, a total of 12750 images of wheat in five growth stages were screened, namely, the emergence-tillering stage (the first day of emergence to the day before tillering), tillering-overwintering stage (the first day of tillering to the day before overwintering), overwintering-greening stage (the first day of overwintering to the day before greening), greening-jointing stage (the first day of greening to the day before jointing), and jointing-heading stage (the first day of jointing to the day before heading). Some of the collected images are shown in Figure 1.

The images of five wheat growth stages were preprocessed. The resolution of the images of the wheat growth period collected by the camera was 4600 × 3070, and the size of an image reached about 16 MB. If such images were directly put into the model for learning, this would bring a great burden to the training of the model. Therefore, the image normalization operation was first carried out on the images of wheat in five growth periods by adjusting the image resolution.

All the images of the wheat growth period were collected under complex backgrounds. A lot of field background information unrelated to the wheat image could be found around the perimeter of the collected image. Therefore, the wheat images containing irrelevant information were clipped using the center clipping method, and then all images were uniformly scaled to a size of 224 × 224 × 3. Finally, the size normalization of all images was realized.

With the deepening of the calculation depth of the model, the number of parameters also increases gradually. If the size of the dataset does not reach a certain number, the model will be overfitted. The model often has high accuracy



(a)

(b)

(c)

(d)

Figure 1: Continued.

(e)

Figure 1: Some sample images of wheat canopy growth period. (a) Emergence-tillering stage. (b) Tillering-overwintering stage. (c) Overwintering-greening stage. (d) Greening-jointing stage. (e) Jointing-heading stage.

on the training set, but it cannot perform well on the test set. In this case, the generalization ability of the whole model will be very weak. To prevent the overfitting phenomenon, the method of increasing the amount of image data was adopted in this study. Generally, image translation, image scaling, image cutting, and other methods can be exploited to amplify the dataset. In this paper, the method of image rotation of wheat in five growth stages was selected to amplify the dataset. The method rotated the image by 90°, 180°, and 270° to increase the wheat image data from different angles.

In this way, the dataset of five wheat growth stage images was expanded threefold. Finally, the five types of wheat canopy image data were expanded into a total of 38250 balanced samples, including 16,050 pieces of "Yumai 49," 15,450 pieces of "Zhoumai 27" and 6,750 pieces of "Xinong 509." 20% of the samples were randomly selected in each wheat growth stage to form a test set. All the comparative experiments in this paper were completed on this dataset. The data sample distribution is shown in Table 1.

Table 1: Wheat canopy image samples.

Growth stage category	Number of training set samples	Number of test set samples	Total sample size
Emergence-tillering stage	6300	1350	7650
Tillering-overwintering stage	6300	1350	7650
Overwintering-greening stage	6300	1350	7650
Greening-jointing stage	6300	1350	7650
Jointing-heading stage	6300	1350	7650

2.2. Research Method. Knowledge distillation was first applied to the task of image recognition and classification. The core idea was to integrate the extracted knowledge and the capabilities of multiple models into a single model. It was generally believed that the parameters of the model retained the knowledge learned in the model training process. The commonly used transfer learning method was adopted to do pretraining on a large dataset. Then, the parameters obtained by pretraining were fine-tuned according to the task requirements and applied to the target data. The knowledge could be regarded as a mapping relationship between the input and output. In this study, a teacher network was trained firstly. Then, the output result q of the network was taken to train the student network. The output result p of the student network should be as close to q as possible. The loss function is expressed as follows:

$$L = CE(y, p) + aCE(q, p). \quad (1)$$

In the function, CE represents cross-entropy, y is the one-hot encoding of real labels, q is the output result of the teacher network, and p is the output result of the student network.

As conventional large convolutional neural networks (CNNs), both VGG16 and ResNet50 models can achieve good classification results in many classification experiments. However, due to the excessive number of parameters of the two models, huge resources will be consumed in the process of standard model operation, which brings too much burden to the operating equipment. To solve the problem that the model has too many parameters and cannot be run on devices with low computing power, deep separable convolution is adopted by MobileNet to reduce the size of the model greatly [25]. In this paper, standard VGG16 and ResNet50 models were used as teacher networks. To improve the identification accuracy of the MobileNet model at various growth stages of wheat, MobileNet was used as the student model to learn the knowledge of the teacher network.

In the knowledge distillation method, Hinton et al. proposed for the first time to use the generated soft (fuzzy) label to assist the normal label training [26]. Soft labels are the output of a softened teacher network. The specific method of softening is to add the parameter T to the output function Softmax of the teacher network. By adding the parameter T to enlarge the probability value of other categories of the soft label, the student network can learn information more comprehensively.

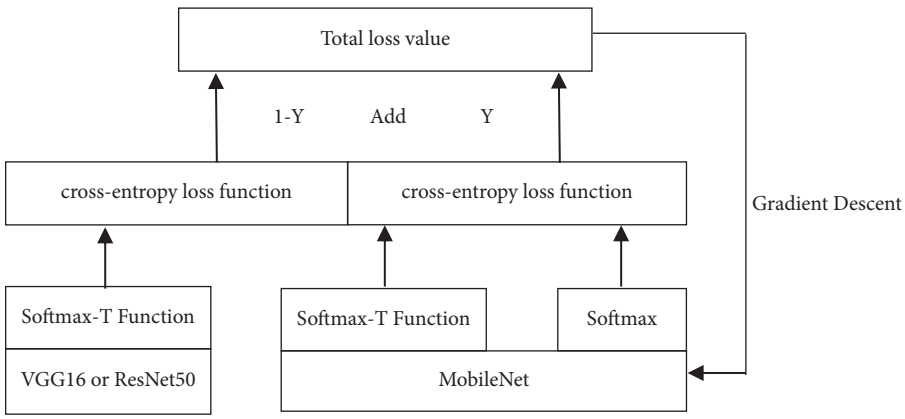


Figure 2: Flow chart of knowledge distillation.

The softening output function qi is shown in the following formula:

$$q_i = \frac{\exp(z_i/T)}{\sum_j \exp(z_j/T)}. \quad (2)$$

In the formula, z_i represents the learning object of the student network and is the logical output before the Softmax function of the convolutional neural network. The reason why parameter T was added is that the Softmax function is a steep curve, and the probability value of error classification would become extremely low after the output of the Softmax function, which would cause the student network to learn little information through the teacher network during knowledge transmission. A complex network can achieve a better classification effect. For a target image, the probability of correct output is much higher than that of error. However, this is not possible for a smaller network. Therefore, in this study, a parameter T was added to the small network Softmax. After the parameter T was added and a larger value was set, the output value would increase when the error classification passed through Softmax again, and the probability distribution of the output results would become more approximate, which is equivalent to a smoothing effect and plays a role in preserving similar information. When the same T value was used to train the small network, the target output would have a uniform distribution. At this time, if T was set to 1 again, the classification probability of a small network would be closer to the high recognition accuracy of a large network.

Knowledge distillation can transfer knowledge from one network to another, and the two networks will be isomorphic or heterogeneous. Meanwhile, knowledge distillation can be used to transform the network from a large network into a small network and retain its performance. The specific process is illustrated in Figure 2.

The basic steps of knowledge distillation are as follows:

(1) A large amount of data is used to train a large model with good performance, and the model is taken as a teacher network.

(2) The hyperparameter T is set and the student network is disaggregated using the pretrained teacher network. Firstly, $L(\text{soft})$ is obtained by the cross-entropy calculation of the prediction of the softened student network and softened teacher network. Then, $L(\text{hard})$ is obtained by cross-entropy calculation between the prediction of the student network without softening and the normal label. Finally, the two cross-entropy functions are trained according to the ratio α to form the final loss function. In this way, the teacher network and the student network can be trained together.

$$L = \alpha L^{(\text{soft})} + (1-\alpha) L^{(\text{hard})}. \quad (3)$$

(3) The trained student networks are classified using normal Softmax functions in the separate prediction stage.

3. Experiment and Result Analysis

The experiments were conducted on a personal computer equipped with Intel i7-8750H CPU, 16 GB main memory, NVIDIA GTX 1060 Ti GPU, and Windows 10 professional operating system. The code was written using the Keras package in Python.

3.1. Distillation Model Training Results. To ensure that the whole experimental process and results were reasonable and effective, all the hyperparameters of the experimental process were unified. 64 samples were selected for 1-time training, and the *L2* regularization term was set to 0.0005. To avoid the problem of fitting the model, the learning progress of the model was controlled at 0.001.

To ensure that the teacher model and the student model were the best models, the experiment compared three mainstream deep convolutional neural networks, i.e., VGG16, MobileNet, and ResNet50 in terms of the accuracy of growth stage identification, the model running time, and the number of model parameters under 3-channel 224×224 RGB images. Figure 3 shows the accuracy variations in the iterative process of these three models on the validation sets of five wheat growth stages.

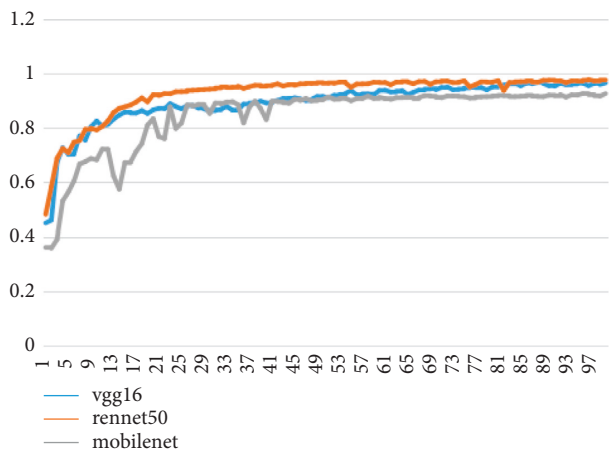


Figure 3: The training results of the three models.

Table 2: Comparison of accuracy of different network structures.

Growth stage category	VGG-16 (%)	ResNet50 (%)	MobileNet (%)
Emergence-tillering stage	95.6	96.8	94.2
Tillering-overwintering stage	95.1	96.4	95.2
Overwintering-greening stage	91.2	93.1	90.2
Greening-jointing stage	90.3	92.2	89.9
Jointing-heading stage	95.4	96.3	93.8
Average accuracy	93.5	94.9	92.6

It can be seen from Figure 3 that in the iteration process, the accuracy changes of these three models on the validation set at the wheat growth stage generally showed different characteristics.

Specifically, the accuracy of all these three models showed obvious jitters in the iteration process. For the lightweight model MobileNet, the accuracy on the validation set of the wheat growth stage was relatively low in the initial iteration process. As the training of the model proceeded, the overall accuracy showed a trend of gradual increase.

Table 2 illustrates the comparison of the accuracy of the three models on the validation sets. It could be seen from the table that the identification accuracy of all the three models was very high for the five wheat growth stages. In particular, for the wheat emergence-tillering stage, the classification accuracy reached 96.8%, and even for the greening-jointing stage, the classification accuracy reached 89.9%, indicating that the model was effective. Through the analysis of misjudgment data, it could be found that the misjudgment mainly occurred in the late period of each growth stage and the early period of the next growth stage. The main reason for the misjudgment was that the phenological characteristics at this time were not obvious.

To verify the influence of taking different depth network models as the teacher model on the accuracy of the student model, the experiment used VGG16 and ResNet50 as a teacher model to guide the training of the student model MobileNet. The recognition results of the two teacher models before and after knowledge distillation are shown in Table 3.

By comparing the experimental results before knowledge distillation and after knowledge distillation, it could be seen that the recognition accuracy of single wheat growth stage and the average recognition accuracy of wheat in these five stages after knowledge distillation of VGG-16 and ResNet50 was improved. Among them, the accuracy of the seedling stage was the highest, which increased by 1.5% compared with that before knowledge distillation. The average accuracy of the ResNet50 model for the five wheat growth stages was the highest, with an improvement of 1.2%. Both VGG16 and ResNet50 models were slightly more accurate in identifying wheat growth stages after knowledge distillation. Although the improvement effect was not obvious, it was an improvement based on the high accuracy of the two models in identifying wheat growth stages before knowledge distillation. The experimental results show that the knowledge distillation of VGG16 and ResNet50 was effective. Through the learning of the knowledge from the VGG16 and ResNet50 models, MobileNet gained some of the missing information, thus improving the accuracy of the model even more than that of the VGG16 and ResNet50 teacher models.

It can be seen from the experimental results that the recognition result of the model was related to the network depth of the model. When ResNet50 was used as the teacher network, the network identification accuracy of the student model MobileNet was the highest, indicating that the greater the network depth of the teacher model, the greater the influence on the student model, and the higher the accuracy of the final model identification result. When ResNet50 was used as the teacher network, the network recognition accuracy of the student model MobileNet was 98.3%. To see how much performance improvement could be brought to the model by knowledge distillation, the student model MobileNet was compared with the teacher models VGG16 and ResNet50 in terms of the recognition accuracy, the number of model parameters, the memory of the model, and the training time of the model. It can be seen from Table 4 that after knowledge distillation, the number of parameters in the VGG16 model was 43.4 times that of the MobileNet model, and the number of parameters in the ResNet50 teacher model was 9 times that of the MobileNet model.

The number of parameters of the model reflects the complexity of the model and directly affects the deployment of the model on devices with relatively little computing power. The model training time indicates that the convergence time of the student model MobileNet after distillation was about 20 h. The accuracy of the distilled VGG16 model and ResNet50 model was 94.8% and 96.4%, respectively. Compared with the conventional deep convolutional neural network model, the distilled MobileNet model could improve the accuracy slightly and greatly reduce the size of the model and the training time of the model, thus speeding up the convergence of the model.

Table 3: Comparative results of accuracy before and after knowledge distillation.

Growth stage category	VGG16		ResNet50	
	Before distillation (%)	After distillation (%)	Before distillation (%)	After distillation (%)
Emergence-tillering stage	95.6	96.1	96.8	98.3
Tillering-overwintering stage	95.1	95.9	96.4	97.1
Overwintering-greening stage	91.2	92.1	93.1	94.8
Greening-jointing stage	90.3	91.9	92.2	93.1
Jointing-heading stage	95.4	96.4	96.3	97.3
Average accuracy	93.5	94.8	94.9	96.1

Table 4: Comparison of model performance with and without knowledge distillation.

Model	Number of parameters	Model size (MB)	Training time (h)	Accuracy rate (%)
MobileNet-distilled	1332300	19.7	20	98.3
ResNet50-undistilled	27941515	102.4	45	96.4
VGG16-undistilled	134289477	512.3	73	94.8

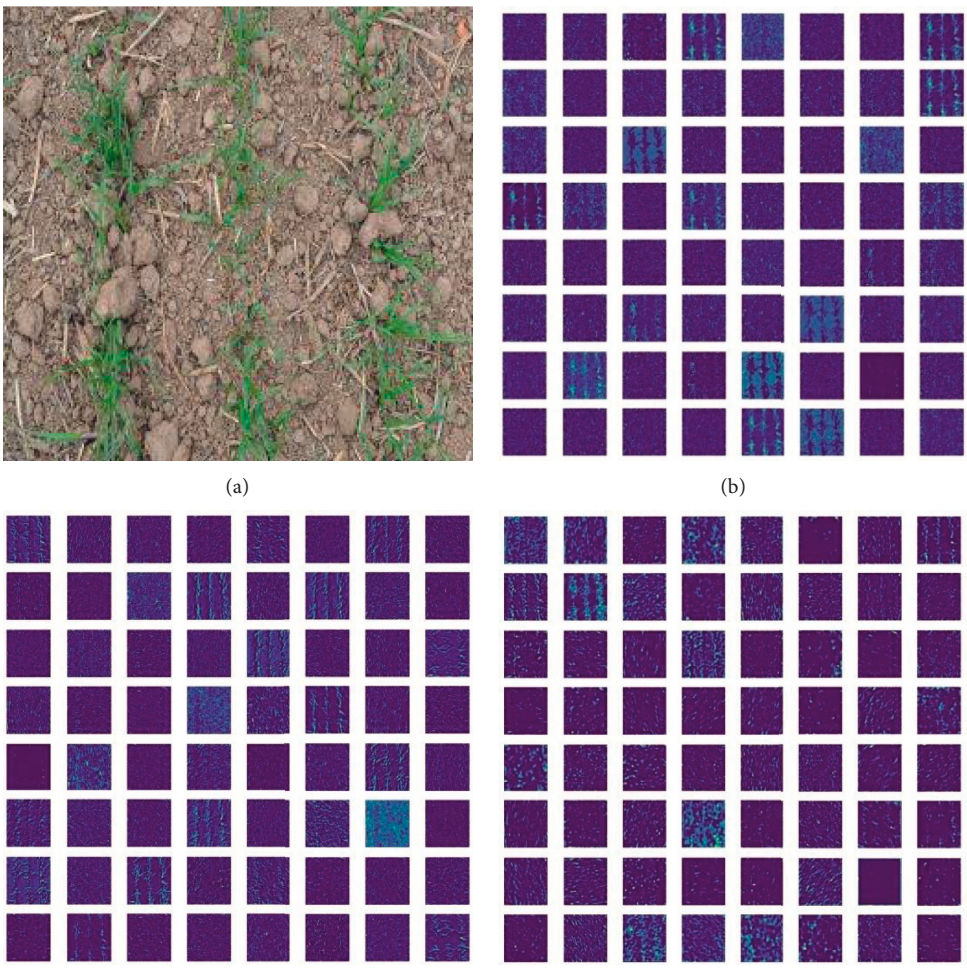


Figure 4: Continued.

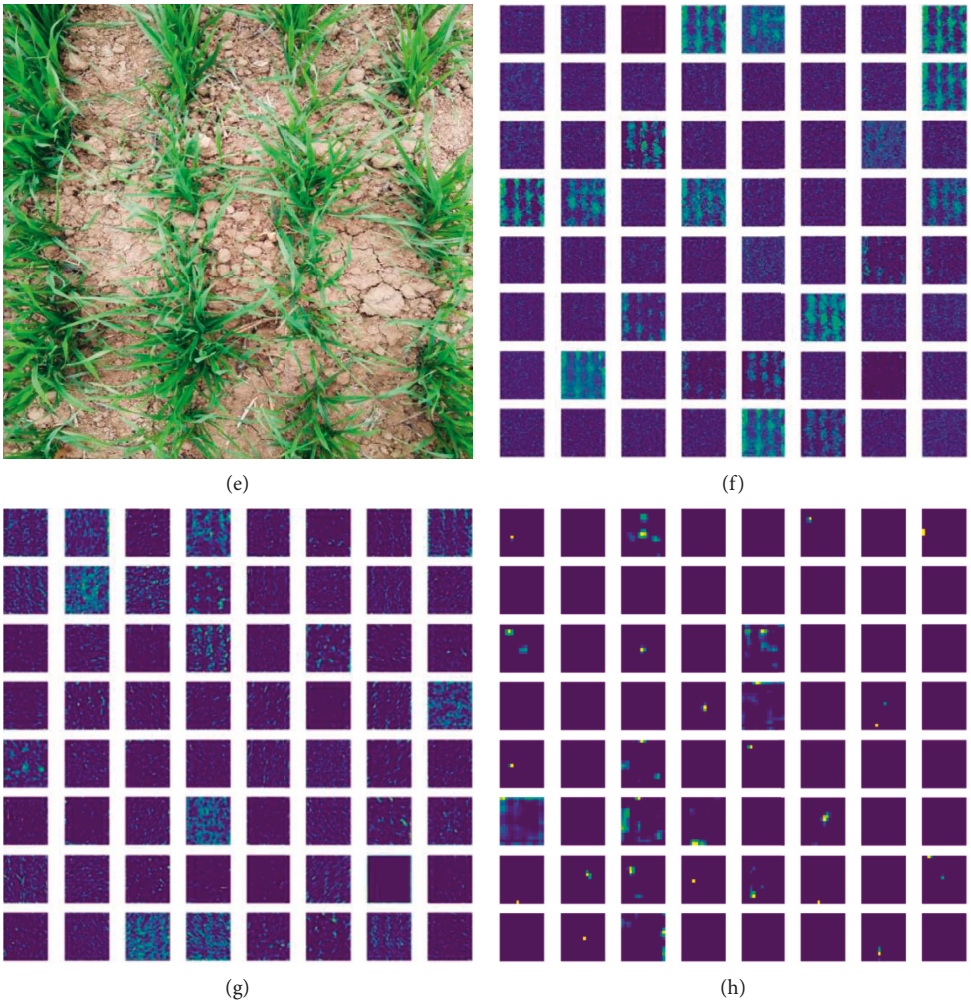


Figure 4: Visualization results of several wheat growth period characteristic images. (a) The original image. (b) The first layer of convolutional network output. (c) The third layer of convolutional network output. (d) The fifth layer of the convolutional network output.

3.2. Visualization Results of the Feature Image. By feature visualization of the convolution layer in the teacher network, the running process of the model could be better understood. The convolutional layer was selected from a shallow layer to a deep layer for visualization, and the results are shown in Figure 4.

The front convolution layer of neural network is a shallow convolution layer, and the back convolution layer is a deep convolution layer. The two layers focus on different emphases. In Figure 4, each small graph is visualized by different convolutional layers in an increasing order from the shallow layer to the deep layer. It can be seen from the figure that the shape of the image becomes less obvious. This is because the features extracted from the shallow convolution layer emphasized texture and detail information, and the basic shape of the object can be clearly illustrated. As the number of layers increases, more abstract features are extracted and more transformation operations are performed to describe an object more comprehensively. Generally, the deeper the layers, the more representative the extracted features. Through the visualization of the network [26], the focus of the network on object recognition can be better understood. The brighter the image, the more obvious the features.

4. Conclusion

To address the problems of huge model parameters and long model training time of neural networks, this paper proposes to use knowledge distillation technology to establish a classification model to identify five different wheat growth periods. The main conclusions are as follows:

(1) The standard CNN models VGG16 and ResNet50 and the lightweight CNN model MobileNet were used to predict the wheat growth periods on the test set. The average accuracy of these models was 93.5%, 94.6%, and 92.6%, respectively, which indicates that the convolutional neural network is feasible and efficient for wheat growth periods and recognition.

(2) When ResNet50 was used as the teacher model, the accuracy of the student model MobileNet was

improved to 98.3%. Then, the trained student model MobileNet was evaluated by the accuracy of wheat single growth periods, the number of model parameters, the memory occupied by the model, and the time spent in the model training. The results showed that the average accuracy of the MobileNet model after distillation was 97.3%, the number of model parameters was only more than 1.3 million, the model size was compressed to only 19.7 MB (88.9% smaller than that of ResNet50), and the operation convergence time of the model was only 20 hours (only half that of the teacher model). The model after knowledge distillation has high accuracy and can meet real-time performance requirements.

(3) Knowledge distillation can make the accuracy of a small model close to that of a large model, thereby greatly reducing the number of parameters, model size, and running time of the identification model of wheat growth periods. Based on this, the trained model is easy to deploy and run on equipment with low computing power, which provides technical support for intelligent wheat production in the field.

Data Availability

Due to the limitations of the funded projects, the research data related to this study are not suitable for public sharing at present. When the project is completed, relevant research data can be provided.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Acknowledgments

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Retraction

Retracted: Life Prediction Model of Wooden Structure Based on Artificial Intelligence Algorithm

Mobile Information Systems

Received 8 August 2023; Accepted 8 August 2023; Published 9 August 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] N. Cao, "Life Prediction Model of Wooden Structure Based on Artificial Intelligence Algorithm," *Mobile Information Systems*, vol. 2022, Article ID 3591967, 10 pages, 2022.

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Research Article

Life Prediction Model of Wooden Structure Based on Artificial Intelligence Algorithm

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The ancient wooden structure in China is a precious architectural cultural heritage in history, which has high cultural and artistic value. However, due to the influence of its own material structure and the long-term preservation and maintenance process, due to long-term loads, earthquakes, fires, man-made damage, etc., ancient buildings have suffered more or less damage, which may cause sudden failure of the structure, which seriously affects the safety of the building structure. Therefore, the research on the prediction of the life of ancient wooden structures has guiding significance for sustainable development. This paper studies the life prediction of ancient buildings and introduces artificial intelligence algorithms. By comparing the old and new of the ancient building with the damage of the various structures of the ancient building, and using a variety of methods to find a more accurate method to predict the life of the ancient building, through various aspects of research and comparison, we have discovered the variation of wooden columns and beams. The coefficients are 22.97% and 22.54%, which affect the service life of wooden members. The residual strength ratios of the compressive design strength and flexural design strength of the new material and the old material are 60.42% and 26.67%, respectively.

1. Introduction

Ancient Chinese wooden structure has a very important position in the history of Chinese cultural development and architecture. It is a vivid teaching material for people's education patriotism, socialism, national tradition, and revolutionary tradition. In particular, some ancient buildings have become symbols of cities and culture. The ancient wooden structure to a large extent shows the development characteristics of architectural culture, art, and technology. At present, many ancient wooden structures are an important part of China's outstanding and valuable cultural heritage, which not only has high academic value but also is closely related to the people's growing spiritual and cultural needs. Architecture reflects the technological and scientific level of an era, it faithfully reflects people's past lives, and is a nonrenewable resource, so it has a high social and cultural value. If these precious cultural heritages are not protected as soon as possible, they may suffer devastating damage. Preventing and eliminating the damage to ancient buildings and delaying the progress of damage in a targeted manner are important issues that need to be solved urgently. Robots are the crystallization of artificial intelligence, but their applications in the prediction of the life of ancient wooden structures are few and far between. For the management of major wooden structures, it is a very important and meaningful work to scientifically and effectively predict the service life of wooden ancient buildings. This paper uses artificial intelligence algorithm to study the service life of wooden structures, which has a certain innovation. The research of this paper can be widely applied to the monitoring and prediction of settlement of ancient buildings, the prediction of changes in physical properties of wooden structures of ancient buildings, and other related archaeological problems.

Many people have studied ancient architecture. Zhang research found that Huizhou architecture is one of the four ancient architectural schools in China, with wood as its core. Accurately predicting the timber life of Huizhou buildings is of great significance for protecting ancient buildings. At

present, there is little research on Huizhou architecture. Elman neural network is a typical multilayer dynamic recurrent neural network, which has the function of mapping dynamic characteristics by storing internal states, so that the network has the ability to adapt to time. Variation characteristics can be used to predict complex nonlinear time-varying systems. The basic Elman neural network is slow to train and tends to reach a local minimum. Therefore, a particle swarm optimization algorithm using an adaptive mutation operator is used to improve the basic Herman neural network. The algorithm optimizes the weight of each layer. By improving the network, training values can be fitted more accurately and test values can be effectively predicted. Simulation results show that the network structure can be applied to life well. Span prediction of Huizhou buildings [1]. FX shows its abstraction through the research of artificial intelligence. Unlike in the past, current buildings are denser, resulting in reduced horizontal ventilation. However, high-density environments still offer opportunities to control solar radiation by providing shadows on-site and within the building. Traditional buildings use climate as a morphological modifier. Social and cultural aspects influence architecture, and as a result, local materials have evolved as part of modern architecture in urban areas. With surviving buildings in the largest cities, this study provides new vitality to the environmental changes in Surabaya as a lowland region and Malang as a highland region. A field study was conducted to identify and evaluate the actual condition of the building envelope surface through daily measurements. Infrared thermometers are used for on-site measurement of surface temperature. In addition, hygrometers are used to check the moisture content of materials, and solar power meters are used to check the surrounding solar radiation. The results of this study show that lowland houses have better material performance in climate control by reducing extreme conditions than highland performance. Overhangs and terraces as transition spaces can significantly reduce the amount of daily radiation, exceeding 1500 W/m^2. Generally, the problem of tropical houses is not only due to the frequency of receiving solar radiation penetration but also due to insufficient shielding of building materials [2]. Levin research found that AI-centric transhumanism and the large-scale data collection and surveillance pursued by commercial and government entities share core characteristics. That is, knowledge is informational in nature, technology is value-neutral, and ethical challenges can be technical procedural terms. In this article, I mainly focus on the manifestation of these characteristics of the latter in the whole society. Here, the critical uses that lead to technology-process change in data practice are limited because they create the illusion of basic progress, while retaining questionable assumptions about knowledge and value intact. Because the closest things are the hardest to collect, if we see them operating in a completely different and surprising environment, we might be able to more easily discern these assumptions. Ancient rhetoric embodies our version of three factors. Plato's critique of rhetoric and his philosophical methodological aspects can help us understand why we should refute the increasingly popular view of knowledge and values—but otherwise. [3]

In this paper, through the investigation and study of ancient wooden buildings, through a comparative study of all aspects of the building and the introduction of multiple methods of artificial intelligence, the structural reliability assessment and remaining life prediction of the wooden ancient buildings are conducted. Preservation has a positive effect. It can not only repair and renovate ancient wooden structures in a timely manner but also reduce the occurrence of hidden safety hazards and leave valuable cultural heritage for future generations [4]. Therefore, how to better protect ancient buildings is of great significance.

2. Proposed Method

2.1. Prediction Method of Remaining Life of Structure. The current methods for predicting the remaining life of structures generally only consider a few key factors among the various influencing factors, and the prediction methods will involve multiple disciplines. The factors affecting the service life of ancient wooden buildings mainly include physical, chemical, and biological aspects. Due to various factors, it is difficult to quantify the remaining service life of ancient wooden structures, so the prediction process is relatively complicated. For the prediction method of the remaining life of the structure, experts and scholars at home and abroad have proposed the following aspects [5, 6].

(1) Empirical prediction method: This method is mainly related to the researcher's experience, knowledge level, and prediction results. It is based on the results obtained by a large number of sites and laboratories and related experience and knowledge accumulation. Life is semi-quantitative to reason about predictions. Therefore, it is highly subjective.

(2) Residual life prediction method considering economic risk optimization: Considering the costs of detection, reconstruction, or expansion in the whole life cycle of the structure, conditional reliability and failure rate functions of existing structures, combined with optimization theory, are used to predict the remaining life of the structure [7].

(3) Theoretical prediction method of structural reliability: This prediction method is based on the principle of structural resistance gradually declining with time, and based on the non-stationary random process of the structural cross section, the relationship between structural reliability and time is established to calculate the structure reliability, the remaining life of the structure is the bearing capacity life of the structure minus the useful life of the structure, which is the remaining life of the structure. This method for predicting the service life of a structure is more reasonable.

(4) Structural durability prediction method: This prediction method uses the gray correlation as the standard, and divides the durability of the structure into two indicators: the degree of deterioration indicator and the rate of deterioration indicator. The

structure is evaluated at multiple levels and changes over time. The relationship of the structure deteriorates, and the remaining life of the structure is obtained [8, 9].

There are few algorithms for predicting the life of wooden ancient buildings, mostly focusing on the cumulative damage model of wooden structure, finite element analysis model, and BP neural network. In recent years, some experts and researchers have adopted intelligent methods such as neural network method, fuzzy method, and dynamic analysis method to predict the remaining life of the structure, and have achieved some important results, but further research is needed.

2.2. PLSS Measurement Method. In practical applications, because the relationship between the dependent variable and the independent variable is usually not linear, there is a complex nonlinear relationship between them. Traditional PLS is only suitable for linear models, which will cause large deviations in practical applications. The PLSS algorithm is a spline transform added to the PLS algorithm. The spline function is constructed using the idea of piecewise fitting. Its advantage is that it can be cut as needed to adapt to the continuous change of any curve. Spline functions are smooth and continuous [10, 11].

Collect independent and dependent variables [A, Y], and perform spline transformation on independent variable A to transform nonlinear problems into quasi-linear problems in high-dimensional space. The model uses a cubic B-spline function as the basis for the transformation.

$$\Omega_3\left(\frac{A_j-\xi_{j,l-1}}{h_j}\right)=\frac{1}{3!h_j^3}\sum_{k=0}^{4}(-1)^k\binom{4}{k}\left(a_j-\xi_{j,l-1+k}\right)^3. \quad (1)$$

Among them, $\xi_{j,l-i}$ are the added insertion points for partitioning variable x_j; h_j is the segment length for partitioning variable A_j.

The minimum observation value of the variable x_j is min (A_j), and the maximum observation value is max (x_j).

$$\xi_{j,l-1}=\min\left(a_j\right)+(l-1)h_j,$$
$$h_j=\frac{\max\left(a_j\right)-\min\left(a_j\right)}{M_j}, \quad (2)$$
$$\left(l=0,1,\ldots,M_j+2\right).$$

Among them, M_j is the number of segments divided for the variable A_j. The nonlinear function relationship between all independent variables and dependent variables is

$$y=\beta_0+\sum_{j=1}^{p}\sum_{l=0}^{M_j+2}\beta_{j,l}\Omega_3\left(\frac{a_j-\xi_{j,l-1}}{h_j}\right)+\varepsilon. \quad (3)$$

Among them, y has a linear relationship with $\Omega_3(x_j-\xi_{j,l-1}/h_j)$, which can be transformed into a quasi-linear regression model. Each dimension x_j is subjected to three B-spline transformations $x_j \longrightarrow Z_j$, and the original variable space (A, Y) is transformed into (Z, Y).

Use the new independent variable and dependent variable (Z, Y) to predict the PLS algorithm and find $\hat{y}$.

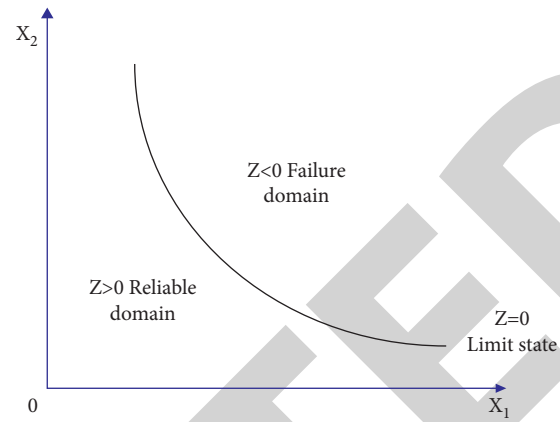

Figure 1: Working status corresponding to function.

2.3. Building Limit State. The limit state of a structure refers to a state in which the structure cannot be used normally, which mainly means that the overall structure or a part of the structure exceeds its prescribed bearing capacity [12]. The factors that affect the reliability of the structure include material strength, calculation mode, and load effect. These factors can be expressed as random variables. If $X_1, X_2, \ldots, X_n$ represents the basic random variable of the structure, the function of the structure is used to describe the function of the structure's working state, which is expressed as:

$$Z=g\left(X_1,X_2,\ldots,X_n\right)\begin{cases}<0, \text{Failurestate},\\ =0, \text{Limitstate},\\ >0, \text{Reliablestatus}.\end{cases} \quad (4)$$

$Z=g(X_1,X_2,\ldots,X_n)$ is called the limit state equation of the structure [13, 14]. Figure 1 shows the working state of the structure in a rectangular coordinate system:

From the perspective of structural reliability, the factors affecting structural reliability can be divided into two random variables: structural resistance R (the ability to deform the structure or the ability to resist damage) and load effect S (the deformation caused by the load effect, internal force, etc.) At this time, the structure function can be expressed as:

$$Z=R-S\begin{cases}<0, \text{Failurestate},\\ =0, \text{Limitstate},\\ >0, \text{Reliablestatus}.\end{cases} \quad (5)$$

2.4. Wooden Frame Structures of Ancient Buildings. One of the most remarkable features of the ancient Chinese wooden structure is the tenon-and-mortise connection between the beams and columns. The ingenious tenon-and-mortise connection method does not require a nail or an iron, and is

unique in that it shows strong semirigid connection joint characteristics. It has a history of thousands of years in China. The tenon is usually inserted into the column about half the diameter of the column. The tenon connection can withstand a considerable bending moment. The wooden tenon that was common in ancient building repairs breaks along the vertical plane [15, 16]. On the other hand, the tenon-and-tenon joint weakened the cross section of the wooden members, which reduced the bearing capacity at the nodes. However, the material tolerance in the ancient building structure was extremely large, so the flexibility of semirigid joints was fully utilized. The drop connection not only changed the characteristics of the structure but also absorbed part of the energy from the deformation during the earthquake, reducing the seismic response of the structure [17, 18].

The tenon-and-mortise structure has many forms. From the perspective of mechanical properties, it is divided into straight and dovetail. Dovetails are usually used at the top of the tower, and straight tenons are usually used in the tower.

The dovetail structure can withstand both tensile and compressive forces. The beam with a straight tenon structure can withstand the pressure under the limit load, but because it is only inserted into the rectangular hole in the middle of the cylinder, it can withstand only a tenon. Maximum friction is there between the column and the pores of the column. When the tensile force exceeds the maximum friction force, the tenon will be pulled out [19]. Due to the pullout, there is a large relative movement between the structural members. This movement changes the integrity of the structure on the one hand and the internal force distribution of the structure on the other. Another ideal aspect of this structure is that under the action of dynamic loads such as earthquakes, the resulting structural looseness and friction between components will absorb a large amount of energy, which can improve the seismic resistance of the structure [20, 21].

The combination of the tenon of the beam and the cymbal of the column can not only withstand large pressure and small tensile force but also withstand a certain bending moment, and the bending moment will generate a certain secondary stress. This secondary stress will include both bending moment stress and shear stress that are stored simultaneously. In general, the bending moment stress is mainly considered [22, 23]. In addition, secondary stress also includes axial stress. This axial secondary stress is very small compared to the initial stress and can be ignored during calculations. The reason for the secondary stress is that when the tenons are combined, the tenons have a certain length when they are embedded in the tenons. This restricts the beam from rotating around the cylinder, which creates bending moments. Therefore, the node can be simplified into a variable stiffness element with certain stiffness in the calculation and added to the finite element program for calculation [24, 25].

When the wooden structure is not subjected to horizontal forces, the beams of the lower frame are unstressed, and the vertical load is borne by the columns. In the initial phase of the horizontal load, the tenon begins to engage and the structure shows a small amount of slip. At this stage, the tenon can be regarded as articulated. Continue to load, the mortise begins to be affected by shear and bending moments, and the structural strength increases until the yield load and the mortise is firmly connected. Continue loading to the limit load. The two ends of the column are connected to the tenon head, that is, the column and the foundation stone, and the top of the column and the bucket arch are pulled up or even detached. At this time, although the beam-column joint tenon is misaligned, it does not come out. Therefore, according to the working condition of the hoe under the horizontal load, the load-displacement curve of the wooden structure can be obtained as shown in Figure 2.

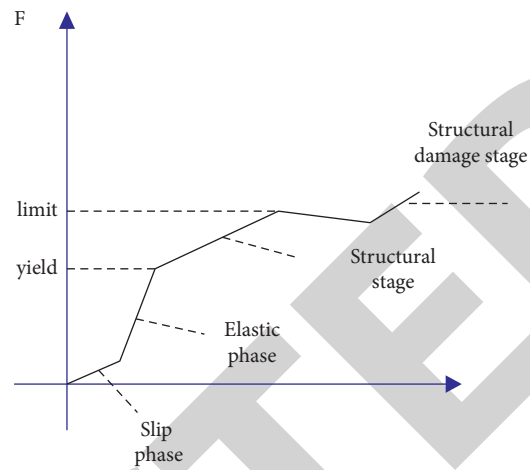

Figure 2: Structure F-δ curve.

Structural damage is mainly caused by the insecure connection between the two ends of the column, disengagement, and weakened structural integrity. Therefore, as long as the two ends of the cylinder are strengthened, certain measures should be taken at the same time so that the hoes connected by the beam and column will not fall under the most unfavorable conditions. Strengthen the connection between various components, improve the structural rigidity, and give full play to the mechanical properties of the material, and then improve the bearing capacity of the structure, as shown by the dashed line in Figure 2. Eventually, the destruction of the structural material is destroyed.

The connection between the straight tenon and the column is mostly a semirigid connection. When the tenon is deformed, the axial deformation caused by the axial force of the tenon is nonlinear. It can be considered that elasticity is not a decrease in material properties. Except for the maximum static friction, the internal force of the beam formed by pulling out the tenon and the displacement of the beam including both ends of the tenon are similar to the ideal elastoplastic yield curve due to geometrical reasons. This relationship means that the relationship between the axial force of the beam and the relative deformation of the mortise is nonlinear, as shown in Figure 3.

2.5. Calculation Methods for Different Wooden Beam Characteristics. For ancient wooden beams, the above-mentioned constructor function method is only a macro

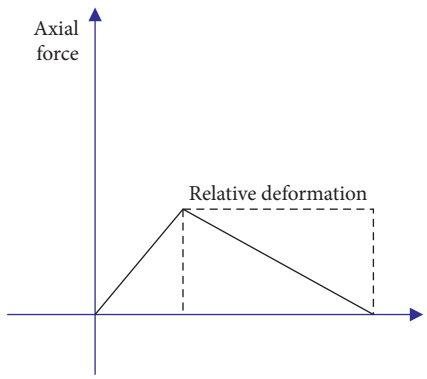

Figure 3: Relationship between beam axial force and relative deformation of camphor.

concept, and the following factors have not been considered specifically. First of all, the boundary conditions are different: wood structure beams and columns are connected by mortise and tenon, and the two ends of the wooden beams are semirigid bearings. The boundary conditions are between simple supported beams and fixed beams. Partial settlement at the beam support is prone to increase the deflection value; the third material is different: due to the existence of wood knots and other defects, the ancient process retains the irregularity of the log beam section; the fourth constraint is different: the wooden beam belonging to a single-span beam, the maximum deflection in the span has become a concern. In the following, the influence of the above four factors on the method of deriving the deflection of a wooden beam based on strain is studied.

In theory, simply supported beams have no bending moment under external force, but there are bending moments at both ends of non-simple supported beams. The existence of such bending moments causes the structure's strain distribution to change at the beam section, changing the deflection value. However, the tenon joint between the beam and the column in the traditional wooden structure belongs to the semirigid support of the nonrigid beam, so the bending moment of the support must have a certain effect on the deflection. From the perspective of mechanics, considering the semirigid bearings, the applicability of the combination of strain measurement and construction function method to the measurement of deflection of wooden beams is studied. Semirigid bearings are a kind of beam between simple support and fixed connection, so it is difficult to quantitatively determine the deflection equation theoretically. Therefore, the total strain of the beam can be divided into the strain due to the load and the strain due to the equivalent additional bending moment of the semirigid bearing, as shown below.

$$\Delta\varepsilon = \Delta\varepsilon_v + \Delta\varepsilon_F, \tag{6}$$

where $\Delta\varepsilon$ is the total strain, $\Delta\varepsilon_v$ is the strain generated by the equivalent additional bending moment of the semirigid bearing, and $\Delta\varepsilon_F$ is the strain generated by the load.

For simple supported beams, the settlement of the support will not cause the internal force of the beam to change. For members with semirigid supports at both ends, the beam's ends will generate additional bending moments, which will cause strain. However, according to the above, the additional strain of the beam body caused by the additional bending moment of the bearing may be included in the additional strain generated at the bearing, that is,

$$\Delta\varepsilon_F = \Delta\varepsilon_{\text{Load}} + \Delta\varepsilon_{\text{settlement}}. \tag{7}$$

The superimposed strains of bearings and loads are superimposed according to the same function form, and the calculation of the transformation of strain into deflection can be realized. However, the deflection value caused by the settlement of the support not only includes the strain but also the displacement. The algorithm only considers the deflection value caused by the strain, that is,

$$\omega(x) = \omega(x)_\varepsilon + \omega(x)_\Delta, \tag{8}$$

where $\omega(x)_\varepsilon$ represents the deflection due to strain, and $\omega(x)_\Delta$ represents the deflection due to settlement displacement.

In order to make the coefficients of the constructor function available through the strain solution, it is necessary to ensure that the unknown coefficients after the derivative do not disappear.

$$\omega(x) = A(x)\sum_{i=1}^{k} X_i g_i(x). \tag{9}$$

Equation (9) only represents the deflection ω_ε caused by the strain, and on this basis, ω_Δ can be linearly superimposed according to the proportional relationship between the settlement values Δ_l, Δ_r of the bearings at the left and right ends, that is,

$$\omega(x)_\Delta = \frac{l_2 - x}{l_2 - l_1}\Delta_1 + \frac{l_1 - x}{l_1 - l_2}\Delta_r. \tag{10}$$

Finally, the form of the deflection structure is obtained as follows:

$$\omega(x) = A(x)\sum_{i=1}^{k} X_i g_i(x) + \frac{l_2 - x}{l_2 - l_1}\Delta_1 + \frac{l_1 - x}{l_1 - l_2}\Delta_r, \tag{11}$$

where l_1 and l_2 are the lengths from the beam boundary (when l_1 is 0, l_2 is the beam length).

2.6. Deformation of Compression Members

2.6.1. Deformation of Pillars. In ancient Chinese architecture with wooden frames as the main body, wooden columns were the main load-bearing members. Depending on the position of the pillar, its load varies greatly. For example, the inner gold pillars and the middle pillars have larger loads than the eaves pillars, but the load on the various pillars is grain pressure. From the perspective of the damage of the pillar, it can be divided into several types of damage: the stigma, the root, and the entire shaft.

Stigma under pressure: the long-pressed wood pillar often splits into several petals along the grain at the stigma. What is more, the cracked part rises beyond the diameter of

the column. In this case, the gold column in the top layer of the Yingxian wooden tower is the case where the cracked part appears under pressure.

Roots are rotten: the roots of ancient buildings easily rot due to prolonged humidity or rain. The wooden pillars are wrapped on the wall, and the roots of the wooden pillars are more susceptible to decay. The wooden pillars are corroded into jujube nuclei, and the surroundings of the wooden pillars become powdery substances. Both the eaves and the center pillar of Jingqingmen are this phenomenon. The root of the Jingqingmen pillar rotted, causing the pillar to sink. Another type of looming pillar that was not enclosed on the wall was eroded by wind and air temperature and corroded into grooves along the wood grain. This phenomenon also appeared on the outer eaves of the second-level flat tower of Yingxian wooden tower. It even erodes a stump to make it thin, but it is relatively rare that the stump is compressed and split.

Pillar splitting: early wooden buildings did not use ground rods, and all wooden components were exposed. Affected by various factors in nature for a long time, the cylinder will be split to different degrees. Some extend from the stigma at the stigma to some stumps, and some extend upward from the stumps. The fissures sometimes crack at multiple locations on the pillar and reach one centimeter, approximately the diameter of the pillar. The occurrence of cracks will inevitably affect the bearing capacity of wooden columns. The destruction of the wooden pillars was mainly due to compression along the grain.

2.6.2. Deformation Bucket of Bucket Arch Member. The function of the arch is to transmit the load of the tile roof and the beam frame to the column, so it is a group of complex members with complex forces. It is composed of a number of arches, hangs, warps, and buckets, which transfers the load to the stigma. In the process of force transmission, it is often cracked or broken at the intersection of arch and warp. The most common is the phenomenon of large buckets or interactive buckets splitting under pressure. The stigma and corner bucket arch are also easy to split due to the concentrated force, but the damage of the arch is mostly caused by the compression of the horizontal stripes.

2.6.3. Deformation of the Beam. Girder deflection: beams and hangs in ancient buildings are upper load-bearing members. Due to long-term load, beam bending is a common deformation in ancient buildings. This is the case in the Sanqing Hall of Yongle Palace, and the main hall of Chongfu Temple and Nanchan Temple in Shuoxian County has beam bending.

Beam splitting: cracks also occur in the beams of ancient buildings. One case is cracks around ill knots and turbines. Second, the internal stress of the beam is complicated. Under long-term stress, the strength of the wood gradually decreases, and these parts are also prone to damage.

Splitting of components such as beam: rafter, and crossbeam, which has a small cross section, has been subjected to long-term cleavage or bending deformation, which is more common in ancient buildings. Crossbeam is a member that is both compressed and tensioned. Crossbeam is a compression member that bears the load transmitted by the tween arch. Rafter acts as a ring beam at the intersection of the stigma and is also subject to a certain amount of tension. In another case, due to the long-term compression, the fracturing phenomenon along the wood grains in the middle or end of the poppet poplar, or the diagonal cracks occurred, which indicates that the compressive strength of the transverse grains was reduced and the damage occurred.

3. Experiments

3.1. Test Object. China's ancient architecture has been passed down for more than 7,000 years. It has always maintained an independent structural principle and has been recognized by future generations. It is an important cultural heritage protected by China's Cultural Relics Bureau. A proud treasure, but after many years of preservation, the ancient wooden structures that have gone through vicissitudes are destroyed by humans and natural forces to varying degrees. For example, the famous Mogao Grottoes in Dunhuang at home and abroad is a good representative. Due to the influence of natural environment and engineering geology, and the rapid development of industry and tourism in recent years, environmental pollution has caused many impacts. This article compares the old and new structures of ancient buildings with the damage of various structures of ancient buildings, and uses a variety of methods to find more accurate methods to predict the life of ancient buildings, and have better prevention and correction of ancient buildings.

3.2. Design and Implementation of Experiments. This article compares new and old materials through experiments, finds the difference between old and new wood through comparison, and predicts the life of wood and buildings through the time of wood. And through different prediction methods, it finds a more accurate prediction method, and by using artificial intelligence makes predictions more accurate and accurate. This article also conducts experimental comparisons of various parts of ancient buildings, and finds the useful life of different parts through comparison to make the prediction and research of ancient buildings more specific and accurate. It is hoped that the research and investigation of this article can promote the protection of ancient buildings in China and make them better protected.

4. Discussion

4.1. Comparison of Compressive Strength and Flexural Strength of Old and New Wood. The statistical results of the experimental data of the compressive strength and flexural strength of the old and new materials are shown in Figure 4. Through comparison, it can be found that the average values of the compressive strength and flexural strength of the old materials are significantly lower than those of the new materials, indicating that the after about 350 years of service, the material properties of ancient wooden components have deteriorated severely. The coefficient of variation of the

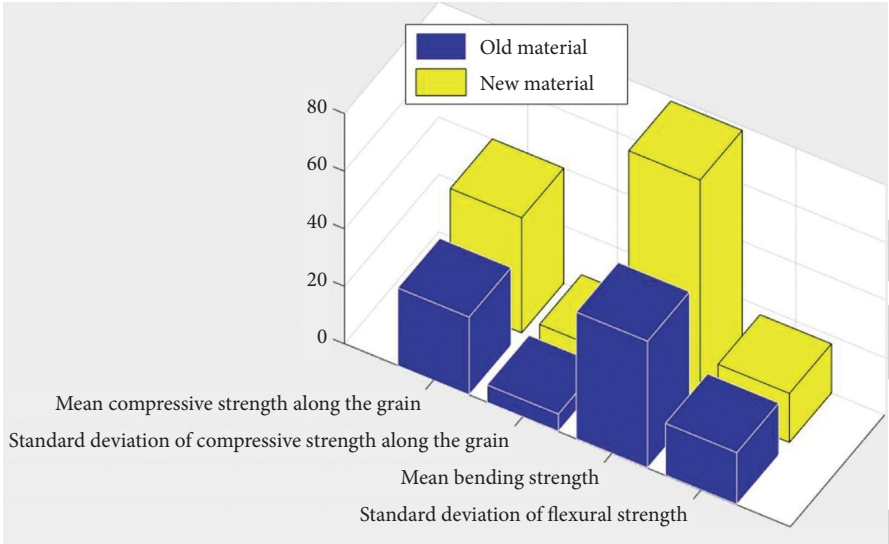

Figure 4: Comparison of old and new wood.

Table 1: Design strength of new and old materials.

Index	Design value of compressive strength along the grain (MPa)	Design value of flexural strength (MPa)
Old material	14.5	8
New material	24	30
Residual strength ratio (%)	60.42	26.67

index of compressive and flexural strength of the old wood is obviously lower than that of the new wood, indicating that in the long service history of the component, the wood in different parts is in different environments, and the degree of material strength degradation is different, and the influencing factors. Uncertainty leads to an increase in the dispersion of the test intensity index.

Due to the large variability of the test results, in order to ensure the reliability and safety of the analysis results in the evaluation of the bearing capacity of wooden members, various mechanical performance indicators of wood need to be converted according to a certain guarantee rate. The design strengths of the tested old and new materials are shown in Table 1. Compared to the new materials and old materials, the residual strength ratios of the compressive design strength and flexural design strength of the new material are 60.42% and 26.67%, respectively.

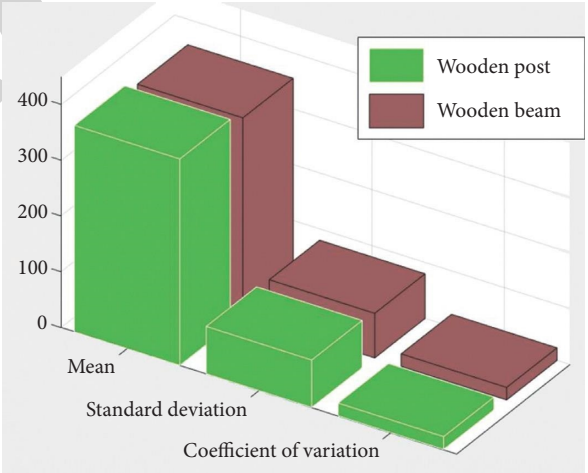

Figure 5: Statistical indicators of service life.

4.2. Comparison of Wooden Columns and Beams. The statistical indicators of the service life of wooden columns and beams are shown in Figure 5. The corresponding average values of the columns and beams are 370 and 355 years, respectively, and the coefficients of variation are 22.97% and 22.54%, respectively. Uncertainty leads to greater uncertainty in the service life of wooden members.

Table 2 gives the service life of the wooden columns and beams when the reliability indicators are 1.0, 2.0, and 3.0, respectively. It can be seen that the longer the predicted service life, the higher the probability of failure of the component, and its reliability and the lower the degree.

Table 2: Correspondence between service life and reliability index.

Reliability index	Service life of wooden pillars (years)	Service life of wooden beams (years)
1.0	285	282
2.0	230	233
3.0	195	190

4.3. Comparison of Different Prediction Methods. Table 3 shows that the PLSS method based on missing data estimation given in this paper has higher prediction accuracy. The prediction accuracy of the PLSS model based on missing

Table 3: Comparison of prediction results of different prediction methods.

Model	RPE
PLSS completion data	0.11
BP neural network	0.31
PLSS delete column	0.35
PLSS complement 0	0.16

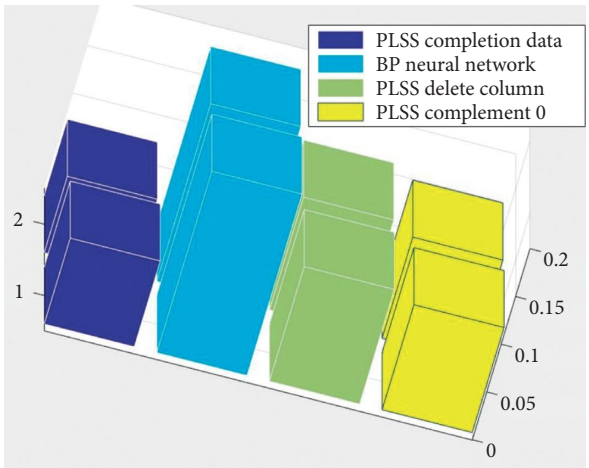

Figure 6: Comparison of prediction accuracy of actual collected data.

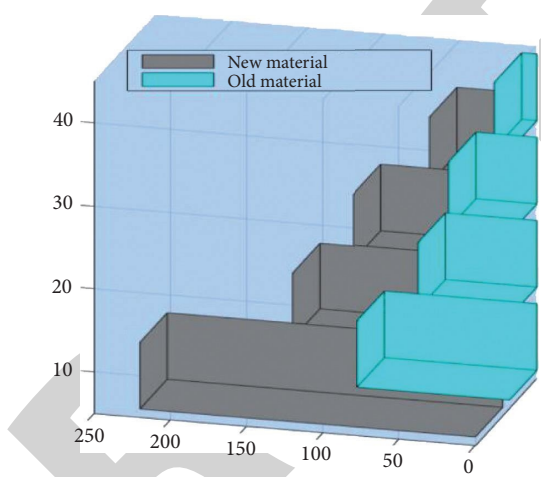

Figure 7: Effect of material properties on vertical bearing capacity of joints.

data estimation is higher, and the prediction result is closer to the original data result. It can be seen from Figure 6 that under the actual data collection prediction method, the estimated value of the PLSS ancient wooden structure based on the missing data is more consistent with the actual life value than other algorithms. It shows that the PLSS regression model has better prediction effect than other models.

4.4. Bearing Capacity of New and Old Timber Nodes. As shown in Figure 7, it can be seen that the change in the bearing capacity of the new material and the old material with the increase of the angle is similar, but the bearing capacity of the old material node is significantly lower than that of the new material node, and the bearing capacity of the new material is significantly lower. Therefore, accurately obtaining the mechanical properties of ancient wood is very important to scientifically and reasonably evaluate the bearing performance of nodes.

5. Conclusions

Based on the available data, this article mainly affects the life of ancient wooden structures: load factors of wooden structures, environmental factors, and characteristics of wood structure materials. The life prediction methods of ancient wooden structures are summarized, and fault diagnosis methods based on data feature extraction are introduced into the life prediction and anomaly detection of ancient wooden structures. This paper analyzes several main factors that affect the life of ancient wooden structures, and gives a systematic overview of the reliability theory and remaining life prediction methods of ancient wooden structures. Chinese ancient architecture is an important part of Chinese culture. It not only integrates architectural functions, literature, and art, and has a profound content. It shines brilliantly in the forest of world architecture, and has important artistic, historical, and scientific value. The structural reliability theory and the basic knowledge of remaining service life are introduced. At the same time, the commonly used reliability calculation methods and remaining service life methods of existing structures are summarized, laying a theoretical foundation for future research. It is an important responsibility of our scientific researchers to learn from the good mechanical properties of ancient buildings and apply them to modern buildings. This article uses artificial intelligence to predict the life of buildings, which is more efficient and more predictive, implying complex nonlinear relationships.

This article studies the main factors that affect the service life of ancient wooden structures, the lack of further experimental research and analysis of data collected by sensors for ancient wooden structures, and the impact of other non-main factors cannot be ignored. The assessment did not take into account the non-primary factors. At the same time, there are limitations in data sampling. Partial data can reflect part of the overall structure of the building and cannot fully reflect the actual overall state of the structure. The results have certain limitations. Fire, earthquake, and man-made situations may occur randomly in the actual environment of the wooden ancient buildings in service. This paper mainly monitors the long-term use, and does not consider the short-term transient conditions, and further research is needed. Due to the large number of wooden structural components and the extreme conditions shown by each component, health monitoring of each component is impossible. In order to effectively monitor the state of the structure and determine the impact of component reliability on the overall structure reliability, this method is also worthy of further research. In the finite element modeling process, due to the

limitations of the analysis software functions, some of them are not very accurate when selecting the element properties and yield criteria, which have a certain degree of impact on the analysis results. Due to the large number of bucket arches and tenons used in ancient wooden structures, and their mechanical properties are very complicated, they show different characteristics under different stress states. How to correctly simulate in the finite element model, how to correctly judge, and how to correctly reflect the real situation need further analysis. In the modified cumulative damage model, some parameters need to be measured by sampling and statistically calibrated. However, no such data is currently available, and experiments are urgently needed. In the evaluation of the cumulative damage model under the action of bending moment, due to the lack of data and theoretical analysis, it is assumed that the ultimate bending strength is unchanged, which is biased relative to the actual situation, and details need to be studied in detail. Therefore, in the cumulative damage assessment of wooden structures, more experimental research is needed to verify.

All in all, this thesis introduces some methods of fault diagnosis into the life prediction and anomaly detection of ancient wooden structures, and provides a scientific, effective, and real-time method for the long-term maintenance and repair of ancient wooden structures. The application of these methods can more scientifically and accurately adjust the environment of ancient wooden structures, determine the repair or replacement time of wooden components, better perform conditional maintenance, and extend the life of ancient wooden structures. Through the experimental part, it can be seen that the bearing capacity of new materials and old materials is similar with the increase of angle, but the bearing capacity of old material joints is significantly lower than that of new material joints, while the bearing capacity of new materials is significantly lower. It is hoped that the research in this article can better provide decision-making basis for the conditional maintenance of ancient wooden structures.

However, the above research conclusions are obtained, but there are still some deficiencies in this paper, which need to be paid attention to in the future research. The research methods of this paper need to be further improved. The combination of various research methods is not strong. We will continue to study in the future to improve the life prediction model of wood structure.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no potential conflicts of interest in this study.

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Research Article

Forecast of Ground Deformation Caused by Tunnel Excavation Based on Intelligent Neural Network Model

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With the development of science and technology, the demand for traffic has increased, and the requirements for tunnel excavation have become more and more stringent. Tunnel excavation is an important traffic construction engineering technology. Due to the influence of many factors in the excavation process, surface settlement or deformation will inevitably occur, so its deformation must be predicted in real time to prevent safety accidents and property losses. The previous numerical methods and neural network methods cannot accurately predict in real time, and the intelligent neural network model can more accurately predict the deformation of the ground because of the characteristics of adaptive organizational learning according to different situations and different environments. This article aims to study and design an intelligent neural network model to predict and calculate the amount of ground deformation caused by the tunnel excavation process. An intelligent neural network model with more accurate prediction is proposed, and simulation experiments are carried out on tunnel excavation of different terrains, and the accuracy of the model for predicting the deformation amount is calculated. The experimental results show that the prediction error range of the model is 10 times smaller than that of the traditional neural network. The prediction accuracy of this model is above 95%, and the volatility rate of prediction accuracy is lower than 11%, while the volatility rate of traditional prediction accuracy is even more than 365%. The intelligent neural network model can effectively predict the deformation of tunnel excavation.

1. Introduction

1.1. Background and Significance. With the continuous development of world science and technology and the continuous improvement of people's living standards, the demand for transportation is increasing. As an important transportation construction technology, tunnel engineering plays an increasingly important role in transportation. In the process of tunnel excavation, it is inevitable that there will be settlement and deformation problems on the surface of the tunnel. In order to avoid safety accidents and property losses caused by such settlement and deformation, it is necessary to predict the amount of settlement or deformation more accurately before tunnel excavation so as to timely understand the potential safety hazards during the excavation process, and take corresponding preventive measures to ensure the safety of the tunnel excavation process. There are many factors in the tunnel excavation process, which may produce different settlement and deformation, such as noise, signal interference, and air environment. Therefore, it is necessary to predict the possible settlement and deformation before excavation and in real time during the excavation. If it can accurately predict the amount of settlement or deformation that may occur during excavation, this will be a major technological breakthrough. Neural network is an increasingly widely used data analysis tool. Neural network has been developed for many years. At present, intelligent neural network will be the key research area of neural network. Intelligent neural network is more efficient and can adapt to various complex situations, self-organized learning, and other characteristics. Using intelligent neural network to predict the deformation caused by tunnel excavation will be

a huge challenge (mainly refers to the establishment of intelligent neural network model) and a great project.

1.2. Related Work. With regard to the prediction of surface deformation caused by tunnel excavation, more and more scholars have conducted in-depth research. Among them, Lin et al. studied the deformation behavior of the existing tunnel based on numerical simulation (rely on electronic computer, combined with the concept of finite element or finite volume, through numerical calculation and image display methods, to solve engineering problems, physical problems, and analysis methods of various problems in nature), studied the undercrossing oblique crossing of the newly built double tunnel, and analyzed the change law of the foundation settlement trough and the Earth pressure acting on the existing tunnel during the construction of the shield tunnel, obtained the lateral deformation, internal force, and torsion behavior of the existing tunnel caused by the excavation of the new tunnel. In addition, he also conducted parameter studies. The results show that due to the oblique crossing, the lateral deformation and internal force of the existing tunnel show obvious asymmetric characteristics, and the existing tunnels on both sides of the new tunnel show irreversible partial torsional deformation after shielding [1]. In order to reveal the stratum displacement and stress distribution caused by the excavation of shallow shield tunnels in composite strata, the equivalent layer method (method of equivalent multilayer complex problem to one-layer or two-layer simple problem, the essence of equivalent layer thinking is to transform a more complex practical problem into a simple familiar problem under the same effect so as to highlight the main factors, grasp its essence, and find out the rules. Therefore, when applying the equivalent method, it often substitutes simpler factors for more complex factors to simplify the problem and make it easier to solve and is used to simplify the problem to stratum displacement and stress distribution. Helin et al. used the modified Ronaldson formula to derive the expressions of formation displacement, strain component, and stress component, and established a displacement field distribution prediction model. Based on the theoretical prediction model, the predicted value and the measured value are compared. The research results show that during the tunnel construction process, the upper hard and lower soft stratum has displacement and stress diffusion, and the upper soft and lower hard stratum has displacement and stress concentration [2]. In geological engineering, mechanical problems such as overloading on the ground surface and shallow tunnel excavation are often encountered. In order to eliminate the infinite singularity, the far-field displacement obtained by the modified displacement solution of the complex variable method is logically consistent with the reality. Lin et al. proposed two basic cases of a single overload load acting on the ground surface and a single tunnel excavation to verify the modified displacement solution, and a good agreement was observed. By comparing with the original solution, the main advantage of the proposed solution is that it eliminates the singularity of the infinite displacement and makes the far-field displacement logically conform to the field observation [3]. Many new excavations are planned and constructed near or parallel to existing tunnels. Adjacent excavations may significantly affect the stress and deformation of existing tunnels. In order to evaluate the deformation and stress transfer mechanism, Sun et al. use an advanced nonlinear constitutive model (called a reduced plasticity model, refers to the constitutive model where the stress-strain relationship curve is parallel to the abscissa axis) to conduct a reverse analysis of the fully-instrumented centrifuge model test. The research results show that the tunnel is elongated vertically and compressed horizontally. The tunnel on the side of the basement is elongated along the junction between the right shoulder and the left knee, and compressed between the left shoulder and the right knee [4]. In recent years, with the development of underground construction, multitunnel engineering has become a concern of people. Because the close interaction between the tunnels will cause additional deformation of the ground and surrounding structures, and even cause serious damage to the buildings on the surface. Taking into account the influence of various factors such as the anisotropy of soft clay, Jin et al. uses numerical methods to effectively predict these tunnel displacement and soil deformation problems. The researchers analyzed the results including ground settlement, lining force and bending moment, and tunnel convergence. This research can provide references for the design and construction of multiple tunnels [5]. The Himalayan fold zone is full of geological wonders, and "hybrid" is one of them, which brings difficulties to tunnel construction. The mélange is characterized by a chaotic and heterogeneous geological mixture of strong blocks (scale independent) and weaker shear fine-grained matrices. The heterogeneity of tectonic mixing leads to stress concentration in the rock block, and there is also relatively high deformation in the matrix. The new Austrian Tunneling Method (NATM) adopted by Dhang proved to be a useful tunneling tool [6]. Due to the massive excavation and unloading of the ground surface, a large number of cracks and fractures appeared in the segments of the underlying shield tunnel. Dai uses a finite element simulation method, from the aspects of stratum conditions, Earth excavation, construction, etc., and the changes in the displacement and internal force of the underlying tunnel during the process of large-scale excavation and unloading on the surface, the sequence, the assembly quality of the segments, and the locations of segment cracks and fractures are analyzed. The results show that the overall uplift deformation of the underlying shield tunnel shows a law of decreasing horizontal diameter and increasing vertical diameter. The bending moment of the tunnel vault and the arch bottom is reduced, the axial force remains unchanged, and the internal tension is replaced by the lateral tension of the local area of the tunnel vault. The vault joint changed from an inner opening to an outer opening and internal extrusion [7]. However, these studies have certain shortcomings. Either it is difficult to implement, or the calculation is not accurate enough, or the cost is too high, so it is

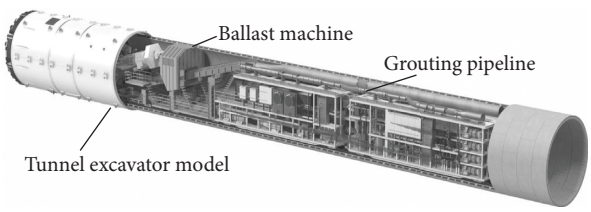

Figure 1: Model diagram of tunnel excavator.

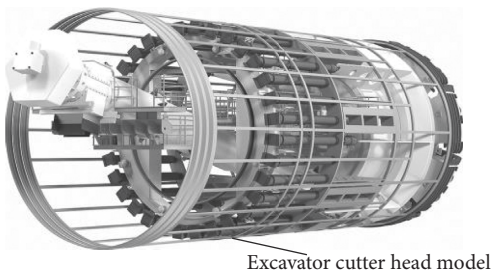

Figure 2: Cutter head model diagram.

difficult to pass. Compared with the intelligent neural network, its cost is relatively low, the calculation accuracy is high, and it is easier to implement. Therefore, the research of this paper has practical value and significance.

1.3. Innovation. (1) Utilizing the self-organizing learning characteristics of intelligent neural network, it can adapt to a variety of different complex environments, and it can solve the complex and changeable problems of the tunnel excavation environment. (2) The tunnel excavation process requires real-time acquisition of surrounding environment information for calculation to predict the resulting settlement or deformation. The intelligent neural network model can detect and calculate this in real time. (3) Carrying out tunnel excavation simulation experiment to test the intelligent neural network model, and use data to prove the feasibility and accuracy of the model. (4) Comparing the traditional tunnel excavation deformation prediction method with the intelligent neural model prediction method in this paper can better reflect the advantages of the model's predictions, such as more accurate, higher stability, and reliability.

2. Tunnel Excavation Deformation and Intelligent Neural Network

2.1. Deformation Caused by Tunnel Excavation

2.1.1. Tunnel excavation process. The tunnel excavation process must be rigorous and orderly. The topography is surveyed before excavation, and after the survey is completed and all preparations and necessary equipment are gathered, the drilling can be carried out. According to different terrains and topography, the drilling machines or drilling methods used are different. After drilling, fill the medicine and use the detonator to detonate. After the blasting is completed, the ventilation treatment must be

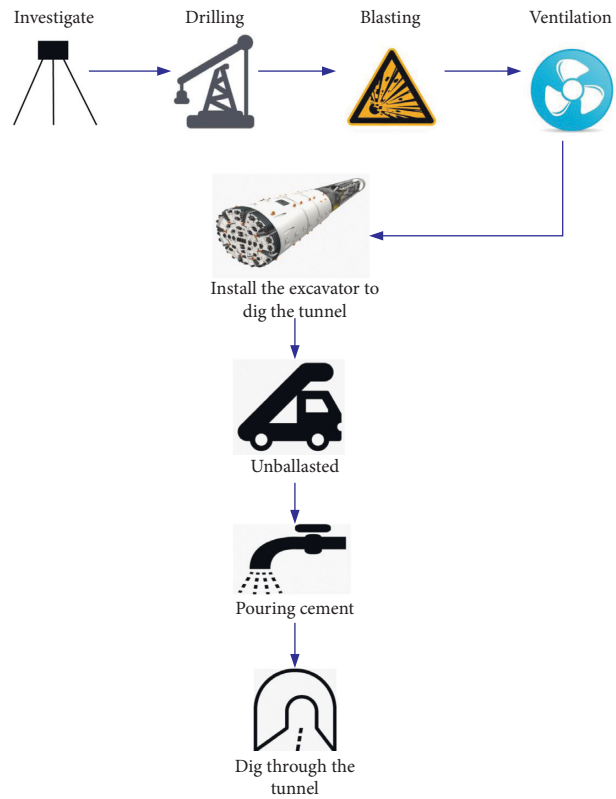

Figure 3: Tunnel excavation process.

carried out first, and the ventilation process must be continued, and then, the tunnel excavator is installed, the model is shown in Figure 1. Figure 2 shows the model of the cutter head of the tunnel excavator. After the installation is completed, excavation and ballasting are carried out, then concrete spraying for the first time, followed by excavation, ballasting (the operation of transporting the blasted ballast out of the tunnel and discarding it) and concrete spraying (construction method of spraying and pouring fine stone concrete with pressure spray gun), and so on repeatedly. During this period, it must continue to detect the terrain to prevent accidents [8], the process can be shown in Figure 3.

2.1.2. Surface Deformation. Tunnel excavation destroyed the original equilibrium state of the soil. In addition, the change of the water level caused the original stress state in the soil to change, resulting in surface deformation. The main reasons for the deformation of the tunnel surface include (1) the influence of the characteristics of the stratum soil, (2) the influence of groundwater, (3) release of rock stress, (4) the superimposed influence of the tunnel effect, (5) construction method, (6) influence of excavation footage, and (7) initial support stiffness [9].

The excavation process of a shield excavator is taken as an example. The main torsion force comes from the advancement and friction of the cutter head. The cutter head model is shown in Figure 2. To analyze the torque of the cutter head, the friction torque of the cutter face can be shown by

$$T_a = \frac{2\pi r^3}{3}\left[\alpha_1\alpha_2\lambda S f(1-u) + f(P_1+P_2)(1-u)\right], \quad (1)$$

where r represents the radius of the excavator blade, α_1 is the adjustment parameter, α_2 is the pressure coefficient, λ is the soil volume, f is the friction coefficient, u is the cutting rate of the cutter head, and S is the tunnel depth, P_1 is the initial lateral pressure, and P_2 is the additional squeezing force generated by excavation [10].

The friction torque of the tool surface attachment can be expressed by

$$T_b = \pi r^2 f\lambda SW(1+\alpha_1), \quad (2)$$

where W is the width of the cutter head.

The torque T_c required for cutter head cutting can be shown by

$$T_c = 8\pi r^3 u\theta_c + \frac{r^2}{2}\frac{v_1}{v_2}\left(P_1\alpha_3 + 2F\sqrt{\alpha_3}\right), \quad (3)$$

where θ_c is the shear strength of the soil, v_1 is the forward speed of the excavator, and l_2 is the rotation speed of the cutter head.

The rotating torque of the cutter head can be expressed by

$$T_d = \pi r^2 P_1 u d_1 f_g, \quad (4)$$

where d_1 is the diameter of the roller, f_g is the coefficient of rolling friction.

The torque of the cutter head weight can be expressed by

$$T_e = m_0 d_0 f_g. \quad (5)$$

where m_0 is the weight of the cutter head and d_0 is the contact radius.

Then, the total torque formula of the cutter head in the operating system is as follows:

$$T = Ta + Tb + Tc + Td + Te. \quad (6)$$

Then, the ground deformation can be calculated by the differential method, that is, the arbitrary microelement stress of the shield excavation surface is

$$D_p = p_0 r\ dr\ d\theta. \quad (7)$$

The amount of deformation generated by the shield excavator in the three-dimensional direction during the excavation process is represented by I_1, J_1, and K_1, and the amount of deformation I in the horizontal and transverse direction is

$$I_1 = \sum i = i_a + i_b + \cdots + i_e. \quad (8)$$

Deformation in horizontal and longitudinal direction J is as follows:

$$J_1 = \sum j = j_a + j_b + \cdots + j_e. \quad (9)$$

Vertical deformation K is as follows:

$$K_1 = \sum k = k_a + k_b + \cdots + k_e. \quad (10)$$

In the process of pouring cement, its pouring amount and pouring pressure will affect the amount of terrain deformation. Similarly, use the differential method to express any microelement:

$$D_p = p_t r\ dr\ d\theta. \quad (11)$$

The amount of deformation produced in the horizontal and vertical directions is represented by I_2, J_2, and K_2, and the total horizontal and lateral deformation produced during the construction process is as shown in

$$I_x = I_1 + I_2. \quad (12)$$

The total horizontal and vertical deformation is

$$J_y = J_1 + J_2. \quad (13)$$

The total deformation in the vertical direction is

$$K_z = K_1 + K_2. \quad (14)$$

2.1.3. The Surface Subsidence or Uplift. The excavation of the tunnel causes the surrounding rock of the excavation surface to squeeze out, or the surrounding rock to relax due to the collapse. After excavation, the surrounding rock and the support, the gap between the surrounding rock and the lining were consolidated due to the drop of the groundwater level, which caused the support in the weak surrounding rock to sink, causing the ground to sink. When the surface deformation reaches a certain level, it will cause the surface to settle or uplift [11].

2.2. Common Methods for Predicting Deformation

2.2.1. Empirical Method. Using previous construction experience, the measurement data are replaced with a formula, and the necessary mathematical operations are performed on the formula to study the relationship between the respective variables and functions. For example, the Peck prediction formula (15) for the distribution of surface subsidence is as follows:

$$Y(d) = Y_{\max}\exp\left(-\frac{d^2}{2l^2}\right). \quad (15)$$

where $Y(d)$ is the surface settlement value at the position d away from the central axis of the tunnel, l is the introduction parameter of ground settlement width, $Y_{\max}$ is the maximum settlement value of the center line of the tunnel, and $Y_{\max}$ satisfies the following formula:

$$Y_{\max} = \frac{V_l}{\sqrt{2\pi l}}. \quad (16)$$

2.2.2. Actual Measurement Method. Hence the name implies, it is to compare the actual measurement data with the

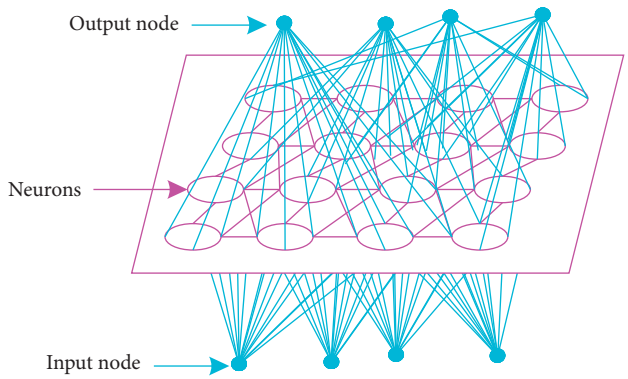

Figure 4: Neural network model.

requirements of construction specifications and quality standards and allowable deviation values to determine whether the construction safety and quality meet the requirements [12].

2.2.3. Numerical Analysis Method. The method of numerical simulation to study the mechanical properties of rock and soil is mainly based on the two aspects of continuous medium mechanics and discontinuous medium mechanics. The basic principle is based on the most basic Newton's second law of motion. Based on the rigid body motion equation of each element, an explicit equation set describing the motion of the entire system is established, and then, iterative calculations are performed by the dynamic relaxation method (i.e., dynamic analysis method), analysis over time, and the dynamic relaxation method is also introduced in LS-DYNA3D to solve the implicit problem. It adopts the calculation idea of backward time step iteration and adds artificial damping to approximately solve the static problem. The larger the artificial damping is, the faster the convergence will be. However, the size of the artificial damping cannot exceed the critical damping; otherwise, the calculation time will be too long (or very small). It is mainly used to explicitly solve the static load of the previous model. The basic motion equation is shown as follows:

$$Y(t) = w_m(t) + f_m(t) + e_m(t), \tag{17}$$

where Y represents the load function, m represents the displacement, e represents the elastic parameter, f represents the friction coefficient, and w represents the mass.

Using this equation to solve, combined with data analysis, can understand the changes of various mechanical parameters of terrain movement.

2.2.4. Neural Network Method. The deformation of the rock and soil around the tunnel and the settlement and deformation of the ground above the tunnel caused by tunnel excavation is a very complex nonlinear dynamic system, and there are many factors involved in ground settlement. Neural network has the advantages of parallel distributed processing, nonlinear processing, self-learning, self-organization and self-adaptive ability, fast information processing speed, strong calculation ability, and high fault tolerance, so it can solve this problem well. Figure 4 is a model diagram of a neural network. The neural network is divided into an input layer, a competition layer, and an output layer. The input information is clustered and output to the output layer under the self-learning process of neurons in the competition layer. The process of using neural networks to solve problems is (1) determining the problem and the way of data expression; (2) establishing the neural network model; (3) setting the network parameters; (4) determining the training mode; (5) test samples; (6) test results [13].

Among the above methods, the concept of the empirical formula method is simple. Although the calculation is convenient, the empirical formula is an empirical method and lacks theoretical foundation. The physical meaning of the parameters involved is not clear, and it is not convenient for popularization and application. Although the actual measurement method can comprehensively and monitor in real time the construction process, it has strong pertinence, the monitoring results can be directly fed back to the engineering practice, the content of on-site monitoring is often scattered, the workload is relatively large, and the cost is relatively high. Numerical simulation analysis methods have high flexibility, convenient modeling, and can better reflect the actual geotechnical conditions, but the results are some qualitative conclusions, which are difficult to meet the quantitative requirements in specific engineering applications. The neural network method has a powerful nonlinear mapping function. It can build a network "model" based on the existing data to predict the future development trend and provide a reference for the next step of decision-making and control. However, the traditional neural network method requires too much sample data and too many calculations, and the credibility of the obtained results still needs a lot of verification. The intelligent neural network method proposed in this paper will improve the stability and reliability of the results, and the amount of calculation is much less than that of the traditional neural network [14].

2.3. Theory of Intelligent Neural Network

2.3.1. The Origin of Neural Networks. The Kohonen Network proposed by Professor Teuvo Kohonen of the University of Helsinki in Finland is a self-organizing competitive neural network. Self-organization means that the network is unsupervised and can learn independently, and adjust the element value through the self-organizing function relationship according to the characteristics of the environment so that the neural network can automatically distinguish and aggregate and classify. In this form of expression, neurons will match a specific input form and enhance the impression, resulting in sensitivity. Therefore, the input form can be divided into different clusters through self-organizing training and learning, and each cluster has different response characteristics to the input form, so the neuron can become a detector in a certain environment [15].

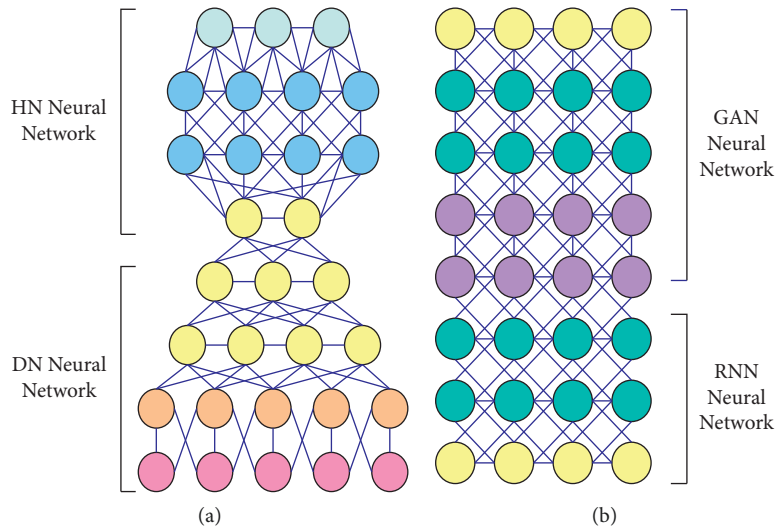

Figure 5: Intelligent neural network model.

2.3.2. Types of Neural Networks. After years of research and development, the current neural network can be roughly divided into (1) Feedforward neural network: the most common type of neural network in practical applications. The first layer is the input, and the last layer is the output. If there are multiple hidden layers, we call it a "deep" neural network. Calculating a series of fusions that change the similarity of samples, and the activity of neurons in each layer is a nonlinear function of the activity of the previous layer. (2) Circulating neural network: the current output of a sequence is also related to the previous output. The specific manifestation is that the network will memorize the previous information and apply it to the calculation of the current output. That is, the nodes between the hidden layers are no longer unconnected but connected, and the input of the hidden layer includes not only the output of the input layer but also the output of the hidden layer at the previous moment. (3) Symmetrically connected network: symmetrically connected network is a bit like a cyclic network, but the connections between units are symmetrical (they have the same weight in both directions). Compared to cyclic networks, symmetrically connected networks are easier to analyze. There are more restrictions in this network because they obey the law of energy function. A symmetrically connected network without hidden units is called a "Hopfield network," and a symmetrically connected network with hidden units is called a Boltzmann machine. However, when dealing with some big problems, a single neural network is often not enough. Therefore, a combination of multiple neural networks is currently combined into a group of neural networks. According to the structure and combination model of neural network, it can be divided into single neural network group and combined neural network group. The intelligent neural network group studied in this paper is a combined neural network group. Figure 5 shows the structure of two types of intelligent neural network models. Figure 5(a) is an intelligent neural network composed of DN neural network (a deconvolutional neural network, also called an inverse graph network, is the inverse process of a convolutional neural network) and HN neural network (i.e., the Hopfield network mentioned earlier), and Figure 5(b) is an intelligent neural network composed of the RNN neural network and GAN neural network [16].

The intelligent neural network model can be expressed by the function formula:

$$F = f\left(i_1 + i_2 + \cdots + i_n\right). \tag{18}$$

where F is the output of the intelligent neural network model and i_{n} is the output value of the nth neural network.

Setting the neural network prediction deviation value to D_{n}, then,

$$D_n = \frac{\sqrt{h}}{L} w. \tag{19}$$

where h is the predicted trend parameter value, L is the predicted logical value, and w is the neural network feature dimension value.

The improved output accuracy A_n of the intelligent neural network model is as follows:

$$A_n = \frac{D - \overline{D}}{D} \times 100\%. \tag{20}$$

where $D = \sum_{n=1}^{n} D_n$, $\overline{D} = D/n$.

3. Tunnel Mining Simulation Experiment Based on Intelligent Neural Network

3.1. Design of Intelligent Neural Network Model

3.1.1. Selection of Model. Compared with the other two common neural networks, the feedforward neural network has a wider application range, higher flexibility, and can better meet the calculation requirements of this experiment. Therefore, the intelligent neural network model studied in this paper is based on a CNN neural network (a convolutional neural network is usually used to deal with highly nonlinear abstract classification problems). A CNN

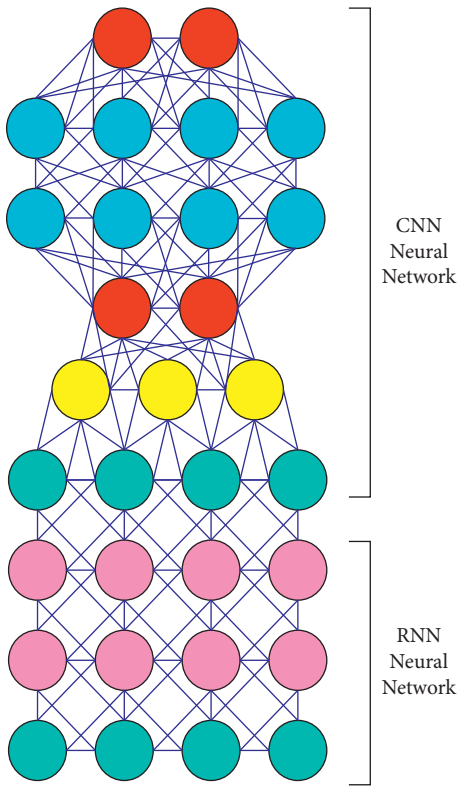

Figure 6: Intelligent neural network model.

(convolutional neural network) is a kind of feedforward neural network with convolution calculation and deep structure, which is one of the representative algorithms of deep learning. Convolutional neural networks have the ability to learn representations and can perform translation-invariant classification of input information according to its hierarchical structure and RNN neural network as prototypes for improved combination. The improved neural network has more detailed calculations and higher accuracy. The model diagram is shown in Figure 6 [17].

3.1.2. Performance Analysis of the Model. The neural network model has self-organized learning and self-adaptive ability can store a large amount of information and perform large-scale processing and has strong fault tolerance. The learning rate is faster than the traditional neural network, the network structure is layered clearly, and the experimental prediction effect is more [18].

3.1.3. Acquisition and Training Methods of Data Samples. The data in this article are derived from the actual values of the simulation experiment, and the actual values of the simulation experiment fluctuate randomly within a certain range according to the actual situation. The training method is based on the continuous monitoring of one of the deformations of the tunnel to obtain the deformation values i_1, i_2,..., i_n that change over time, then according to its adaptive learning, predict the deformation values I_1, I_2,..., I_n for a period of time later, and compare the predicted value with the actual value, and adjust the error adaptively, after many studies until the required high accuracy is achieved. Each neural network consists of three layers. The first neural network that has been trained with high accuracy is used to calculate the predicted value, and then, the predicted result is compared with the actual result and fed back to the second neural network for training and recalculation, and finally, the obtained prediction result is used as the test result. The training method can be shown in Table 1 [19]:

Table 1: Sample learning and learning goals based on intelligent neural network.

Code	Learning sample	Learning target
1	i_1, i_2, i_3,..., i_m	I_1, I_2, I_3,..., I_m
2	i_{m+1}, i_{m+2}, i_{m+3},..., i_{2m}	I_{m+1}, I_{m+2}, I_{m+3},..., I_{2m}
...	.....	.....
N	i_{n+1}, i_{n+2}, i_{n+3},..., i_{n+m}	I_{n+1}, I_{n+2}, I_{n+3},..., I_{n+m}

Table 2: Training samples.

Code	C	T	W	Q	R	I
1	6	22.0835	0.6	0.6	3.44	−14.2306
2	6	19.9195	0.3	0.6	3.5	−23.1595
3	2	21.5777	0.9	0.8	3.57	−12.3851
4	6	21.9869	0.3	0.7	3.52	−30.8177
5	4	21.7265	0.7	0.6	2.9	−16.73
6	4	19.5688	0.5	0.7	3.32	−20.6861
7	5	21.9521	0.6	0.7	2.82	−8.5844
8	4	20.0172	0.3	0.5	2.92	−17.4464
9	5	21.8737	0.5	0.9	3.54	−1.824
10	3	22.029	0.7	0.8	3.63	−19.0228
11	5	20.2748	0.7	0.5	2.93	−3.4179
12	5	19.5615	0.5	0.9	3.7	−17.2956
13	3	20.3181	0.9	0.6	3.04	−20.342
14	3	21.8145	0.8	0.5	3.35	−21.6668
15	5	20.4117	0.5	0.5	2.82	−12.409
16	3	20.4561	0.3	0.9	3.4	−13.5146
17	4	22.1227	0.9	0.9	3.15	−27.5172
18	5	20.3638	0.2	0.6	2.88	−11.1454
19	3	21.0117	0.7	0.5	3.14	−5.7283
20	2	21.7048	0.9	0.9	3.16	−22.0582
21	3	21.1194	0.4	0.6	3.01	−20.233
22	3	20.4192	0.7	0.5	3.43	−14.5012
23	5	20.7241	0.5	0.9	3.63	−27.7672
24	6	20.8682	0.3	0.6	2.95	−22.4095
25	5	19.3898	0.2	0.5	3.12	−20.1598
26	4	21.1154	0.6	0.6	3.23	−6.4165
27	3	19.7719	0.4	0.6	3.16	−13.9018
28	6	19.3	0.8	0.9	3.44	−24.413
29	2	19.5552	0.8	0.7	2.85	−30.8232
30	4	20.645619	0.9	0.7	3.67	−12.1187

3.1.4. Test Method. According to the actual parameters of the simulation experiment as the input value, the calculation is performed by using the trained super intelligent neural network algorithm to obtain the accurate prediction, and the calculation result is the predicted deformation value. According to the predicted deformation value, the experimental parameters are modified to verify the accuracy of the predicted result, and calculate the error and accuracy between the predicted result and the actual result [20].

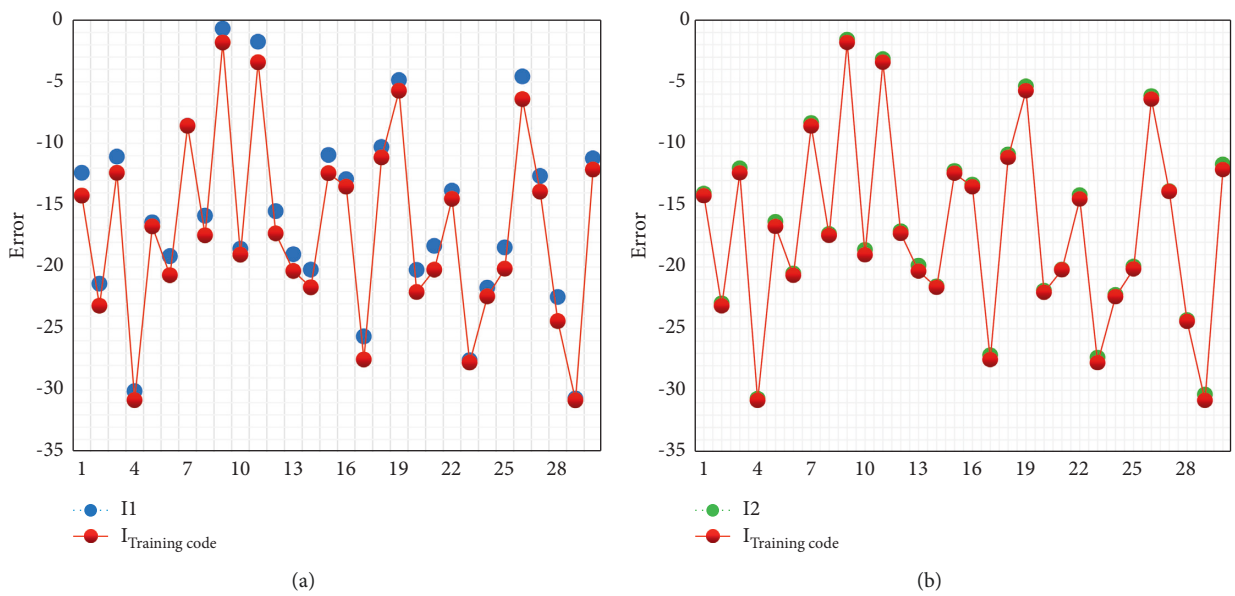

Figure 7: Fitting results of intelligent neural network. (a) The first set of fitting. (b) The second set of fitting.

3.2. Design of Simulated Tunnel Excavation Experiment. This paper simulates different terrains and environments, taking real-time data of settlement monitoring points as samples, and the obtained deformation value is the output value. The relevant data of several main factors affecting settlement are obtained below. Among them, the rock grade is C, the temperature is T, and the groundwater condition is W, the construction quality is Q, the monitored settlement value is I, and the tunnel excavation depth to diameter ratio is R. The training data obtained are shown in Table 2.

According to the adaptive and self-organizing learning capabilities of the intelligent neural network, the training data in Table 2 are used for multiple training so that it can generate sensitive feature relationships on the data and accurately predict the output value. The training result of the training sample is the final value obtained through the training of the multilayer neural network. In order to obtain a more accurate prediction effect, this experiment carried out two sets of training on the samples. The first set of training results is represented by I1, the second set of training results is represented by I2, and the actual value of the sample is represented by I. Fitting the two sets of training results with the actual values of the sample can see whether the efficiency and prediction accuracy of the neural network model's self-organized learning can meet the requirements. The two sets of fitting results are shown in Figure 7 [21].

Among them, the second set of fitting is performed after the first set of fitting. As can be seen from Figure 7(a), the fitting result is relatively acceptable accuracy, but the range error is still not small. After the second set of fitting is performed, it can be seen from Figure 7(b) that the fitting effect is significantly better, and it fits almost perfectly. This also shows that the intelligent neural network has a strong self-learning ability and a deep sensitivity to data. The calculated second set of fitting results has sufficient accuracy for sample testing [22].

Table 3: Testing sample.

Code	C	T	W	Q	R
1	5	19.6289	0.3	0.7	3.08
2	2	19.9658	0.8	0.8	3.65
3	6	21.0852	0.2	0.6	3.31
4	4	21.2788	0.2	0.5	2.9
5	2	20.893	0.5	0.7	3.24
6	6	21.039	0.3	0.8	3.28
7	5	21.309	0.4	0.6	3.18
8	3	21.1381	0.2	0.6	3.22
9	3	21.6857	0.3	0.9	3.18
10	6	19.957	0.4	0.7	3.39

Table 4: Forecast and actual results.

Code	I_a	I_b	I_c
1	−1.8445	−1.1857	−1.9383
2	−28.675	−27.8552	−28.6918
3	−28.2115	−27.9404	−28.2523
4	−0.2879	0.5114	−0.2861
5	−3.5766	−3.2795	−3.6135
6	−8.101	−7.8074	−8.1865
7	−21.9469	−21.6983	−22.0258
8	−10.3944	−9.7134	−10.4923
9	−3.7454	−3.6781	−3.8201
10	−1.6545	−0.818	−1.7492

Using the second set of fitted intelligent neural networks to test the actual measured data of the simulated tunnel excavation, and predict the output value, that is, the amount of deformation I, according to the aforementioned parameters, as shown in Table 3.

3.3. Predicted Results. The intelligent neural network selected according to the above test samples is tested and compared with the traditional neural network, and the

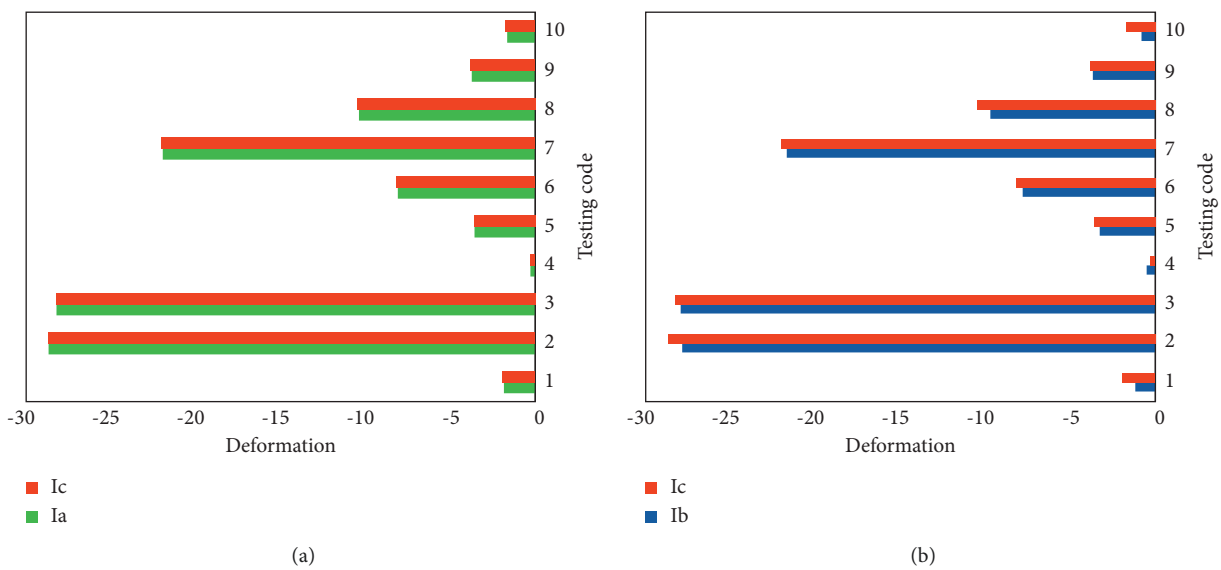

Figure 8: Comparison of prediction results between intelligent neural network and traditional neural network. (a) Comparison of intelligent neural network and actual results. (b) Comparison of traditional neural network and actual results.

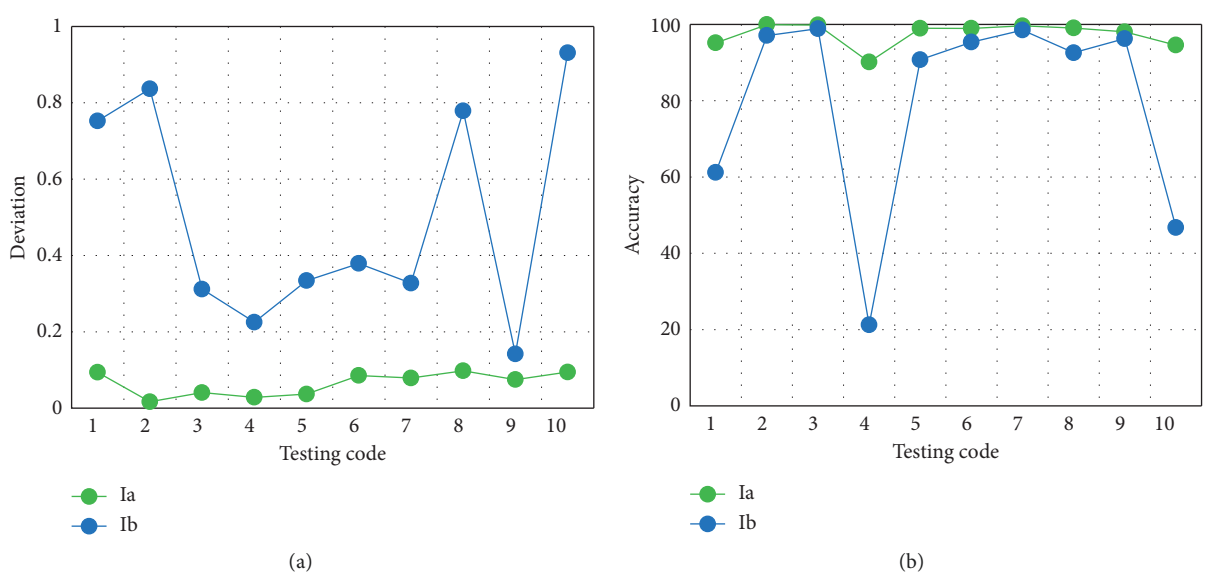

Figure 9: Comparison of prediction errors and accuracy of two neural networks. (a) Comparison of prediction errors. (b) Comparison of prediction accuracy.

intelligent neural network prediction value is I_a, the traditional neural network prediction result is I_b, and the actual result is I_c. The comparison is shown in Table 4 [23].

From this, the prediction error values of the two neural networks can be obtained, as shown in Figure 8.

It can be seen from the comparison of Figure 8 that the graphical prediction value of the intelligent neural network is almost consistent with the actual value, while the prediction error value of the traditional neural network is still relatively large, and some are even larger than the predicted value, such as 4 test values. The prediction result of the intelligent neural network is always a little smaller than the actual value, which is very close to the actual result. From Table 4, the prediction error (absolute value) and output accuracy A_n of the two neural networks can be obtained, as shown in Figure 9.

It can be clearly seen from Figure 9(a) that the prediction error value of the intelligent neural network is significantly lower than that of the traditional neural network, and its prediction error is stable at about 0.1. The error value of the traditional neural network is between 0.1 and 1, and its error range is about 10 times that of the intelligent neural network.

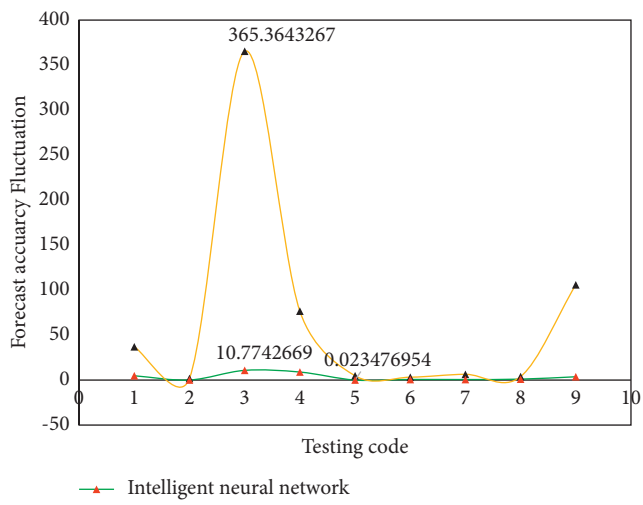

Figure 10: Comparison of volatility of calculation accuracy between intelligent neural network and traditional neural network.

It can be seen from Figure 9(b) that the accuracy of the intelligent neural network model is always above 90%, while the accuracy of the traditional neural network model fluctuates in a relatively large range. Although there is also relatively high accuracy, its accuracy is always lower than the prediction accuracy of the intelligent neural network [24].

In order to understand the actual reliability of the prediction results of the intelligent neural network system, this paper calculates the accuracy of the two prediction results before and after the two types of neural networks and obtains the fluctuation rate of the calculation accuracy, accuracy fluctuation rate = (precision difference between the previous two times/precision after one time) × 100%, and take the absolute value. The volatility of accuracy here is calculated under the premise that the accuracy meets the requirements. The greater the volatility of accuracy, the greater the forecast error and the lower the forecast reliability. That is, the reliability of the prediction result is inversely proportional to its volatility, and the final calculation result is shown in Figure 10 [25].

It can be seen from Figure 10 that the test accuracy of the intelligent neural network has very little volatility, no more than 11%, and its prediction results are very stable. However, the prediction accuracy of traditional neural networks is relatively volatile, with the highest volatility exceeding 365%, and its stability is obviously not as good as that of intelligent neural networks. It can be seen that, whether it is a comparison of the accuracy of the prediction results or the comparison of the stability of the prediction, the intelligent neural network has obvious advantages. Using intelligent neural network to predict the deformation of tunnel excavation will effectively improve the accuracy of the prediction results [26].

4. Discussion

The intelligent neural network studied in this paper can solve the shortcomings of traditional neural network algorithms to a certain extent and can meet the accuracy requirements (required accuracy cannot be lower than 90%, and most construction projects use cement as the main building material. The total allowable error in the construction of concrete columns, beams, and walls is about 10 to 30 mm. The inclination of the axis of high-rise buildings is required to be 1/2000 to 1/1000. The total error of steel structure construction varies with the construction method, and the allowable error is 1–8 mm. The construction error of the upper stone is allowed to reach 10 cm of tunnel deformation monitoring, predictive analysis and safety evaluation. However, because the article involves a lot of content and author's level is limited, there are still many areas that need to be improved [27].

(1) The factors of surface deformation caused by tunnel excavation are complex, which involve many qualitative factors. In terms of quantification of qualitative influencing factors, only rare data and experience cannot accurately express the magnitude of its influence. There is a need for clearer guidance and in-depth research in the quantification of qualitative factors.

(2) The tunnel excavation process must ensure the stability of the excavation surface, and what kind of engineering measures should be taken to reduce the impact of shield construction on the surrounding environment is not deep enough.

(3) When selecting the single model of the combined model, not every single model will improve its output after the combination. How to select a reasonable single model to achieve the best combination effect will require further research [28, 29].

(4) There are certain limitations to relying only on real-time monitoring data to test the predictive deformation evaluation parameters of tunnel excavation, and there is no comprehensive use of knowledge of multiple disciplines.

The actual process of tunnel excavation is more complicated than expected in this article, and the terrain will change with the progress of the excavation process. In addition, the construction process has the influence of natural weather, such as drought and rain, and the stress of the terrain structure will change. Due to the limited knowledge of the author, further study and exploration are needed [30, 31].

5. Conclusions

This article first investigates the current research status of many scholars on tunnel excavation prediction deformation in the related work part and understands the commonly used prediction methods among them. Combined with the research of intelligent neural network, it is proposed to use the characteristics of intelligent neural network to predict the deformation of tunnel excavation. Also, it is proposed to further study the process and principle of tunnel excavation, understand the reason of deformation during excavation, and use mechanical analysis to calculate the deformation

amount. Then, it analyzes the commonly used methods of predicting deformation, including empirical method, actual measurement method, numerical analysis method, neural network method, and compares the characteristics of these commonly used methods. It is concluded that the intelligent neural network model obtained by using multiple neural network combinations can obtain more accurate and efficient predictions. Then, in-depth theoretical research on the intelligent neural network is conducted and the intelligent neural network model is designed, and then the simulation experiment of tunnel excavation is carried out, and high self-learning and self-organization ability of the intelligent neural network is used to conduct data sample training. The trained intelligent neural network has a high degree of data sensitivity, and its prediction accuracy is high enough. Then, the trained model is used for sample testing, and the prediction results obtained are compared with the actual results. The results show that the prediction error range of the model is below 0.1, while the maximum error of the traditional neural network is above 1, and its error range is reduced by 10 times. The prediction accuracy of this model is above 95%, and the volatility rate of prediction accuracy is less than 11%, while the volatility rate of traditional prediction accuracy is even as high as 3.65 times. It can be clearly seen that the intelligent neural network model can more effectively predict the deformation of tunnel excavation.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

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Research Article

Wearable-Based Virtual Display Information Processing and Data Fusion Research

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This paper is combined with the existing acquisition module design to achieve the upper computer online information monitoring system. Real-time mapping technology is adopted to change the trend of data collection potential for real-time tracking and monitoring. The monitoring data can be predicted and analyzed by changing trend, at the same time combined with SQL2008 database technology, user login system, registration system, monitoring system, data query, and data storage system. The integration and other functions are improved, so that the system not only has the advantages of information management platform but also realizes the remote client base matching layer wireless information real-time monitoring function. Data fusion technology refers to the information processing technology that uses computer to automatically analyze and synthesize some observation information obtained in time and sequence under certain criteria, so as to complete the required decision-making and evaluation tasks. The intelligent wearable online information monitoring system designed in this paper realizes wireless sensor network, to some extent feedback and monitoring of underlying real information. Through the corresponding information processing and data fusion, the user can easily and clearly get product information. Based on the existing 80 sets of data, the experiment trains and extracts 320 feature vectors, which verify the effectiveness of the method.

1. Introduction

Nowadays, with the development of mobile Internet technology, the traditional labor force and resources can no longer meet the needs of technological innovation. With the gradual narrowing of innovation space such as smartphones and the near saturation of the market, smartphones can be worn. Technology as a branch of the Internet of Things has been widely recognized in various fields [1]. The development of mobile Internet to wearable devices provided a good experience platform; with the continuous improvement of technology, consumers are more able to accept such new products and things. The difference between networking is that garment factories and jewellers are joining the ranks of smart wearables. Adidas has also developed a fitness chase sneakers. In this way, wearable equipment is gradually opening up the market to the garment and other industries. Today's development is mainly in the following areas. The results of the continuous technological innovation are as follows: (1) rapid development of microelectronics technology, (2) development of multimedia technology, (3) development of embedded software and hardware technology, (4) continuous improvement of wireless communication technology, and (5) development of new generation structure design technology and human-computer interaction technology. The development of wearable equipment cannot be separated from the increasing demand of society. The research and development of monitoring equipment such as product are very meaningful [2–4]. With the rapid development of technology in various industries, the combination of development, wireless sensor networks, information fusion technology, and wearable computing makes wearable smart clothes.

From the development of wearable devices in the field shown above, we can see that wearable smart clothing will be a long time in the future. In the meantime, its main task

is to change and improve the traditional clothing function by using high and new technology and information technology, so that clothing can become the carrier of modern scientific and technological progress, which will be mainly reflected in the research and development of intelligent wearable clothing. Now, a broad definition of wearable smart clothing can be simply understood as information-based clothing; that is, through all kinds of microchips, sensors, power supply, and other devices are embedded in clothing, making clothing a man-machine with specific functions. Intelligent clothing is the traditional textile and garment technology, information sensor technology, and communication technology; artificial Intelligence is an organic collection of many fields. It uses advanced electronic information technology to process, perceive, input, and transfer information. At the same time, the electronic hardware equipment is miniaturized and flexible and then embedded into traditional clothing. Without affecting the overall comfort of clothing, wireless information acquisition, transmission, analysis, and other functions are realized. A set of wearable electronic equipment can be used to real time carry out the physical parameters and health indicators of human body and the environmental information of the tester. The advent of the era of smart wearable devices means the extension of human intelligent technology. Through these wearable devices, on the Internet, with the assistance of network technology, information can be processed efficiently, so that wearers can better perceive their own situation and external environment. Research in this field is still at a relatively preliminary stage. In many developed countries in the world, intelligence is the key factor. Wearable equipment research has invested a lot of financial and material resources, intelligent wearable equipment, and related products research.

Virtual display technology is a real-time representation of a computer-generated world that simulates human perception, sometimes referred to as a virtual environment. The "world" here refers to a realistic three-dimensional figure, which can be either a real reproduction of a particular real world or a world of ideas. Operators can interact with them through visual, auditory, tactile, and force sensations, thus creating an "immersive" scenario, so virtual reality technology provides new interactive media for human interaction. Virtual display technology mainly includes simulation environment, perception, natural skills, and sensing equipment. It is a challenging cross-cutting discipline and research field. Virtual display technology is a combination of various technologies, including real-time 3D computer graphics technology, wide angle, stereoscopic display technology, tracking technology of the body parts of the observer, as well as tactile and force feedback, stereo, network transmission, voice input and output technology. At present, the development of virtual display technology is becoming more and more mature and has made great progress in many fields, such as medicine, aerospace, urban planning, architecture, virtual studio, art, entertainment games, and education. With the development of the times, in virtual reality, the application of virtual display technology in the future will become an indispensable technical means in the future.

2. Related Work

2.1. Development Background of Wireless Communication Technology. With the development of microelectronics, computer technology, and wireless communication technology, intelligent wearable devices are becoming more and more popular. Wireless sensor technology can provide people with a comprehensive and efficient method to monitor the economic layout and acquisition parameters of nodes [5–7]. Zigbee wireless communication technology is an intelligent wearable device. One of advantages of this technology is that its low cost enables more consumers to enjoy the high-quality services brought by science and technology while at the same time bringing people to life. They are freed from the complex and restricted wired equipment, so that the wearer has a higher degree of flexibility and mobility. At present, Zigbee technology is widely used in wireless communication technology. It has its unique application characteristics [8]. It is mainly used in wireless communication technology and control system with short distance transmission and small amount of information. It is suitable for monitoring physiological and environmental parameters of human body. At present, Zigbee is mainly used in the following fields: smart home: commercial buildings can use Zigbee to complete automatic control, reducing the efficiency of manpower management and management costs. With this intelligent system at home, we can easily monitor the usage of tap water, electricity, gas, etc., and we can also use it. It has the function of safety monitoring. Industrial field: use wireless sensor technology to collect data in each workshop of the factory, and automatically process and analyze. Thus, work personnel can monitor the operation in real time to prevent accidents [9]. At the same time, it can communicate with the host computer to realize assistant decision-making, thereby improving production efficiency and increasing benefits. Master's Degree Thesis of Beijing Institute of Fashion Three Medical field: using sensors, we can real time monitor human heart rate, body temperature, and other signs. It has greatly reduced the number of doctors and nurses. The workload of the staff and nurses cannot regularly inspect the patient's physical parameters, only on the terminal equipment regularly [10].

2.2. Background of Information Fusion Technology. As early as the 1970s, the concept of information integration was gradually proposed, and the concept of "data fusion" introduced by JDL laboratory experts in the United States put forward that the concept of information fusion was widely used in the 1990s. From the initial military field to today's, various industries have applications [11–13]. The core of data fusion is coordination, optimization, and comprehensive processing. Information fusion uses specific mathematical methods and techniques. The tool processes, correlates, and synthesizes multisource information to obtain high-quality useful information [14]. So choose one. An optimal intelligent data fusion algorithm monitors the collected data and trains and analyses the data, so as to establish a certain data fusion system. It is of great significance in real life that some evaluation systems can be used to predict unknown

risks and minimize risks and losses. Establishing a remote terminal through the algorithm of information fusion technology can transparently reflect the tester's own condition or field environment. Real-time monitoring and prediction, as well as inquiry and analysis of past information, are convenient, fast, and easy to operate [15–17].

2.3. Virtual Display Technology. Virtual display technology can create and experience a virtual world generated by computers and experience the realities and things in this environment. Virtual display technology has significant features such as presence and interactivity. This technology simulates human sensory functions such as vision, hearing, and touch by combining computer graphics and image technology, multimedia timely, and real-time simulation. It can let people in the virtual world created by virtual display use real-time communication methods such as language and action. This technology has developmental help in many fields.

Virtual display has four characteristics: immersion, interactivity, multiperception, and conception. The user wears a sensor device such as a helmet display and gloves to keep himself in a virtual environment and achieves close to natural human-computer interaction, so the user has visual, tactile, taste, and other perceptions in the virtual reality environment. Users can build a tailor-made virtual reality environment through their own imagination.

2.4. Contribution. This topic combines the product itself with the electronic intelligent equipment, takes the wireless sensor network as the carrier, and at the same time uses the wireless sensor network as the carrier, integrating the advantages of the monitoring system, perfecting the user monitoring management system, and facilitating the user to manage the data of the remote acquisition module and queries and intelligent analysis of data. Using wireless communication technology to achieve ultralow power consumption is the current software design. In the future, the monitoring of product parameters will be an automated mode of operation. The terminal software can automatically analyze the parameters of the acquisition point. When the environmental parameters are not within the normal range, the host computer software will automatically analyze the parameters of the acquisition point,so as Judge, analyze and timely process and issue an alarm signal. It can effectively avoid artificial misjudgment and facilitate management data. Inquiry improves the work efficiency of field personnel, and wireless communication also improves the safety of staff and the availability of equipment. Reliability management, remote control, and remote operation are realized at the same time. Because this new type of intelligent wearable device can be increased or decreased, wireless acquisition module can be used for different needs. Necessary modifications are made to make wearable smart product more widely used. For example, it has been extended in the fields of combat, field rescue, human posture, and emotion recognition. In a word, intelligence with information processing function product has broad application prospects. The research of these key technologies can be extended to aerospace and other fields. Applied research lays a very strong foundation for the engineering and practicality of intelligent wearable product.

3. Design of Wearable Intelligent Product Architecture

3.1. Intelligent Product Architecture Design. In the design of the system, we need to consider the architecture of the system and design it according to the specific environment and actual needs. Intelligence wearable system embeds various sensor modules, signal transmission units, information processing units, and microcontrollers in garments. At the same time, it must satisfy different application requirements so that it has the functions of perception, transmission, calculation, and display [18]. All wearable systems have general computing power. Using hardware and software platforms, sensor models with different functions are designed according to demand analysis and block to collect some physiological signals and environmental parameters of human body. Figure 1 shows a schematic diagram of the wearable network structure.

The design architecture of each functional module of the whole system is shown in Figure 2.

3.1.1. Design Characteristics of Intelligent Wearable System

(1) Modularization of architecture design. Each module includes sensor module, storage module, and communication module for sensing environmental parameters. Block, power supply module, etc. Table 1 shows the wearable data fusion model

(2) Multiapplication oriented. Modules can be configurable to be added or subtracted to suit different application areas, such as for medical health, rescue, and fighting

(3) Low energy consumption and real time. The system uses Zigbee wireless communication technology, which saves energy consumption and has good reliability. Sex meets design requirements

(4) It has the function of information fusion. Sensors can collect product signals and environmental parameters of human body, requiring complex information, information processing, and fusion decision-making in order to improve the accuracy of discrimination

(5) The material of product is suitable for harsh environment. The material used in smart product should be wear-resistant, moisture-proof, and fire-proof. The characteristics meet the requirements of field operation

3.2. Network Structure Design Based on Intelligent Wearable System. The whole system involved in this paper includes the existing modules of the research group: temperature and

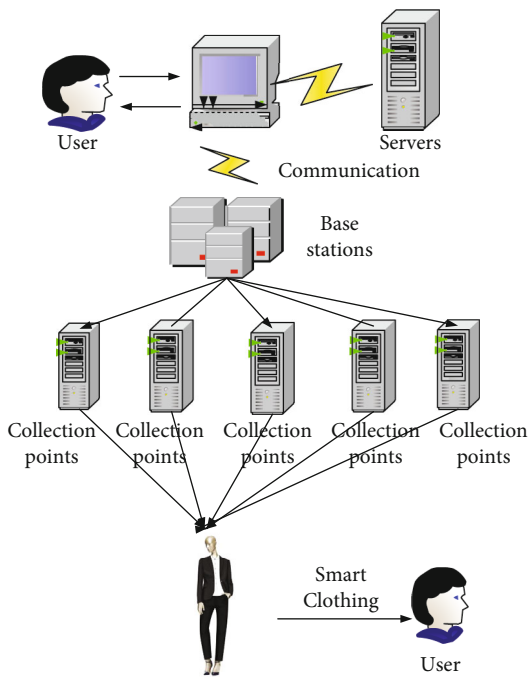

Figure 1: Wearing network structure diagram.

humidity module, methane gas module, and acceleration module. In this paper, besides increasing the number and optimizing the accuracy of the existing modules, we also design a new model based on it. The photoelectric pulse acquisition module based on Zigbee technology carries out serial communication and on-line information remote monitoring for all modules, and uses database technology for data processing

3.3. Hierarchical Structure Design of Intelligent Wearable System. Wearable system can be divided into four layers: application layer, service layer, driver layer, and hardware layer.

3.3.1. Hardware Layer. The hardware layer is mainly composed of wireless sensor module based on Zigbee protocol embedded in smart clothing. And these module can realize the functions of acquisition, calculation, display, input, output, and storage. The design of these hardware modules is the first requirement. To meet the needs of intelligent design, we can collect product parameters, environmental parameter information, and so on. Secondly, in order to ensure these work, energy module can judge information better and realize human-computer interaction. Processors are needed to filter the collected signals digitally: wave, decision-making, feature extraction, and other information processing. Finally, the hardware design of the system needs to be comfortable and accessible. It is mobile and convenient for normal human activities. Figure 3 shows the 4 levels of the wearable system.

3.3.2. Driver Layer. Driver layer can provide a unified signal interface to service layer according to the characteristics of each functional sensor module.

3.3.3. Service Layer. As the core level of the system, the service layer realizes the preliminary acquisition of information through signal allocation, scheduling, and decision-making. Fusion and wisdom can ultimately achieve high-level fusion of information to meet the requirements of different applications.

3.3.4. Application Layer. The system can be used for different users to meet the relevant application needs. Different scenarios are implemented according to different design requirements.

4. Information Processing Analysis Based on Wearable Devices

Photoelectric pulse sensor has high integration and is easy to use; noncontact measurement can be realized; output signal stability is fixed, and there are no signal amplification processing or filtering processing and other advantages. Pulse sensor has high sensitivity, low complexity, and low adjustment circuit. The characteristics of good output effect fully meet the design requirements of the hardware circuit of the system. IAR is the main working environment of software system design and compilation in this paper. IAR embedded workbench is a type stable, complete, and easy to apply professional embedded application development tools; its C cross compiler function is powerful, compatibility to be strong. IAR embedded workbench can provide a unified user interface for different microprocessors. At present, it supports at least 35 8-bit, 16-bit, and 32-bit ARM microprocessor architectures. Fully compatible with standard C language, the program speed of the built-in corresponding chip is fast, which supports efficient floating point operation, memory mode selection, and so on. Figure 4 shows the sensor pulse measurement graph.

According to the data in Figure 4, it can be seen that our measurements are divided into five groups, and each group uses this system measurement and professional system measurement to form a data comparison. After the experimental data, it is found that the difference between the two systems measurement is small, which shows that the measurement system designed in this thesis has practicality.

Although the above method can achieve pulse frequency acquisition, the pulse signal sampling cycle is too long, the user waiting time. In response to this problem, it immediately occurred to reduce the timing time to 10 seconds to calculate the pulse signal in this period of time to estimate the number of pulse signals per minute with the obtained value. Arithmetic mean filtering is one of the software filtering methods; it is suitable for random interference signal filtering and simple implementation. The specific implementation method is as follows: set the timing time to 5 seconds and calculate the pulse within 5 seconds. The number of beat signals and the sampling values within 3 timing times is obtained continuously, the arithmetic mean value is taken, and the arithmetic mean filtering is carried out. Finally, the number of pulse signals per minute is obtained.

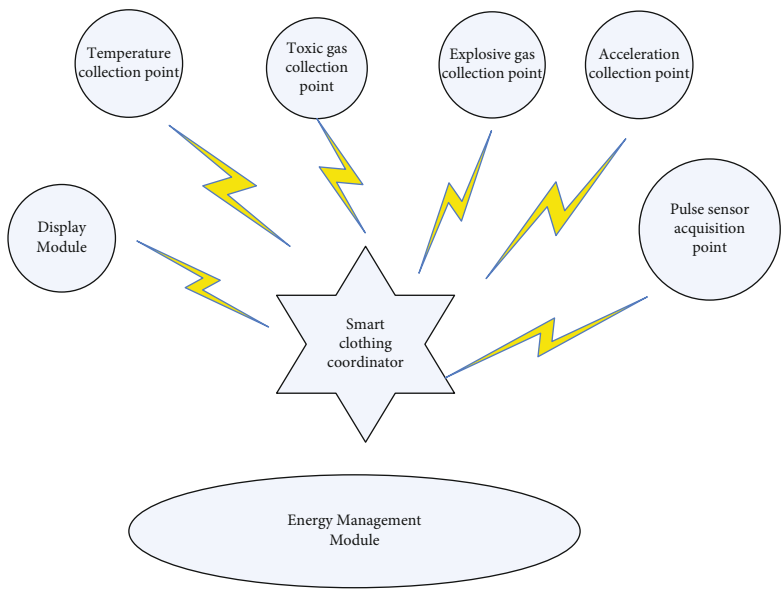

Figure 2: Wearable function module diagram.

Table 1: Wearable data fusion model.

Input	Output	Description
Data	Data	Data-level convergence
Data	Features	Feature extraction
Features	Features	Feature fusion
Features	Decision-making	Pattern recognition
Decision-making	Decision-making	Decision convergence

5. Attitude Discrimination Based on Data Fusion Algorithm

In this paper, MMA7455L sensor is used to collect the triaxial acceleration of human body, and the information is summarized. Combined with the treatment, the body posture of field rescue personnel was determined. The following uses different algorithms for analysis and discrimination. The method is from easy to difficult, and the accuracy is from low to high. Data fusion technology utilizes computer technology and embedded technology to multiplex. The information obtained by sensors, under certain rules, can be intelligently analyzed, optimized, and synthesized to complete the decisions and estimates we need. The optimal data fusion algorithm is selected to train and analyze the collected triaxial acceleration values so as to realize the difference. Table 2 shows the comparison of fatigue detection methods.

According to the data in Table 2, it can be seen that each of the three methods has its own advantages. The physiological parameters are measured with better reliability but must be in physical contact with the user, the vehicle operation measurement is greatly influenced by the measurement model, and the driver behavior measurement is simple to operate.

5.1. Empirical Value Fall Algorithm Based on a Single Acceleration Sensor. The acceleration sensor module designed in this paper can make corresponding signal acquisition and judgment according to the product. In this paper, an empirical value fall detection and analysis algorithm based on statistical theory is designed, which can collect three squares of triaxial acceleration.

5.1.1. Establishment of Spatial Coordinate System. Point O through space as three perpendicular number line, they all start with O and have the same unit length. These three number axes are x-axis, y-axis, and z-axis, respectively, which are collectively referred to as coordinate axes. As shown in Figures 2 and 3, it works on an upright product. Firstly, a three-dimensional coordinate system is established to facilitate the judgment of triaxial acceleration. MMA7455L sensor is adopted in this paper. It is a three-axis acceleration sensor, it can detect the movement and direction of objects, and it is based on the movement and direction of objects. Change the voltage value of the output signal. The placement of sensors must also be strictly controlled; otherwise, it cannot accurately obtain the three axes of information.

5.1.2. Establish Human Motion Model. The coordinate system has three vectors perpendicular to each other, and any vector change through any point in space will have one. The sum of three vectors in space is better to have a vector with both magnitude and direction than acceleration in all three directions. The space vector and calculation are shown in

$$a = xi + yj + zk. \tag{1}$$

Changes in parameters collected by the acceleration sensor are caused by the product. Now, the accelerations in the three directions are set asax,Ay, and$az$with three values. In this paper, the support vector machine is used to reduce the computational complexity and the amplitude of the

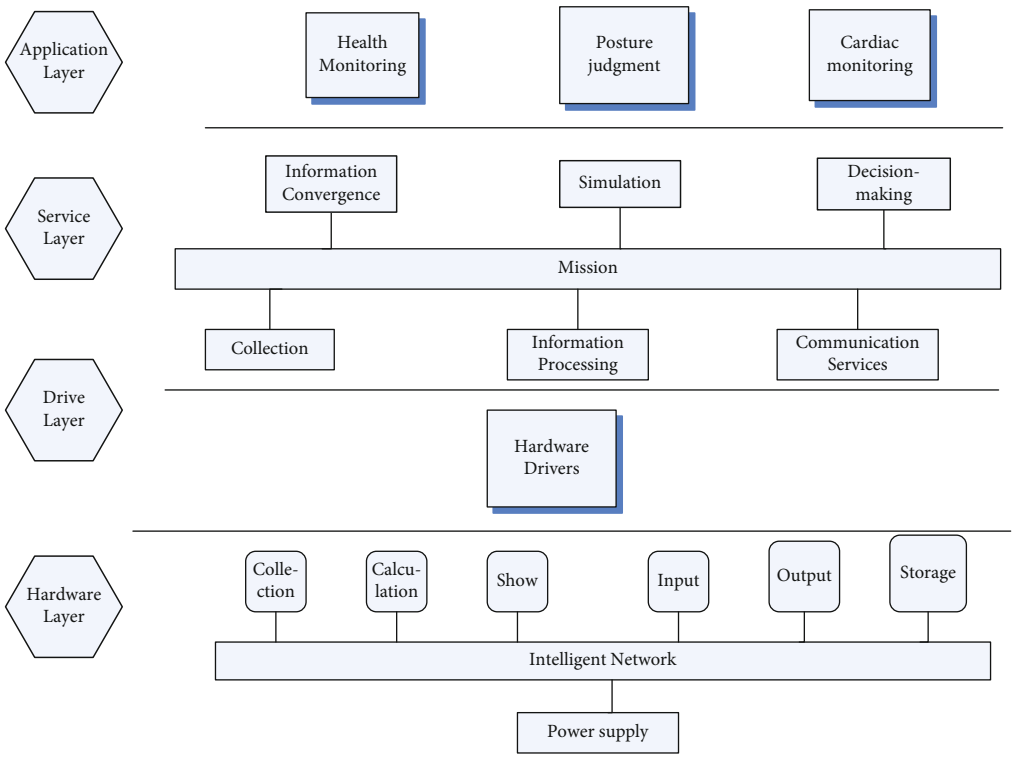

Figure 3: Wearable system hierarchy.

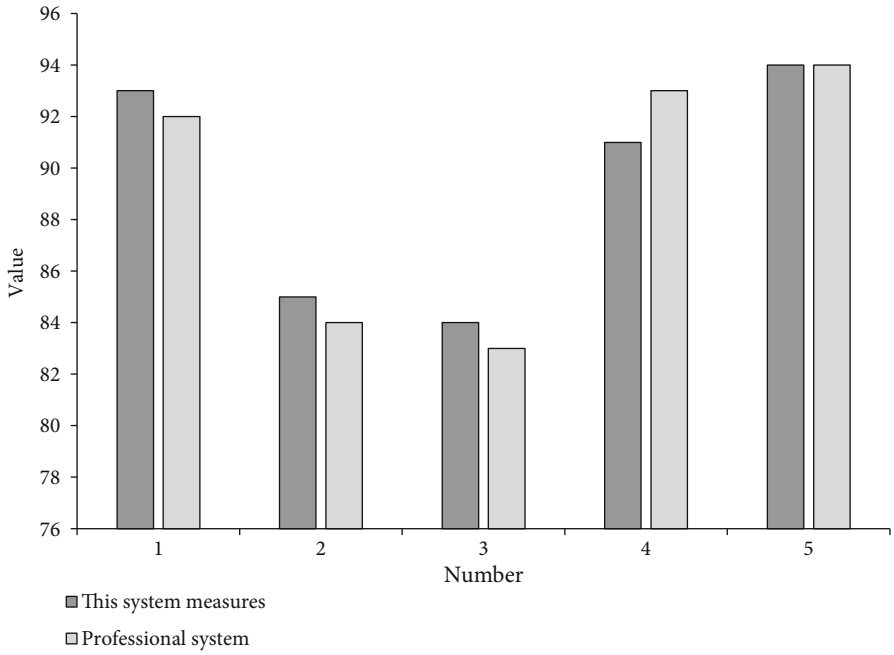

Figure 4: Sensor pulse measurement graph.

Table 2: Comparison of fatigue detection methods.

Method	Features	Reliability	Practicality
Physiological parameters	Physiological indicators	Better	Contact with the body
Vehicle operation	Vehicle status	Poor	Influenced by model
Driver behavior	Facial features	Low	Easy to use

Table 3: Acceleration action data characteristics.

Features	Description
Acceleration	The acceleration with the largest window difference
Angular velocity	Sum of speed
Average speed	Regular speed

Table 4: Moment brain wave states.

Type	Frequency	Status
Delta	0.1-0.2	Sleep
Theta	4-6	Fatigue
Alpha	10-15	Relaxation
Beta	12-29	Tension

Table 5: Televoting rate settings.

BO	B1	Baud rate
Low	Low	9500
High	Low	1100
Low	High	58000
High	High	*

Table 6: Packet format description.

Marker	Description
!	Start
Ac0	Acceleration
Gy0	Angular velocity
Att,med	Concentration

acceleration. Vector changes can reflect the intensity of product movement. Then, the resultant acceleration is shown in

$$a = \sqrt{a_x{}^2 + a_y{}^2 + a_z{}^2}. \tag{2}$$

When the acceleration in three directions is known, the change angle of product posture can be obtained, which can be used to calculate the angle alpha between the fall and the vertical direction of the ground, as shown

$$\sin \alpha = \frac{\sqrt{a_x{}^2 + a_y{}^2 + a_z{}^2}}{|a|}. \tag{3}$$

Similarly, the angle values in the other two directions can be obtained. In this paper, the angle difference between the two postures is calculated. The value, according to the trend of change, can judge whether the state of the product changes dramatically. Table 3 shows the acceleration action data characteristics.

5.1.3. Specific Implementation of the Empirical Value Algorithm for a Single Acceleration Sensor. Judge whether to fall forward: the forward fall is mainly caused by the acceleration change of z-axis and x-axis and the acceleration of y-axis. The degree basically does not fluctuate much, and the angle between the x-axis and the z-axis also changes a lot. For a single acceleration sensor, it has been verified by a large number of experiments that the change of a caused by product vibration will not exceed 1/2 g, because the y-axis acceleration is essentially unchanged, except that the acceleration in the other two directions is not exceeding the acceleration due to gravity. The sample can preliminarily set a boundary with the acceleration, as shown in

$$\frac{1}{2}\mathrm{g} < a < \sqrt{2}\mathrm{g}. \tag{4}$$

But this restriction alone does not preclude a change in attitude angle caused by a product squatting down sharply, even though it is X. The acceleration in the y-axis direction is basically unchanged, but the z-axis direction changes a lot, so it is not possible to accurately judge whether a fall occurs. It can be concluded from experience that when the acceleration change in the x-axis excludes vibration interference, the acceleration change in its direction exceeds 1/5 gravity. Acceleration can be used to determine whether the product falls by adding the limited conditions of formula (5). The angle between the two will increase, and when the angle value changes more than 55 degrees, it can be judged that the product is in a forward leaning state.

$$a > \frac{1}{5}\mathrm{g}. \tag{5}$$

5.2. Fall Detection Algorithm Based on Secondary Judgment

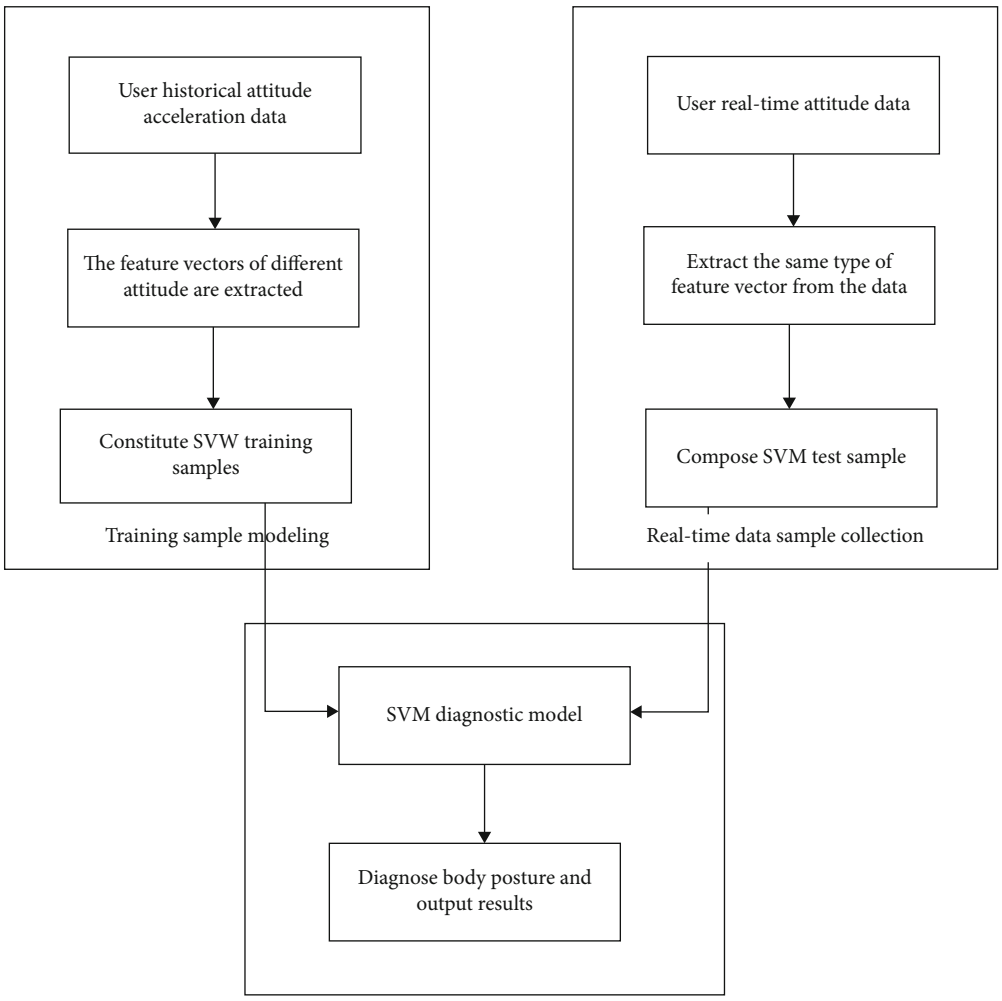

Figure 5: SVM human posture feature extraction.

5.2.1. Algorithm Flow of Secondary Judgment and Fall Detection. The fall detection method of secondary judgment designed in this paper is to add the fall time on the basis of the empirical value fall algorithm The change of speed is judged by the over threshold. When the critical threshold is reached, a timer is used to start the timing for 30 seconds, if within 30 seconds. If the acceleration remains the same, that means the fall. Otherwise, if you go back to the upright position in 30 seconds, the acceleration will be the same change, so that it can be judged as a miscarriage of justice, cancel the alarm, so as to effectively improve the accuracy of the judgment. Table 4 indicates the brain wave states at this moment.

According to the data in Table 4, it can be seen that after the measurement of the physical state by professional instruments, the mental state at different time periods can be accurately predicted, and then, the experiment can be conducted according to different states. Table 5 shows the telecast special rate setting.

According to the data obtained needed to be described, the data is judged and parsed, and the individual results are judged in real time, with specific reference to Table 6.

According to the Table 6 data system, TÜV sets specific markers for each data in advance in order to pack and unpack the data, so that misordering can be avoided during data sending and receiving.

5.3. Figure Recognition Based on SVM. SVM is based on statistical theory, according to the complexity and learning ability of finite sample information model. Seek the best compromise between, in order to obtain the best generalization ability. SVM is mainly used to solve a small number of samples in the pattern. There are great advantages in recognition, which can be extended to learning problems of function fitting and other machines [19, 20]. In this paper, SVM is proposed. The realization of the classification algorithm for human gesture recognition requires two stages: training stage and recognition stage. In the training stage, section mainly establishes different classification models for acceleration values of several different dimensions of acceleration sensor and in the identification phase online identification of different test samples.

5.3.1. SVM Human Posture Recognition Steps. The training of the original data samples mainly consists of the following three steps, which correspond to the SVM human posture recognition in the figure above. Other system block diagram is as follows: (1) for the known attitude I $(I = 1, 2, 3 \cdots, n)$

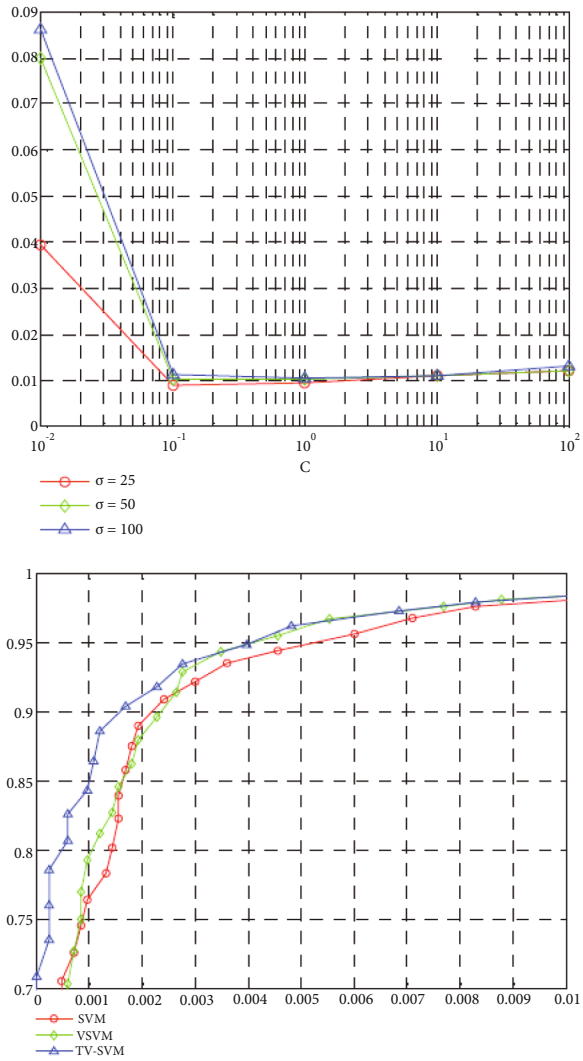

Figure 6: Comparison of data fusion algorithm.

collect data as training samples; (2) to extract the same eigenvalue (triaxial direction and parameter size of different attitude) from the data to form the eigenvector; and (3) establish a multiclassification model for existing data samples. After the completion of the training, the real-time data are diagnosed and identified.

5.3.2. SVM Human Posture Feature Extraction. In the process of product posture discrimination as shown in Figure 5, different features can be extracted from the values on each axis of the acceleration sensor. To obtain the signal characteristics of time series, in the description of relevant literature, four features are usually selected as the posture characteristics of human body. The characteristic data are mean value, variance, correlation coefficient, and data value of each dimension. In this paper, by placing sensors in different places, the state is used for data collection and the characteristic parameter values of X, Y, and Z in three different directions. Based on the existing 80 sets of data, 320 feature vectors were trained and extracted, among which 160 stood up, 40 fell forward, forty left, forty right, and forty down. These original eigenvectors are associated, every four vectors as one. The discrimination group, in the process of training, uses the self-detection classification algorithm to evaluate, uses the training data set to train the classification model, and uses the classification model to classify the test data. SVM self-detection classification algorithm is adopted, and SVM branch is used. The vector machine is used to judge the test data.

5.4. Decision Layer Data Fusion Is Used to Judge the Fall State of Human Body. Data fusion at the decision-making level belongs to the highest level of information fusion, through the calculation of the original data, feature recognition and the corresponding logical operation, and the final output decision results. The comparison of data fusion algorithm is shown in Figures 5 and 6, which is the general classification of information analysis and processing, in a more humane and accurate way to identify the product, and when the data processing is associated with the upper computer algorithm, remote real-time monitoring and alarm can be issued to facilitate display.

6. Conclusion

This paper is combined with the existing acquisition module design to achieve the upper computer online information monitoring system, using VS2010Platform, serial port communication, IAR, and other platforms adopting C# programming language to display the data of each acquisition module in real time. Monitor, analyze, and alarm abnormal data and information. Real-time mapping technology is adopted to change the trend of data collection, potential for real-time tracking and monitoring. The monitoring data can be predicted and analyzed by changing trend, at the same time combined withSQL2008 database technology, user login system, registration system, monitoring system, data query, and data storage system The integration and other functions are improved, so that the system not only has the advantages of information management platform but also realizes the remote client base matching layer wireless information real-time monitoring function. In this paper, the three-axis acceleration of the acceleration module is analyzed. With calculation, different algorithms are adopted to track and distinguish the product. Smart wearable devices can to some extent to prevent serious consequences caused by the occurrence of hazards, reduce the hazard index, and facilitate timely rescue, in real life is very necessary. The intelligent wearable online information monitoring system designed in this paper realizes wireless sensor network to some extent feedback and monitoring of underlying real information. Through the corresponding information processing and data fusion, the user can easily and clearly get the product parameter information reflected by human physiological parameters and does not have to tangle with the underlying network structure and data calculation. Although wearable devices designed in this paper can achieve the purpose of prediction and monitoring, the collection accuracy and algorithm are divided into two parts.

The optimization degree of analysis needs to be further improved and deepened.

Although this paper has carried out in-depth research on virtual display information processing and data fusion using wearable devices, there are still many deficiencies. The depth and breadth of this research is not enough, and my academic level research is also limited. According to the existing technology and level, we will study suitable ways and means from more angles and continuously improve the quality and performance of the technology.

Data Availability

This article does not cover data research. No data were used to support this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Research Article

Administrative Punishment Supervision System Based on Internet of Things Driven by Big Data

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In order to study the administrative punishment supervision system based on the Internet of things driven by big data, firstly, based on the full collection of materials, this paper makes a detailed induction and analysis from the perspective of demonstration, and discusses the problems existing in the practice of administrative punishment. In terms of theory, first determine the concept of administrative punishment from the overall direction, and then locate it to administrative punishment. Then, it analyzes the specific contents of the construction of the supervision system based on the Internet of things driven by big data and the key technologies of the cloud platform system of the Internet of things. Finally, focusing on the judgment cases published by the municipal and county courts in a province from 2014 to 2017, the analysis results are displayed, discussed, and summarized. The results show that the construction of intelligent supervision system is realized, the intelligent response to supervision needs is completed, and the scientific and effective supervision is promoted.

1. Introduction

As one of the important state powers, administrative punishment plays an irreplaceable role in the operation of administrative power in China, which is closely related to the vital interests of citizens, legal persons, and other organizations. Administrative punishment is an important state power (Figure 1), which plays an important role in the operation of administrative power in China and is closely related to the vital interests of citizens, legal persons, and other organizations. Its establishment and application are related to the power allocation of various state organs and the reform of administrative institutions, as well as the coordination and rationality of the legal sanctions system. Due to the differences in tradition, economy, culture, politics, and law, the differences in legal tradition, cultural origin, political environment, and economic situation in western countries also lead to the differences in administrative punishment, showing different characteristics. The expression of administrative punishment in civil law and common law countries is also different. Administrative means an administrative position, noncombat administrative service. Civil law countries call it "administrative penalty," that is, the sanctions given to the acts that violate the obligations stipulated in administrative law. "Administrative penalty" has different understandings in broad and narrow sense [1]. In a broad sense, administrative penalty refers to the legal sanctions against those who violate administrative obligations, including administrative penalty and order penalty. In a narrow sense, administrative punishment refers to the sanctions against the perpetrators who violate administrative obligations but have not yet constituted a crime. Its content limits all administrative punishments except administrative punishment. The system of administrative punishment is relatively developed in civil law countries including Germany, Austria, Japan, and Italy. The administrative punishment in Germany can be traced back to the police punishment. The federal system in Germany enables the States to enjoy a certain degree of national sovereignty and autonomy in a certain range of affairs. The division of authority among the States

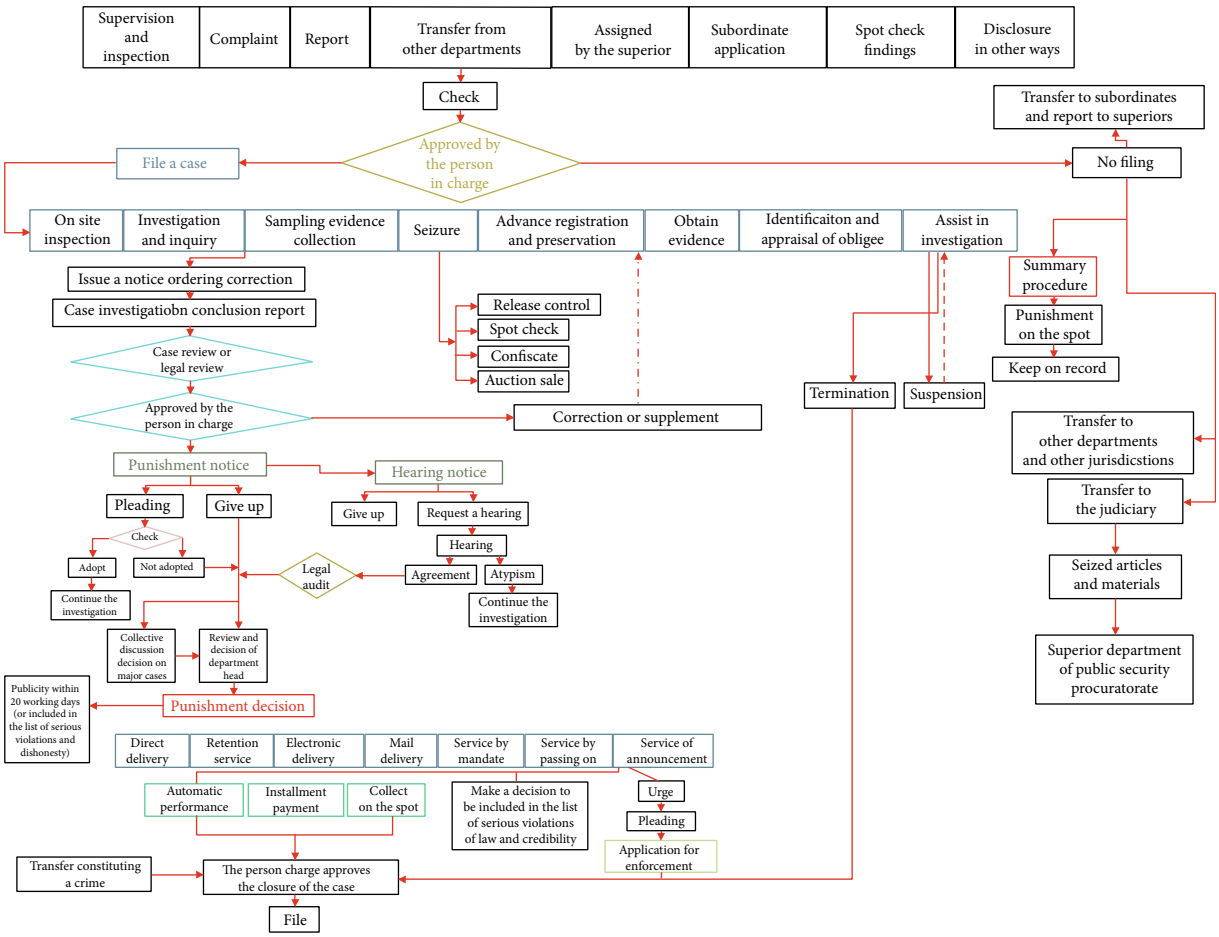

Figure 1: Administrative penalty system flow.

also enables the States to enjoy unique jurisdiction over affairs, and other states cannot interfere [2].

China's legal circles have different expressions on administrative punishment and the concept. The following statements have great influence: (1) Administrative punishment is "the sanctions given by the state administrative organ to those who violate administrative regulations. If only minor violations are not enough for criminal punishment, the punishment must be in accordance with the provisions of the law." Therefore, administrative punishment can be summarized as a specific administrative act implemented by a specific administrative organ or other statutory organizations. What kind of organization can exercise the power of administrative punishment in what aspects is clearly authorized by legal norms, and not any administrative organ has the power of administrative punishment. Although administrative penalties are often implemented by individuals, the perpetrators are in the name of the organization rather than in the name of individuals. Administrative punishment is a kind of disciplinary action against the offender and a kind of administrative legal sanction. This kind of measure will punish the violator so that he will not repeat it in the future. Therefore, from the perspective of time continuity, it is often a one-time, unilateral expression of will of the administrative subject based on the administrative power, and cannot be mediated or negotiated [3]. With the deepening of judicial openness on the Internet in China, the information of judicial power operation can be obtained more conveniently, and the data we can store and process has reached an unprecedented level, which provides the original data for the analysis of legal big data. Apply a thorough revolution of the traditional sampling survey to the legal field, that is, legal workers use big data technology to extract, analyze, and summarize the information made public by the judiciary, so as to get the problems existing in the same type of judicial information at the current stage and the relationship between the information. The conclusion drawn in this way will be more comprehensive, accurate, and referential, and then analyze, summarize, and reflect on the problems, which is the due meaning of modern legal research [4].

On this basis, from the perspective of big data, this paper puts forward the idea of promoting the construction of grass-roots administrative law enforcement supervision platform and solving the problem of poor collection of administrative law enforcement information and incomplete mastery of supervision subjects. First, strengthen organizational leadership and break the interest "barrier" of data island; second, enrich data types and promote the use of law enforcement recorders and other equipment in the whole process; third, strengthen data sharing, explore the

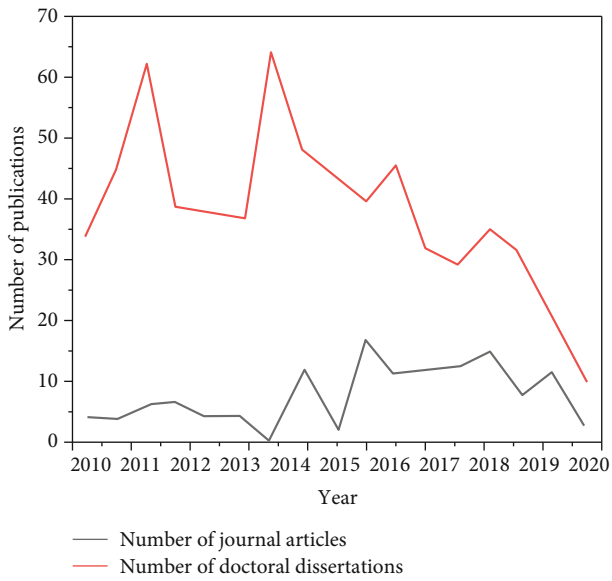

Figure 2: Number of papers on administrative supervision or administrative law enforcement supervision.

application of blockchain technology in big data, prevent information from being tampered with, and implement a distributed administrative law enforcement data sharing and storage mode; fourth, strengthen clue sorting, give play to the role of artificial intelligence research and judgment of big data, and strengthen the analysis of the objects and facts involved; fifth, strengthen investigation and verification, and strengthen the docking of big data supervision platform with case file evaluation, discipline inspection and supervision, judicial supervision, public supervision, and other supervision methods [4].

2. Literature Review

In recent years, the works introducing foreign administrative supervision are shown in Figure 2, and more introduce the content of framework system construction from a political perspective. Ghaniur Rehman and others pointed out in the analysis on the failure of supervision behavior of government administrative departments under information asymmetry that the principal-agent relationship between government administrative departments and supervised units puts government administrative departments in an information inferior position, resulting in the failure of supervision [5]. Lomba, A. and others believe that generally speaking the efficiency of supervision depends on the quantity and quality of information. Some supervised units do not provide original information, or even deliberately provide information that conceals the truth, or provide changed information, resulting in information asymmetry. In addition, the functions of the administrative department check the paper documents afterwards and lack the way to search the information of the supervised object, which leads to the failure to find the loopholes and unreasonable behaviors in operation in time, which is bound to affect the accuracy and effectiveness of supervision [6]. Therefore, none and others proposed to build a flat administrative organization, reduce information filtering, and promote a faster understanding of the information of the supervised units; establish an effective information disclosure system for supervised units; and establish an effective incentive mechanism and punishment mechanism for immoral behavior [7]. Zhang, Y. and others pointed out in the analysis of anti-corruption strategies from the perspective of information asymmetry that since information asymmetry is common between supervision departments and supervised departments, discipline inspection and supervision departments are often in a passive situation because of the limited information they have for various reasons [8]. Jnr, B. A. and others pointed out in the research on information asymmetry in public policy implementation that before the 20th century, many regions and departments in China obtained and released relevant policy information through original communication [9]. In the book development and utilization of government information resources, Hosseini, B. and others summarized and studied the practices and deficiencies in the development, integration, openness, sharing, and value-added services of China's government information resources, and believed that government information sharing is an important starting point for political democratization, building a service-oriented government and avoiding resource waste [10]. Alsaig, A. and others put forward in the book administrative information disclosure in Transitional China that anyone has the right to obtain any information other than the exclusions of organizations exercising public power, and its right basis is the right to know based on the nature of freedom and social rights. The democratization of administrative power is the basic power basis of the administrative information disclosure system. China's administrative information disclosure system should take the elimination of state obstacles, the state's active disclosure, and the disclosure at the request of everyone as the basic form [11]. Tao, F. and others combined with specific examples in the transition period, analyzed the problems existing in the administrative disclosure system, such as the strong color of the rule of man, the lack of deep research on the subject system of administrative disclosure, the large discretion of the disclosure content, the long time to process the request, and the lack of relief means, and put forward some opinions on the development of China's administrative information disclosure system [12].

3. Analysis of Key Technologies of Internet of Things Cloud Platform System

3.1. Analysis of Internet of Things Architecture and Message Transmission Technology

(1) Introduction to Internet of things architecture

Nowadays, the Internet of things has been slowly applied in different industries, such as home appliances and medical treatment. As shown in Figure 3, the system architecture of the Internet of things can generally be divided into three

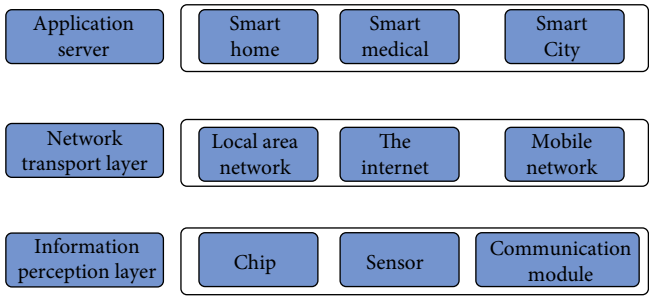

Figure 3: Internet of things system architecture.

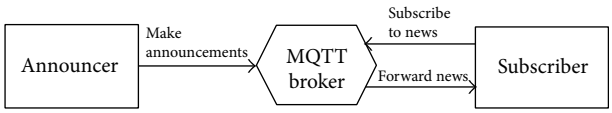

Figure 4: MQTT publish/subscribe model.

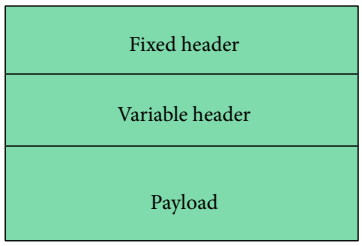

Figure 5: MQTT message structure.

layers: information perception layer, network transmission layer, and application service layer [13].

Among them, (1) the information sensing layer is generally the terminal device in the Internet of things, which obtains the data around the device through RFID, sensors, embedded systems, and other technologies, and connects the device to the network transmission layer and application service layer through ZigBee, Wi-Fi, and other wireless network technologies, so as to realize data transmission and sharing; (2) the network transmission layer generally provides network connection for the information perception layer and the application service layer. The system can choose to send data to the cloud platform quickly and reliably through wireless or wired communication technology, or two communication modes at the same time; (3) the application service layer is generally the service management center of the platform network. It can obtain the equipment data from the network transmission layer and process it, such as calculation, storage, and data mining, and then realize different user functions through the information or results obtained by processing.

(2) Analysis of message transmission protocol

When the terminal is integrated into the network through wireless communication technologies such as Wi-Fi and ZigBee, it needs to provide a stable and reliable message transmission mechanism for data interaction. Through relevant technical analysis, Matt protocol has the advantages of good timeliness, high transmission efficiency, and stable transmission mode in the scenario of Internet of things. Therefore, this paper uses Matt protocol as the communication protocol of message transmission, which is responsible for the rapid transmission of the obtained data to the cloud platform through a stable and reliable transmission mode. As shown in Figure 4, the publisher of the message can publish the message through the message server broker, and the subscriber of the message can also subscribe to the message through the message server. In this way, when the publisher publishes a message, the subscriber can receive the message pushed by Matt Broker at the first time, and both sides of message communication can play the role of publisher and subscriber [14].

In the process of transmitting messages, MATT needs to specify the Topic and Payload to be transmitted. Topic is the type of message to be transmitted. Subscribers obtain the message of the Topic by subscribing to the specified topic. Payload is the message content to be transmitted. The specific format of Matt message is shown in Figure 5, which is mainly composed of Fixed Header, Variable Header, and Payload. The fixed message header is generally used to mark the topic of the message, the size of the message, and other general information. The variable message header does not necessarily exist in all messages. It is mainly used to identify the data header of a specific message, while the message style is used to store the part of the content to be sent by the user.

The corresponding input net_i of the hidden layer at the i node:

$$net_i = \sum_{j=1}^{M} w_{ij} x_j + \theta_i. \tag{1}$$

The corresponding output of the hidden layer at the i node is y_i:

$$y_i = \varphi(net_i) = \varphi\left(\sum_{j=1}^{M} w_{ij} x_j + \theta_i\right). \tag{2}$$

The corresponding input net_k of the output layer at the k

node:

$$net_k = \sum_{i=1}^{M} w_{ij}x_j + a_k = \sum_{i=1}^{q} w_{ki}\varphi\left(\sum_{j=1}^{M} w_{ij}x_j + \theta_k\right) + a_k. \quad (3)$$

The reverse transmission of the error starts from the output layer to calculate the output error value of each layer of neurons, and then relies on the error gradient descent method to correct the weights and thresholds of each layer, so that the final output of the adjusted network structure can be as close to the expected value as possible [15].

The quadratic error function corresponding to each sample p is E_P:

$$E_p = \frac{1}{2}\sum_{k=1}^{l}(T_k - O_k)^2. \quad (4)$$

The sum function of the error function of the entire network for p training samples is:

$$E = \frac{1}{2}\sum_{P=1}^{P}\sum_{K=1}^{L}\left(T_k^p - O_k^p\right)^2. \quad (5)$$

3.2. Functional Requirements Analysis of IOT Cloud Platform System. A basic Internet of things cloud platform system should complete four functions: information acquisition, information transmission, information processing, and information efficiency. Among them, the information acquisition function refers to the collection of data information by the sensing device and the representation of its state, which can be realized by RFID, sensor, and embedded system; information transmission function refers to the information sending and receiving function between different modules in the whole system, and can be transmitted to a public platform for subsequent processing, so as to realize an efficient information network and ensure that the network is reliable; information processing function refers to the data processing process, through the subsequent processing and mining of the data and information transmitted from the terminal to the cloud platform, to obtain valuable information; information application function refers to the process of obtaining results from relevant information and feedback to adjust the running state of things. Therefore, to sum up, the cloud platform system implemented in this topic should be able to complete the following functions:

(1) The terminal sensing device can collect, analyze, and upload the fire environment information in the building, and can monitor the instructions sent by the cloud system in real time, decode and analyze the instructions, and then complete the corresponding state conversion according to the instructions [16];

(2) When the terminal sensing equipment in the building detects abnormal information, it can carry out fire early warning operation and circuit breaking operation, and report the alarm information to the cloud, and then the cloud will analyze, store, and push the message content to the user for subsequent processing

(3) The cloud platform can provide a stable operation environment for the operation of applications. Various services in applications can be deployed in the cloud platform in a distributed architecture, and various application services can run stably, efficiently, and safely [17];

(4) The cloud platform can provide a normal and stable connection for the terminal equipment, and can perform security verification, storage, forwarding, and other related operations on the information transmitted by the terminal sensing equipment in the building, so as to facilitate the subsequent processing of the system

(5) The cloud platform can provide a stable and reliable data warehouse to store the data uploaded by the terminal sensing device and the data of the user system for subsequent processing

(6) The system can store, analyze, and count the collected data, and display it on the front page of the system in the form of visualization, so as to provide data support for users' decision-making [18];

(7) The user can remotely monitor the status information of the fire-fighting equipment in the building, and the system can provide the user with an interface for the user to query the detailed information, historical monitoring data, and data statistical results of the equipment

(8) The system needs to provide an interface for users to query, maintain, and manage the fire equipment information and system user information stored in the system, so that the current information maintained in the system is the latest information

3.3. Overall Construction of Intelligent Supervision System Based on Internet of Things and Big Data

(1) Overall framework

With the support of Internet of things technology and big data technology, we should build a product quality intelligent supervision system that meets the needs of the times and the level of technological development; at the same time, multiple subjects such as regulatory authorities, producers, consumers, and third parties should be included in the regulatory system to form a social network organization and regulatory joint force for supervising product quality. Based on this, this paper proposes a smart supervision system, which is as follows: relying on the Internet of things technology, the supervision departments, product manufacturers, consumers, and third parties are connected to form a common supervision network and communication channels; relying on big data technology, complete the development

and construction of risk early warning module, complaint reporting module, retrospective investigation module, and credit rating module.

(2) Overall framework

The construction objectives of the intelligent supervision system based on the Internet of things and big data are mainly as follows: first, promote the improvement of supervision efficiency [19]. According to the current situation, the traditional supervision mode is no longer applicable. We must establish a new product quality supervision mode, especially for the rapid development of online shopping, form an intelligent supervision system, and enhance the efficiency of product quality supervision. Second, reduce the actual cost of supervision. From the perspective of regulatory authorities, the funds they can use for product quality supervision are relatively limited, so it is very necessary to further reduce the supervision cost. The goal of the construction of intelligent supervision system is to integrate a variety of resources and form a joint supervision force on the basis of ensuring the supervision effect, so as to reduce the actual supervision cost. Third, promote the improvement of product quality. Relying on the construction of intelligent supervision system, strengthen the comprehensive and comprehensive supervision of product quality, achieve the effect of improving product quality, and form a social atmosphere of extensive participation and diversified governance.

(3) Functional structure

The architecture can be divided into five layers, namely, user layer, application system layer, business support layer, data support layer, and information technology facility layer. Among them, the user layer includes regulatory authorities, product manufacturers, consumers, and third parties; in the application system layer, it includes public supervision platform, government supervision platform, industry supervision platform, risk early warning module, complaint reporting module, retrospective investigation module, and credit rating module; The business support layer includes big data technology and Internet of things technology, such as data mining, cloud computing, wireless sensors, and RIFD; the data support layer includes basic database, business database, and platform database; the information technology facility layer includes 4G, 5G, communication technology network, Wi-Fi wireless network, IOT information network, and video monitoring equipment.

3.4. Specific Contents of Intelligent Supervision System Construction Based on Internet of Things and Big Data

(1) Horizontal construction of intelligent supervision system

(1) Regulatory authorities

The supervision department bears the responsibility of the promoter and organizer in the whole product quality supervision activities and the construction of intelligent supervision system, and is the leader of the construction of intelligent supervision system.

(2) Manufacturer

The producer (enterprise) is the producer and provider of products and bears the main responsibility in product quality. For product quality supervision, it is not only a constraint on the manufacturer, but also a protection for the manufacturer, which can effectively avoid the problem of malicious competition and maintain a good market environment.

(3) Consumers

Consumers are buyers and users of products, and product quality is closely related to their personal interests. Consumers' feedback on product quality information is an important way for regulators to obtain product quality status. Incorporating it into the intelligent supervision system can obtain product quality information more accurately, comprehensively, and truly, and provide better support for the implementation of supervision.

(4) Third party

In this study, the third party mainly includes consumer associations, industry associations, professional inspection institutions, media, and other social forces. Bringing it into the command and supervision system can better safeguard the legitimate rights and interests of consumers, help the regulatory authorities accurately understand the product quality information, and improve the pertinence of the law enforcement of the regulatory authorities [20].

(2) Vertical construction of intelligent supervision system

(1) Risk early warning module

For risk early warning, it belongs to the starting point of product quality supervision. In product quality supervision, we must adhere to the supervision mode of "risk" oriented, implementation and prevention oriented. In the operation of the risk early warning module, consumers and third parties realize two-way interaction with the risk early warning module through the public supervision platform (transmitting information and receiving information feedback); The supervision department realizes two-way interaction through the government supervision module and the risk early warning module; the product manufacturer realizes two-way interaction with the risk early warning module through the industry supervision platform. After receiving the information, the risk early warning module relies on big data technology to realize the classification of low-risk enterprises, medium-risk enterprises, and high-risk enterprises, and feed back the relevant information to the regulatory authorities and product manufacturers.

(2) Complaint reporting module

Consumers can participate in product quality supervision by sending complaint information to the complaint reporting module. In the operation of the complaint and reporting module, consumers send complaint and reporting information to the public supervision platform, and a platform transmits the summarized information to the complaint and reporting module; after receiving the corresponding information, the complaint reporting module transmits it to the government supervision platform, and the platform transmits the summary information of complaint reporting to the supervision department; after knowing the corresponding information, the regulatory authorities go deep into the product manufacturer to investigate and verify the situation, and feed back the treatment to the public supervision platform, so as to publicize the investigation and treatment results to consumers.

(3) Traceability module

Retrospective investigation is an important work of the regulatory authorities. The establishment of corresponding modules can improve the work efficiency of the regulatory authorities. With the support of big data technology, extract high-frequency information and transfer it to the traceability and investigation module, which pushes the relevant information to the government supervision platform; after obtaining the corresponding information, the regulatory authorities can trace the source with the support of Internet of things technology, determine the illegal manufacturer, investigate and deal with it according to law, and feed back the relevant information to the risk early warning module; according to the processing information, the risk early warning module adjusts the risk level of the corresponding manufacturer; if the clue comes from the complaint reporting unit, the relevant information will be transmitted to the public supervision platform after the retrospective investigation is completed, so as to ensure that the complainant can accurately understand the handling results; the corresponding processing information will also be transmitted to the credit evaluation module to adjust the credit rating of the corresponding manufacturer [21].

4. Experimental Analysis

In this paper, alpha system and China referee document network are used as retrieval tools, with equal emphasis on authority and authenticity. By inputting the keywords of "administrative punishment" and "Shandong," the administrative punishment cases judged from January 1, 2017, to December 31, 2019, are retrieved, and 235 cases are finally retrieved. Through screening, remove duplicate cases and retain 171 of them as analysis samples to ensure timeliness and representativeness of practical cases of grass-roots public security administrative punishment this year. The order of time is based on the judgment time.

4.1. Data Analysis

Table 1: List of regional classification and judgment results of administrative punishment cases.

City	Win	Lose	Other	Total	Proportion
City A	20	5	1	26	15.20%
City B	19	1	0	20	11.70%
City C	11	2	0	13	7.60%
City D	10	3	0	13	7.60%
City E	10	1	0	11	6.43%
City F	9	1	0	10	5.85%
City G	4	3	1	8	4.68%
City H	5	2	2	9	5.26%
City I	8	1	0	9	5.26%
City K	4	3	0	7	4.09%
City L	4	2	1	7	4.09%
City M	3	3	0	6	3.51%

(1) Overall analysis

Through the above sorting and statistical analysis of the data of previous years, the empirical investigation on the data related to public security administrative punishment from 2014 to 2017 is as follows (see the following chart):

(1) Regional analysis of cases

Among them, the incidence of administrative punishment cases is the highest in City C, with a total of 25 cases, accounting for 15.62%, followed by city B, with a total of 20 cases, accounting for 11.70%, followed by city A, with a total of 13 cases, accounting for 7.60%. The incidence of administrative punishment cases is the lowest in Pingdu, Gaomi, and Anqiu, with only one case, accounting for 0.58%. Then, according to the judgment results, the cases are roughly classified from the perspective of grass-roots public security. The defendant's grass-roots public security is counted as losing if the punishment decision is revoked or confirmed to be illegal by the court. According to the statistics of the cases in which the plaintiff's citizen's claim is rejected by the court judgment, he is in favor. The ruling of rejecting the retrial application and rejecting the prosecution are classified as others, sorted, and summarized, and the following table is obtained (see Table 1). From the rough analysis in the table, we can see that the occurrence rate of grass-roots public security administrative punishment cases is different in different regions, and the concept of rule of law is more popular in economically developed areas. Citizens have high legal quality, and there are relatively few "hate litigation" and "fear litigation." Administrative punishment litigation cases are mostly distributed in City C, City B, City A, and other places. Improving the level of regional economic development will appeal to the law against the non-standard behavior of administrative punishment to a large extent and force the grass-roots public security to standardize the law enforcement behavior of administrative punishment.

Table 2: Cause of action and proportion of administrative punishment cases.

Particular year	Fine	Detention	Fines and detention	Order to stop production and business	Suspension or revocation of license
2014	13	18	14	0	0
2015	21	22	16	1	0
2016	22	17	7	0	1
2017	10	6	3	0	0
Total	66	63	40	1	1
Proportion	37.26%	35.74%	22.18%	0.58%	0.58%

Table 3: List of levels and judgment results of administrative litigation cases brought by citizens for refusing to accept the decision of administrative punishment (unit: piece).

Hierarchy	First instance		Second instance
Judgment result	Maintain the original decision	Reject the claim	Uphold the original judgment
2014	4	15	14
2015	1	30	13
2016	2	10	18
2017	0	1	1
Total	7	56	46
Proportion	7.31%	52.16%	42.30%

Table 4: List of main types and proportion of losing cases (unit: piece).

Project	Type of case	Quantity	Proportion
1	Fine	19	45.34%
2	Fines and detention	9	22.16%
3	Detention	6	15.13%
4	No administrative penalty	5	12.30%
5	Confiscate	1	2.44%
6	Revocation of license	1	2.44%
	Total	41	100.00%

Table 5: List of levels and proportion of courts accepting lost cases (unit: piece).

	Court	Number of cases	Proportion
Hierarchy	Grass-roots people's courts	27	64.95%
	Intermediate people's court	13	32.76%
	Higher people's court	1	3.12%
Total		41	100.00%

(2) Cause of action analysis

The cases in these three years are classified on the basis of cause of action by year. The frequency of fines is the highest, accounting for 37.26%, followed by detention, accounting for 35.74%, followed by fines and detention, accounting for 22.18%. The proportion of ordered suspension of production and business and suspension or revocation of licenses is the lowest, accounting for 0.58% (see Table 2). The administrative punishment applicable to the type of fine has a wide range of illegal acts. For the perpetrator who violates the administrative order, the fine, as a kind of monetary punishment, can leave some room while deterring. For the perpetrator, it is only an economic loss, which can be punished and admonished to promote the public to abide by the law and no longer break the law again. Detention as a restriction on citizens' personal freedom to a certain extent, from the analysis results, the occurrence frequency is also high. The perpetrator violates the administrative order, but does not reach the degree of crime. It is reasonable, legal, and reasonable to use administrative detention to punish him.

(3) Hierarchical distribution and analysis of judgment results

According to the court level and judgment results of the cases accepted by the plaintiff (citizen), there are 109 cases excluding the plaintiff's application for retrial to the higher people's court. It can be seen that in the cases of first instance, the proportion of the judgment rejecting the claim is the highest, accounting for 52.16%, and the judgment upholding the original decision is less, accounting for 7.31%; in the cases of second instance, the judgment results of the cases in which citizens lost the case were to maintain the original judgment, accounting for 42.30% (see Table 3). Based on the number of cases of first instance and second instance, it is found that there is a close difference between the two, which shows that the proportion of citizens who believe that their rights have been infringed and sue to the court is relatively similar to the proportion of continuing to appeal to the court of second instance against the results of first instance, that is, the situation of citizens who continue to appeal to the court of second instance after being rejected by the court of first instance or maintaining the original decision is increasing year by year. It means that citizens' legal awareness is becoming stronger and stronger, and it is common to use legal weapons to defend their rights. This is a sign of further progress towards the era of the rule of the whole civil law [22].

From the results of the above analysis list, we can see that the judgments of 171 administrative punishment cases are systematically sorted and analyzed. Basically, all cases are

Table 6: List of judgment results and proportion of lost cases (unit: piece).

Project	Judgment result	Quantity	Proportion
1	The procedure is illegal, the defendant's administrative punishment shall be revoked	13	32.16%
2	The facts are unclear and the evidence is insufficient, the defendant's administrative punishment shall be revoked	12	28.52%
3	The procedure is illegal, and it is confirmed that the defendant's administrative punishment decision is illegal	11	25.34%
4	The application of law is wrong, the defendant's administrative punishment shall be revoked	5	12.13%
	Total	41	100.00%

litigation cases with citizens as the plaintiff and grass-roots public security as the defendant. Among them, 109 cases were won by the defendant and 41 cases were won by the plaintiff (citizen). It can be seen that the majority of administrative punishment cases in province B from 2017 to 2019 were won by grass-roots public security, that is, in administrative punishment cases, citizens generally have a high rate of losing. Therefore, next, based on the analysis of grass-roots public security losing cases, we will focus on the analysis and discussion of the defendant, that is, the losing cases of grass-roots public security in administrative punishment cases.

(2) Analysis of losing cases of grass-roots administrative punishment

(1) Case type analysis

According to the above statistical analysis, the 41 cases of losing the lawsuit of grass-roots public security administrative punishment are roughly divided into six types (see Table 4): detention, fine, fine and detention, no administrative punishment, confiscation, revocation of license and other types. In terms of the distribution of various administrative penalties, fines account for the largest proportion, about 45.34%; fine and detention followed, about 22.16%; detention ranked third, about 15.13%; fourthly, no administrative punishment, about 12.30%; confiscation and revocation of licenses are the same, both of which are 2.44%. Horizontal comparison of administrative punishment cases shows that among the 41 administrative punishment lawsuits, fines and detention fines are the most serious.

(2) Hierarchical analysis of accepting court

From the perspective of the level of court accepting cases reflected in the judgment documents, the judgments of grass-roots people's courts account for 64.95%, the intermediate people's courts account for 32.76%, and the higher people's courts account for only 3.12% (see Table 5).

The grass-roots people's courts generally accept the litigation actions brought by citizens against the grass-roots public security who have made administrative punishment, such as Ma XX accused Dongying Branch of Dongying Municipal Public Security Bureau, Tian XX and Linqing Municipal Public Security Bureau, the first instance case of administrative punishment of Linqing Municipal People's government, and Wang X and Pingdu Municipal Public Security Bureau. The plaintiff refuses to accept the administrative penalty imposed by the defendant and brings a lawsuit to the people's court; the administrative punishment cases accepted by the intermediate people's court are generally appeals filed by the appellant against the administrative judgment made by the grass-roots court on the administrative punishment. For example, Cao XX and Niuquan police station of Laicheng branch of Laiwu Public Security Bureau have administrative litigation cases in the second instance of public security administrative punishment, Cheng XX and others have administrative litigation cases in the second instance of refusing to accept public security administrative penalty, and Fang XX and Qing District branch of Jinan Public Security Bureau have administrative litigation cases in the second instance of public security administrative punishment; the higher people's court accepts the appeal brought by the appellant against the administrative judgment made by the intermediate court on administrative punishment, such as the administrative litigation case of second instance between Zhang XX and Jining Municipal People's government.

According to the data analysis, administrative penalty litigation cases are generally accepted by the grass-roots people's courts, the intermediate people's courts mostly accept administrative penalty appeal cases, while the higher courts rarely directly accept administrative penalty litigation cases of first instance.

(3) Analysis of the reasons for losing the lawsuit

According to statistical induction and analysis, the judgment results of the court can be divided into four categories in the 41 cases of losing the administrative punishment of grass-roots public security. The judgment result with the largest proportion is: the judgment procedure is illegal and the defendant's administrative punishment is revoked, accounting for 32.16%. The second is that the facts are unclear and the evidence is insufficient, and the defendant's administrative punishment is revoked, accounting for 28.52%. Then, the procedure is illegal, and the defendant's administrative punishment decision is confirmed to be illegal [23], accounting for 25.34%. Finally, the judgment result of the application of law is wrong, and the defendant's administrative punishment is revoked, accounting for 12.13% (Table 6).

The purpose of empirical research on administrative penalty litigation is not to summarize the data, but to find the deeper problems that affect the judgment results and exist in the subjects of all parties to the litigation from the above data. Through the general summary and analysis of the judgment results of administrative punishment litigation cases, it can be seen that the problem of procedural illegality is the problem that the grass-roots public security administrative law enforcement personnel who make administrative punishment pay the least attention to; secondly, the administrative law enforcement personnel have great discretion when making administrative punishment, and impose administrative punishment when the facts are not investigated clearly and the evidence is not adopted completely; thirdly, the professional quality of administrative law enforcement personnel is not enough, and they do not perform their duties in strict accordance with the administrative principle of "no authorization without law."

5. Conclusion

According to the fact that blockchain is a cutting-edge technology in the way of data utilization and preservation and another practical feature from the perspective of big data, this paper proposes to use blockchain technology to prevent the tampering of law enforcement information and realize the real-time sharing of data through the technical characteristics of distributed storage. Then, according to the fact that artificial intelligence is a computer intelligent nervous system based on massive data and the identification and characteristics of big data, it is proposed to strengthen the intelligent analysis, research, and judgment of big data, strengthen the comparison between case file information and on-site law enforcement data, and strengthen the practical effect of administrative law enforcement supervision. According to the characteristics that big data analysis is relevance analysis and fuzziness analysis, it is proposed to strengthen the connection between big data supervision platform and other supervision methods, strengthen investigation and verification, make clues truly become cases, and strive to correct problems such as lax and unfair law enforcement by administrative organs. With the deepening of the construction process of rule of law, it is a wise move to protect the legitimate rights and interests of citizens to find and explore the problems in administrative punishment, and then improve them. This paper adheres to the problem orientation, takes the analysis and summary of the practical cases of administrative punishment as the starting point, deeply analyzes the problems existing in administrative punishment through empirical analysis and comparative research, lists the prominent problems existing in administrative punishment from the aspects of entity, procedure, evidence, and judgment, and puts forward corresponding improvement suggestions.

Of course, although the research conclusion of this paper is put forward on the basis of the analysis of practical problems, it is also drawn under the framework of big data theory. There must be a certain gap from the real landing, both in time and conditions. However, with the rapid development of science and technology and big data, this goal is worth looking forward to and striving for, in order to continuously deepen the construction of China under the rule of law and promote the modernization of national governance capacity and governance system.

Data Availability

No data were used to support this study.

Conflicts of Interest

The author declares no competing interests.

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Research Article

Investigation and Analysis of the Status Quo of Sports Dance Based on Mobile Communication

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Dance sports is an emerging sport that can not only exercise the body but also please the mind and body. Under the theoretical guidance of "lifelong sports" and "health first," in recent years, sports dance courses have not only been introduced in ordinary colleges and universities in China, but the overall quality development of students has been greatly improved, and the call for quality education for the whole people has also been answered. In recent years, the rapid development of mobile communication systems around the world has greatly enhanced the communication services of developed and developing countries to various places. This paper studies the current situation of sports dance based on mobile communication and links the century-old sports dance project with modern mobile communication to promote Chinese sports dance education and summarize more practical experience and methods with reference value. This paper introduces the development of mobile communication technology in detail, focusing on improving the user experience and service quality of sports dance, and introducing the mobile communication network into the geographic grid to solve the problem of the association between the data attributes of the base station and the geographic space. In addition, this paper systematically investigates the current situation of sports dance in A district and designs a targeted questionnaire. On the basis of the analysis of the current situation, corresponding countermeasures and measures are put forward, aiming to provide reference for the development of sports dance and make a modest contribution to promoting the widespread development of national fitness movements and promoting social harmony and civilization progress in the region. The results of the survey show that the residents' sports dance programs have obvious age characteristics, and 77% of the students are 10-20 years old and over 50 years old. In the investigation of the main restrictive factors of sports dance development, sports dance coaches and students both put the restrictive factor of the teaching staff in the first place.

1. Introduction

Sports dance is a form of folk dance that originated in Europe and the United States and has a history of hundreds of years. Sports dance is inherited from European and American traditional court dance and ballroom dance. It is also known as "international standard ballroom dance," and men and women participate together. In the 1930s, sports dance was introduced to China. After years of development, sports dance has become a new star with unique national charm and feeling. In the southern region, physical dance courses are basically popularized in ordinary colleges and universities, and there are many regional studies of sports dance courses. In the northern region, sports dance courses have not yet been popularized in ordinary colleges and universities, and there are very few studies on the regional conduct of sports dance courses. In recent years, sports dance has been widely developed in China, showing its unique charm. The development from sports competition to sports art reflects the further strengthening of people's understanding of sports and is also the result of the need for an aesthetic value required by the development of society at that time.

Through the research on the current situation of sports dance, it can provide practical knowledge and technology

with reference value for the development of sports dance education in China, provide theoretical and scientific basis for the physical and mental health of Chinese people in sports dance activities, and draw appropriate conclusions. This provides an appropriate theoretical basis for the better development of Chinese sports dance, then analyzes the development strategy of Chinese sports dance education, promotes the concept of high-level development of Chinese sports dance, and summarizes higher-level theories, laying the foundation for scientific design.

This paper has consulted most of the relevant materials through the Internet and libraries, summarized the existing research results, and sorted out the relevant theoretical framework. It provides a good theoretical reserve for the smooth development of this research. To make sports dance go to the society, it is better to rely on social forces to establish a sports market. Through the combination of mobile communication technology and sports dance projects, the platform is designed according to the system target requirements, and the corresponding organization and management institutions are established to comprehensively improve the overall quality of residents.

2. Related Work

Immunity and health are closely related. When the body's immunity is strong, it is healthy; otherwise, various diseases will be seen. Sports dance is a leisure fitness exercise that integrates sports, music, beauty, and dance. It takes body movement dance as a compulsory subject and pair or group gymnastics as the main category of sports. Studies have shown that long-term adherence to Taijiquan exercise can significantly improve serum immunoglobulin IgA, IgG, and IgM levels. A. Wang and C. Wang discussed the effect of physical dance exercise on serum immunoglobulin and T lymphocyte subsets in college students. They randomly selected 16 male and female students from the first physical dance class of the public physical education class as the experimental group. They performed bodybuilding exercises 3 times a week, 40 minutes each time, and the training intensity was controlled at a heart rate of 135-150 bpm, 10 weeks in total. In addition, 16 first-grade boys and girls were selected as the control group who did not take physical exercise. All experimental subjects were fasting, and venous blood was drawn from the elbows before and after exercise, but it was not practical [1]. AR (Augmented Reality) is an emerging technology that combines computer and simulation technology. AR (Augmented Reality) uses a computer to create a symbolic environment that immerses the user in the environment. AR can simulate the environment of real objects and show user features such as multidimensional, interactive, and immersive, to achieve an immersive effect. For sports dance, the use of AR technology can also improve the teaching effect. Aiming at the latency and energy consumption of end-to-end devices due to high-speed data transmission and high-tech computing, Xu and Chu proposed a motion dance transmission scheme using the same power allocation on the uplink. First, based on the synergy of the AR sports dance industry, a system model of AR features is established. Second, they conducted a detailed inspection of the structure of the system frame and established a barrier setup to reduce the overall energy consumption of the system. They established a mathematical model of mobile edge computing (MEC), but the application development cost is not low [2]. With the development of modern information technology, the application scope of virtual computer technology is gradually expanding. At present, virtual reality technology has been vigorously promoted and applied in sports training. Virtual reality technology is a comprehensive technology that uses computer, software, and hardware resources to create and experience virtual worlds and generate dynamic simulations of real life. In recent years, it has been widely used in the field of competitive sports, such as diving, gymnastics, trampoline, weight gain, basketball, skiing, and golf. Yuanxiang et al. analyzed the relevant content of sports dance teaching based on his understanding of virtual technology but did not get a clear conclusion [3]. Virtual reality technology can provide teaching teachers and dancers with advanced and scientific training methods and expand the scope of teaching. At the same time, sports dance simulation can promote the development of computer technology. Wang et al. mainly used virtual simulation technology to study sports dance prediction and learned a virtual simulation system for sports dance prediction and practice. The system can provide technical parameters such as team formation configuration, mechanical rationality of movements, and dance coordination for sports dancers and can be used as a powerful assistant for sports dancers. However, it is difficult to achieve all aspects at present [4]. Qi discussed the model of sports choreography assisted by a virtual environment. According to the literature review, the characteristics of dance education can be summarized into the following three aspects. (1) The first type of students has almost no dance foundation, their own conditions are relatively weak, and dance knowledge is relatively lacking. For these students, dance teachers should focus on training them in basic skills and nurturing dance culture, guide and encourage them in the teaching process, and always pay attention to their psychological development. (2) The second type of students has a certain foundation in dance, but they only focus on imitation, without their own style and lack of creativity. For these students, dance teachers should cultivate their creative thinking. (3) The third type of students has a solid foundation in dance and has a certain ability to create dance, but their thoughts fluctuate greatly and are easily disturbed by adverse factors. Therefore, they should be guided in combination with virtual teaching methods. The proposal of this method will promote the development of a sports dance instruction model, but it has not been widely used [5]. Lyu and Tang proposed a physical dance teaching model based on a virtual environment. Dance music is an important means to shape the image of dance art, and it is also an important part of prompting thoughts. Dance is the art of space and time, and music creates auditory images through sound. Dance is a form of the body as a visual image. The combination of the two forms is a dance art form that combines time and space. Music in dance not only gives length to dance

but also makes dance vocabulary accurate, concise, and focused. At the same time, the language and emotional development of dance movements are also reflected in the rhythm. Exploring device development, technical issues, and research trends will have a major impact on the exploration of future images. In the field of education, virtual reality technology clearly presents a three-dimensional space scene, which enables learners to directly interact with various objects in the virtual environment and participate in the change and development of events through various forms [6]. Yoo compares the effects of sports, dance, and yoga programs on body composition, physical fitness, blood lipids, and liver function indicators in the elderly. Method: the subjects of the experiment were divided into sports dance group ($n = 12$, 6 males, age 70.83 ± 5.23 and 6 females, age 68.00 ± 3.03) and yoga group ($n = 12$, 6 males, age 68.33 ± 1.63 and 6 females, age 67.33 ± 2.50). Both groups of exercise programs were performed every 60 minutes (warm-up: 10 minutes, main exercise: 40 minutes, and cool-down: 10 minutes) twice a week for 15 weeks. Results: body composition, physical fitness, blood lipids, and liver function markers were found to have positive effects on all items in both groups, with no significant interaction. A 15-week sports, dance, and yoga program had positive effects on improving flexibility, blood lipids, and alanine aminotransferase. Therefore, long-term regular use of sports, dance, and yoga programs is believed to be beneficial for improving and maintaining physical and physiological variables related to the health of older adults [7]. The above studies provide a detailed analysis of the application of dance, sports, and modern technology. It is undeniable that these studies have greatly promoted the development of the corresponding fields. We can learn a lot from methodology and data analysis. However, there are relatively few studies on sports dance in the field of mobile communication, and it is necessary to fully apply these algorithms to the research in this field.

3. The Combination of Mobile Communication Technology and Sports Dance

3.1. Mobile Communication Technology. Mobile communication refers to the communication between moving objects or between moving objects and fixed objects, and at least one communication object can move. The mobile communication system is mainly composed of mobile switches, communication stations, and mobile phones, as shown in Figure 1. Modern mobile communication technology can be mainly divided into low frequency, medium frequency, high frequency, very high frequency, and ultrahigh frequency. In these frequency bands, technicians can use mobile station technology, base station technology, and mobile switching technology to connect terminal equipment in the mobile communication network to meet people's mobile communication needs.

The development of modern mobile communication systems has gone through five generations [8]:

The first generation (1G) mobile communication system is an analog and semianalog mobile network that emerged in the 1980s and mainly provides voice and voice-related services. Currently, the 1G system has been discontinued in China.

The second generation (2G) mobile communication system is generally defined as the core of digital voice transmission technology, which cannot directly transmit information such as e-mail and software, but only has some basic call and time and date transmission functions. Currently, there are two main systems in the world, GSM and CDMA.

The third generation mobile communication system (3G), compared with 2G, 3G can not only transmit voice but also transmit data, provide wireless network applications, and realize four standards of high-speed data transmission and multimedia broadband services: CDMA2000, WCDMA, TD-SCDMA, and WiMAX [9].

The fourth generation (4G) mobile communication system combines 3G and WLAN, which can transmit high-quality images and video images, and its picture quality is comparable with that of high-definition TVs. The 4G system can achieve a download speed of 100 Mbps, which is a huge improvement compared to the download and upload speeds of 3G, and at the same time meets all the needs of users for wireless services. The current mainstream 4G standards are TD-LTE and LTE-FDD.

The fifth generation mobile communication technology (5G) is a new generation of broadband mobile communication technology with high speed, low delay, and large connection. Its peak theoretical transmission speed can reach 20 Gbps, which is 2.5 GB per second, which is more than 10 times faster than the transmission speed of 4G network.

The characteristics of mobile communication technology are as follows: (1) mobility, (2) complex radio wave propagation conditions, (3) serious noise and interference, (4) complex system and network structure, and (5) high frequency band utilization and good equipment performance are required.

The basic mobile communication station is a bridge between the mobile communication center and the mobile communication network equipment through wireless channels, allowing users to communicate with each other when they are moving [10]. A mobile communication base station consists of internal and external components. The interior is mainly composed of base station controllers, signal receivers, transmitters, and other equipment, which convert and transmit signals without emitting electromagnetic waves. The outside is mainly used for signal transmission and reception, while the antenna is a device that transmits electromagnetic waves to the outside world.

A mobile communication base station is a type of radio station, also known as a radio transceiver station (also known as a signal relay station or relay station). In a specific radio broadcasting area, through the mobile communication exchange, the radio transceiver station transmits the information to the mobile port or fixed telephone [11]. A basic mobile communication station is mainly composed of internal and external components. The interior is mainly composed of transistors, transmission equipment, and other basic station support equipment. The exterior is mainly composed of a support frame (tower), connecting cables (recorder), and antennas. The antenna produces electromagnetic energy conversion, and radio waves are emitted into space [12].

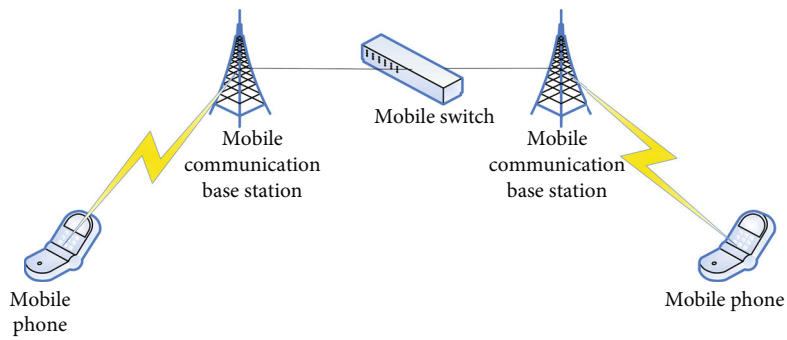

Figure 1: Schematic diagram of mobile communication system.

For a series of network optimization problems, such as how to effectively manage network data, how to evaluate network quality scientifically and efficiently, and how to treat network quality, it is necessary to study the network optimization technology project based on mobile communication network for quality analysis and demonstration system. Solve the existing network optimization problem, ensure the stability of the network to be built, and improve the user experience and service quality of sports dance, network activity, and quality [13]. To fully control network activities and quality status in the entire network, it is first necessary to fully control all kinds of signal data that affect network quality.

Geographical grid is that the earth's surface is divided into surrounding polygonal planes N according to certain rules, each polygonal plane is called a grid unit (called a network element), and each grid unit has a number and number [14]. These polygonal planes are sequentially stitched together before cutting, approximating, and reproducing the surface. Of course, the simulation and regeneration of the surface error must be controlled within the scope of the network element. Its main purpose is to organically combine geospatial locations and geographic features, so that it can locate and present geographic information quickly and accurately. According to the different shapes, geographic grids can be divided into two categories: regular geographic grids and irregular geographic grids. A regular geographical grid divides the earth's surface according to specific mathematical rules and the shapes of the network elements, and its cuts are usually regular shapes, such as squares and hexagons [15]. The network elements of irregular geographic grids generally do not have specific rules, and the division of these grids is often based on geographic features, management areas, and regional functions. Figure 2 is a comparison of regular and irregular grids.

Incorporating mobile communication networks into geographic grids, each entity has its own unique spatial and data characteristics. The spatial dimension is the data used to represent the space size and other information of the spatial entity, and the data dimension is the spatial dimension [16]. Through spatial effects, entity objects can be associated with geographic environments, and entity data attributes can be indirectly associated with geographic environments. The association gives the geographic aspect of the data [17]. In other words, it is how to link the network data generated by the base station with the geographical environment to play the role of network optimization.

The regular geographic grid proposed in this paper effectively solves the linking problem between base station data features and geographic locations. According to the concept of geographically consistent grid, the whole area is divided into several grid planes according to specific grid rules and numbered and marked [18]. The grid to which the base station belongs is determined by the longitude and latitude of the base station, and the number of the base station is based on the effect of the grid to which it belongs and the relationship between network storage data and addition. Base stations and grids are also determined in this way. The regional correlation between the cell signal and the grid is established by the diagonal relationship between the base station cell signal coverage and the grid. Through this area correlation, the network quality score of the base station is allocated to each corresponding grid for analysis according to the area ratio. The following is the calculation method for incorporating specific cellular network quality data into the grid [19].

Figure 3 is a diagram of the relationship between cells and grids. Cells A_1 and A_2 cover grid B_1 at the same time. The overlapping area of A_1 and B_1 is S_1, the overlapping area of A_2 and B_1 is S_2, and the quality score of the indicator P of cell A_1 is P_1. The quality score of the indicator P of cell A_2 is P_2; then, the quality score Q of the indicator P of grid B_1 is as follows:

$$Q = \frac{P_1 * s_1 + P_2 * s_2}{s_1 + s_2}. \tag{1}$$

Assuming that a certain cell B_m is covered by N cells, the calculation formula of the score Q_m is as follows:

$$Q_m = \frac{\sum_{n=1}^{N} P_n * s_n}{\sum_{n=1}^{N} s_n}. \tag{2}$$

Studying the degree distribution of network nodes is the basis for studying network robustness, and different degree distributions of network nodes will lead to different network dynamics [20]. The node degree distribution of the network corresponding to various network models will be introduced in detail below, and the mathematical expression of the

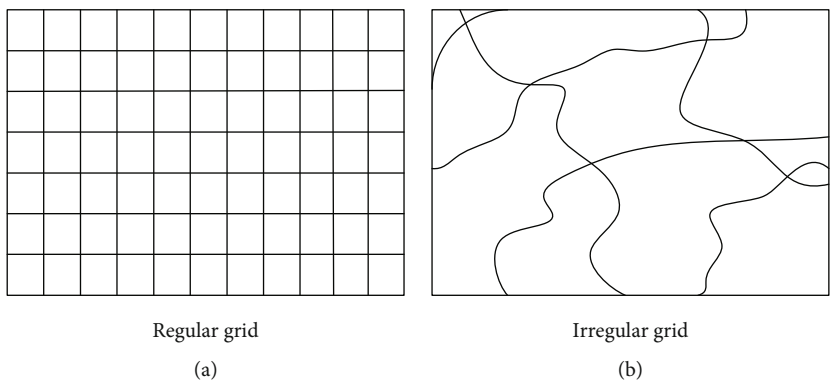

Figure 2: Regular grid and irregular grid rendering.

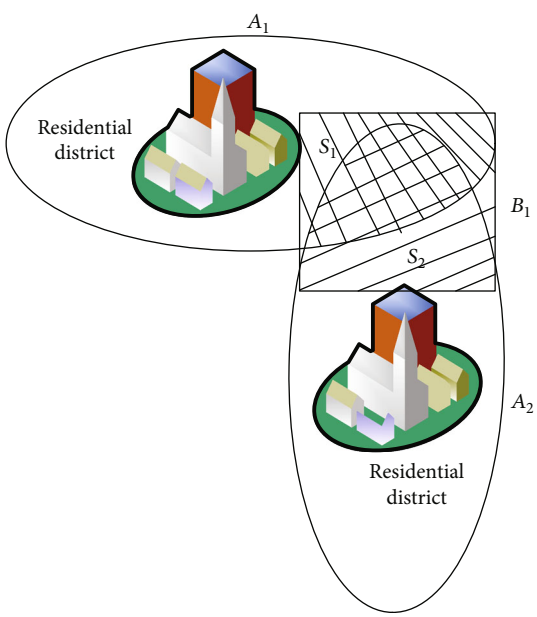

Figure 3: Cell and grid association diagram.

higher-order moment of the corresponding degree will be given.

3.1.1. Regular Network Degree Characteristics. For a regular network, it is assumed that the network has n nodes, and each network node has c neighbors. That is, the degree of any node in the network is c; then, for such a regular network, the probability density function of the degree distribution of the network nodes can be expressed as the following formula:

$$P(k = c) \equiv 1. \tag{3}$$

If the symbol $\langle k \rangle$ represents the average degree of a network, clearly, for such a regular network, the average degree $\langle k \rangle = c$ of its nodes.

3.1.2. Random Network Degree Characteristics. For a random network, assuming that the network has n nodes, and the link probability between any two nodes is p, we first explore the probability of generating a network with n nodes and m edges [21]. Since n nodes will generate at most $n(n-1)/2$ edges, to generate m edges is to sample from $n(n-1)/2$ edges. Extracting m edges, the probability of extracting each edge is p, so the probability of generating a network with n nodes and m edges obeys the binomial distribution shown by the following formula:

$$P(m) = \binom{\frac{n(n-1)}{2}}{m} p^m (1-p)^{n(n-1)/2-m}. \tag{4}$$

So the expected value $\langle m \rangle$ of m is as follows:

$$\begin{aligned} \langle m \rangle &= \sum_{m=0}^{n(n-1)/2} mP(m) \\ &= \sum_{m=0}^{n(n-1)/2} m \cdot \binom{n(n-1)/2}{m} p^m (1-p)^{n(n-1)/2-m} \\ &= p \cdot \frac{n(n-1)}{2}. \end{aligned} \tag{5}$$

Therefore, the average degree $\langle k \rangle$ of the random network is calculated as follows:

$$\langle k \rangle = \frac{2\langle m \rangle}{n} = \frac{2p \cdot n(n-1)/2}{n} = p \cdot (n-1). \tag{6}$$

The degree distribution of a random network is calculated as follows:

$$P(k) = \binom{n}{k} p^k (1-p)^{n-k} = \binom{n}{k} \cdot \left(\frac{\langle k \rangle}{n-1}\right)^k \cdot e^{-\langle k \rangle} \approx e^{\langle k \rangle} \cdot \frac{\langle k \rangle^k}{k!}. \tag{7}$$

The above formula is a Poisson distribution formula, so the degree distribution of the nodes of the random network obeys the Poisson distribution, and its Poisson index is the network average degree of the random network.

3.1.3. Scale-Free Network Degree Characteristics. Assuming that network $B(n, m)$ is a scale-free network, the degree distribution of its nodes obeys a power-law function as shown in the following formula:

$$P(k) = d \cdot k^{-\lambda}, \tag{8}$$

where λ is a power-law exponent and d is a constant. Scientists have found through a lot of statistics that the degree distribution of nodes in many networks in the real world exhibits the power-law distribution characteristic shown above, and the parameter λ usually has a certain range, that is, $\lambda \in (2, 3)$. To analyze the higher-order moments of the nodes of a scale-free network, the size of the constant d needs to be obtained first. Considering that for a power-law function, its cumulative probability density function is 1 for all k values, that is,

$$\sum_{k=0}^{n} P(k) = 1. \tag{9}$$

In view of the fact that usually when discussing scale-free networks, nodes with node degree 0, that is, $P(k = 0) = 0$, are not considered. Second, when generating a scale-free network, the minimum bound a of the degree, which is $k \in [a, n]$, is usually defined. Therefore, formula (9) can be written as follows:

$$\sum_{k=a}^{n} P(k) = 1. \tag{10}$$

Substituting formula (8) into formula (10), we can get

$$\begin{aligned} \sum_{k=a}^{n} P(k) &= d \cdot \sum_{k=a}^{n} k^{-\lambda} = 1, \\ d &= \frac{1}{\sum_{k=a}^{n} k^{-\lambda}}. \end{aligned} \tag{11}$$

In the real communication network, the node scale is very large, that is, the value of n is very large. Therefore, the limit of the above formula can be obtained to obtain the following formula:

$$d = \lim_{n \longrightarrow \infty} \frac{1}{\sum_{k=a}^{n} k^{-\lambda}} = \int_a^{\infty} k^{-\lambda} dk = \frac{1}{1-\lambda} \left[k^{1-\lambda} \right]_a^{\infty} = \frac{a^{1-\lambda}}{\lambda - 1}. \tag{12}$$

Substituting formula (12) into formula (8) has

$$P(k) = \frac{a}{\lambda - 1} \cdot (ak)^{-\lambda}. \tag{13}$$

Next, the higher-order moments of the degree of the scale-free network whose probability density distribution is as above will be calculated. The T moment of the degree of the network is defined as follows:

$$\begin{aligned} \left\langle k^T \right\rangle &= \sum_{k=0}^{n} k^T \cdot \frac{a}{\lambda - 1} \cdot (ak)^{-\lambda} = \int_a^{\infty} k^T \cdot \frac{a}{\lambda - 1} \cdot (ak)^{-\lambda} dk, \\ \left\langle k^T \right\rangle &= \frac{a^{1-\lambda}}{(\lambda\text{-}1)(T - \lambda + 1)} \left[k^{T-\lambda+1} \right]_a^{\infty} \\ &= \frac{a^{1-\lambda}}{(\lambda\text{-}1)(T - \lambda + 1)} \left(\infty^{T-\lambda+1} - a^{T-\lambda+1} \right). \end{aligned} \tag{14}$$

Usually the largest block of the network is marked as LCC. For a network G, if it has N nodes, the number of nodes belongs to $p \cdot N$ when the nodes in the ratio of $1 - p$ are deleted. In other words, the probability of existence of each node is p. If a node i is to belong to the LCC, firstly, it must not be deleted, and secondly, its neighbor nodes also belong to the LCC; otherwise, it is impossible for the node i to belong to the largest block. Assuming that the symbol r is that node i is not linked to the largest block LCC by one of its neighbors, we again assume that the node i we are concerned about has k neighbor nodes, that is, its degree is k; then, the calculation formula of the probability that node i does not belong to LCC is as follows:

$$P(i \notin \text{LCC}) = P(k) \cdot r^k. \tag{15}$$

Therefore, the average probability that node i does not belong to the LCC is the result of the above formula summing k, namely,

$$P(i \notin \text{LCC}) = \sum_{k=0}^{\infty} P(k) \cdot r^k. \tag{16}$$

If node i is not linked to the largest block LCC by one of its neighbors, there are only two possibilities. The first is that its neighbor is deleted. The probability of this event is $1 - p$. The second possibility is that its neighbors are not deleted, but the neighbors do not belong to the LCC. Assuming that the neighbor node itself has k neighbors, the probability of this event occurring is $p \cdot f^k$. So for node i not linked to the largest block LCC by one of its neighbors j and j has k neighbors is the case where node i is equivalent to having degree $k + 1$. In other words, node i has the probability of extroversion degree k, which is $\frac{(k+1)P(k+1)}{\langle k \rangle}$. Therefore, it can be calculated that r satisfies the following relationship:

$$f = \sum_{k=0}^{\infty} \frac{(k+1)P(k+1)}{\langle k \rangle} \left(1 - p + p \cdot r^k \right). \tag{17}$$

To sum up, when the $1 - p$ proportion of nodes in network B lose their functions due to failure and no longer work, the proportion of the remaining nodes in the network remaining in the LCC occupying the original network nodes is as follows:

$$P^{\text{LCC}} = p(1 - P(i \notin \text{LCC})). \tag{18}$$

3.2. Sports Dance. Sports dance is formerly known as International standard ballroom dance, also known as ballroom dance. Sports dance includes modern dance and Latin dance. Modern dances include waltz, tango, Viennese, waltz, trot, and foxtrot. Latin dance also consists of a variety of dances, including rumba, cha-cha, samba, cowboy, and bullfight [22]. Dance sport is an elegant sport in civil society, an effective way to stimulate people's inner emotions through rhythmic physical activity full of energy and rhythm. It is an excellent sports project integrating fitness, competition, leisure, and entertainment and has aesthetic and cultural value. At the same time, it is also a sports art that integrates leisure and entertainment, fitness and health care, and social networking.

3.2.1. The Function of Sports Dance. With the rise of national fitness, sports dance is becoming increasingly popular. With the goal of lifelong learning, a fitness-focused exercise model is rapidly spreading.

(1) From the perspective of building spiritual civilization in street squares and cultural art galleries, sports and dance activity centers seem to have been organized by vibrant community residents. It not only brought the form of national fitness but also played a leading role in cultivating lifelong sports awareness and building a socialist spiritual civilization [23]. Sports dance activity is a form of community spiritual civilization construction. It can bring happiness to people and is a high-level spiritual entertainment

(2) From the perspective of fitness, moderate participation in sports dance can improve blood circulation, promote cardiovascular activity, help improve immunity, and prevent arteriosclerosis. It can be seen that sports dance has a good effect on fitness. Sports dance is very suitable for middle-aged and elderly people to exercise and relax, and it can increase the oxygen consumption of the body, improve the blood circulation, and is conducive to the maintenance of cardiovascular health and physical function

(3) Sports dance has the function of soothing the mind of the participants. Regular participation in sports and dance activities can improve the pleasure of participants, can help to form good self-values, can temper the will and cultivate quality, and improve the ability of interpersonal communication and social activities [24].

Sports dance can meet the aesthetic needs of the subject and is in the main position in the aesthetic relationship. The aesthetic value of physical dance has an impact on individuals and society, which is expressed through performance, competition, physical exercise, and communication in pairs or groups, thus promoting the harmonious development of individuals and society.

3.2.2. Classification of Sports Dance. There are many classifications of sports and dance. From the perspective of emphasizing the effect of physical exercise, sports dance is divided into two categories, namely, mass sports dance and competitive sports dance. Popular sports dance is also known as "ballroom dance," including slow three, slow four, flat four, and jitba. The movements are simple, the forms are eclectic, and there is no limit to the number of participants. It can be performed by one person, two people, or in groups. Popular sports dance has strong popularity and fashion and can keep up with fashion and quickly reflect the renewal and variation of the general public's mental outlook. Competitive sports dance includes two series of Latin dance and modern dance with a total of ten items [25]. Generally speaking, competitive sports dance and movements have stricter technical requirements than ordinary sports dance and are not as popular as sports dance. The competition is divided into two types: team competition and individual competition. The competition evaluates the performance of athletes in terms of music, rhythm coordination, basic body posture, dance movement, mastery of melody, understanding of music, and dance steps. Sports dance is a narrow sense of competitive sports dance, there are two kinds of sports dance in a broad sense, one is competitive sports dance, and the other is dance for fitness and bodybuilding.

If sports want to go to society, it must adapt to the needs of the market economy and build a sports market relying on social forces. Sports dance has developed greatly in Asia in recent decades and is deeply loved by Asian people. At present, sports dance develops in two directions, one is the professional line, and the other is the mass line. Sports dance is not only competitive, but also has a certain popularity. It is a fitness and entertainment method suitable for all ages. Because of this, sports dance has been very popular with the public since its inception and quickly swept the world. The broad mass base of sports dance has laid a solid foundation for the professional development of the project. We should seize this opportunity, adapt to the market demand, build a group of professional talents, and form a virtuous cycle system in which specialization guides popularization and popularization promotes specialization. With the continuous improvement of the status of community sports among the masses, government departments at all levels should seize this opportunity and make full use of financial resources and human resources. In accordance with the law of market economy, the introduction of sports consumption services in the community takes lifelong sports as the main line, and the starting point is to benefit community residents for life. Through reasonable personal health investment, the enthusiasm of residents is mobilized, and sports and dance clubs are organized and planned and at the same time drive other residents in this big atmosphere. The establishment of sports dance clubs will definitely play a positive role in promoting the development of sports dance. Figure 4 shows a schematic diagram of the system target requirements of a sports dance project based on mobile communication.

This system adopts the common three-level structure design, namely, hardware platform, software platform, and application platform. Among them, the hardware platform mainly refers to the hardware system that carries the client and the server, and the software platform mainly refers to

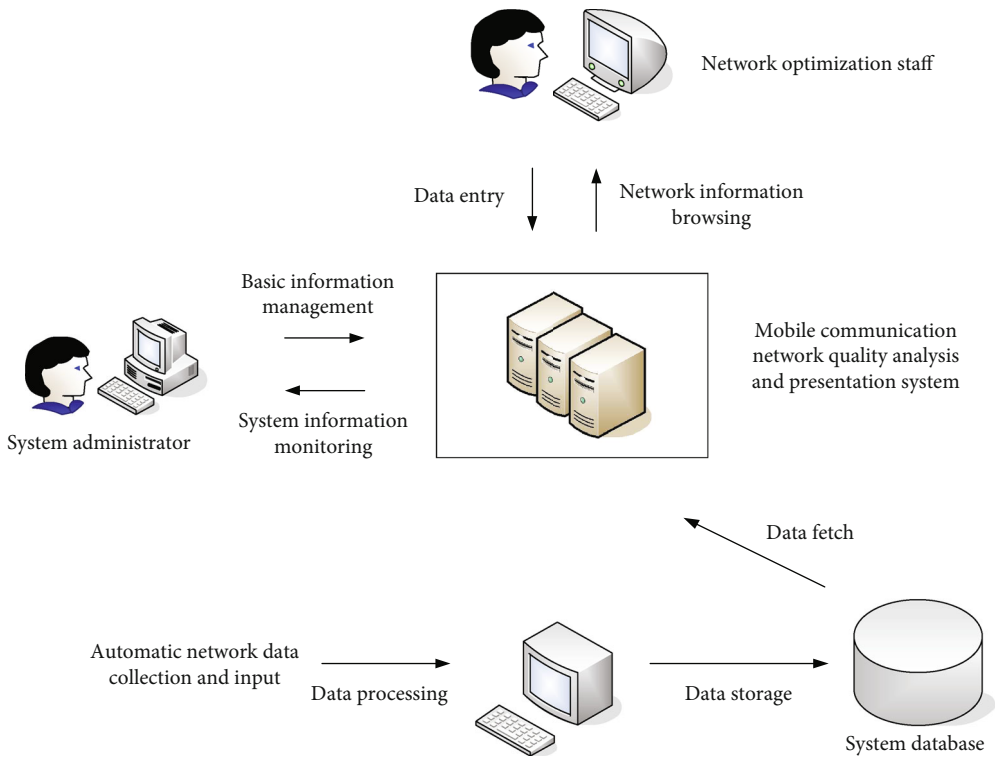

Figure 4: Schematic diagram of system objective requirements.

the operating system, service, database, etc., on the hardware system; the application platform is the client system program itself. The system mainly consists of two main functional units, the application terminal and the data server. To ensure system security, all components of the system are deployed inside the company's firewall and do not provide external access interfaces. The application client and the database server are connected through the network management network. The physical connection of the system is shown in Figure 5.

The degree and quality of sports dance activities depend to a large extent on the quality of teaching. To improve the quality of teaching, it is necessary not only to improve the professional quality of community instructors but also to enrich their teaching methods to flexibly use a variety of teaching methods to achieve the goal of high-quality, high-level, and high-acceptance sports dance teaching. It is necessary to flexibly use a variety of explanation and demonstration methods to teach sports dance knowledge and basic skills to residents. It is necessary to know how to tap and develop the dance potential of the community audience through the rational use of teaching skills, so that the teaching effect can be multiplied with half the effort. Teaching instructors should know how to sum up the experience, explore methods, and accumulate results to continuously optimize teaching methods, improve teaching quality, and try their best to promote sports and dance activities into the hearts of the people. With the extensive use of modern technical means, sports dance activities must also meet the needs of the trend of the times and make full use of advanced technologies such as multimedia, network, light, electricity, sound, and image to make teaching work more vivid and free, and the teaching forms are diversified. It can also make the learning of corresponding technical actions easier to understand and more intuitive and achieve the multiplier effect with half the effort. Figure 6 is a schematic diagram of a sports dance management network platform.

Leaders at all levels and government departments should pay more attention to the emerging activity of sports dance and establish corresponding organizational management institutions. In the specific operation and implementation, the community competent department and the subdistrict office take the lead, take the community sports community committee as the core, and take the sports management station, enterprise sports association, and public institutions as the basis. With sports communities and sports volunteers as the backbone, with the majority of community residents as the main body, relying on various community sports venues, establish community groups and management networks and improve the comprehensive quality and cultural quality of community residents.

4. Experiment Design of the Current Situation Investigation of Sports Dance Based on Mobile Communication

Dance sports, a program that combines sports and art, is very popular. With the development of human society, human's understanding of health and beauty has been further strengthened, the quality of human life has been greatly improved, and the rational spiritual pursuit has also been improved to a certain extent.

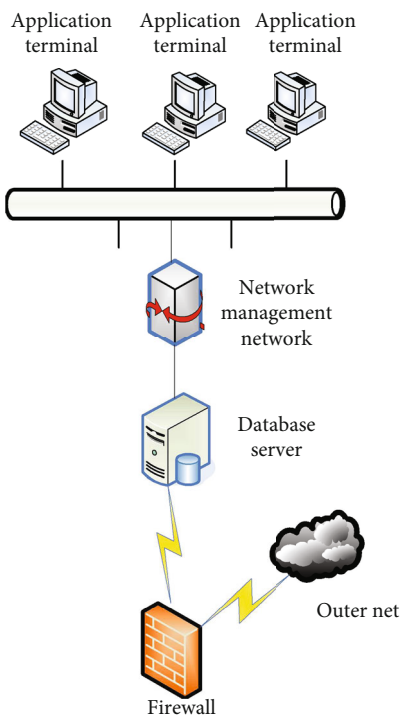

Figure 5: System physical connection design.

4.1. Objects. To understand the current state of dance sports, this study investigated the current state of dance sports in district A. Twenty sports dance coaches and 300 students were randomly selected as research objects for research. The details of the survey respondents are shown in Table 1.

4.2. Methods. The research methods used in the research process of the dissertation include literature data method, questionnaire survey method, mathematical statistics method, and logical analysis method.

4.2.1. Documentary Data Method. To facilitate research progress, relevant literature was specifically researched through local library database resources, and references were made to books, newspapers, and magazines related to dance sports. The analysis of the collected literature and books provides a solid theoretical basis for the design and creation of this project.

4.2.2. Questionnaire Survey Method. A total of 320 questionnaires were distributed in this survey, 320 were returned, and the pass rate was 100%. There were 300 valid questionnaires, and the effective rate was 100%.

The reliability test of this questionnaire adopts the back-test method, that is, within two to four weeks after the first survey of the first questionnaire, the people in the test population in the area A are selected again from the recovery questionnaire to carry out the second retest work. The retest results showed that the content conformity of the two test results reached an average of 92%, indicating that the design of this questionnaire is reliable.

4.2.3. Mathematical Statistics Method. SPSS11.0, Excel, and other software were used for statistical analysis of the survey data.

4.2.4. Logical Analysis Method. This paper uses logical methods such as induction, deduction, and comparison to analyze and straighten out the collected literature and questionnaires.

5. Survey Results of the Current Situation of Dance Sports Based on Mobile Communication

Dance art education plays an important role in the wider development of quality education. The spiritual carrier is the eternal pursuit of human beings, which includes communicating with the human body and soul, inspiring emotions, and enhancing the fusion of wisdom and truth. Dancing with people can bring the body and mind into perfection, forcing people to strive for innovation. It can not only stimulate people's interest in dance art but also encourage them to devote their wide range of interests and hobbies to other artistic fields, thereby encouraging their healthy development and the formation of good personality and psychological qualities. At the same time, dance can also enhance the national consciousness, observation, function, imagination, and creativity. This is why dance sports arts education events are organized in most communities to increase their motivation to learn. Through the statistics and analysis of the questionnaires, we can understand their motivation for learning sports dance and find the characteristics that affect the learning of sports dance, as shown in Table 2.

In the survey, it was found that the age span of the respondents was large, as shown in Figure 7.

It can be seen from Figure 7 that among the surveyed subjects, there are more people in the age group of 10-20 and over 50 years old, especially women over 50 years old, as high as 89. However, the data shows that the reasons why students learn sports, dance, and their education have little effect.

There are 220 students in school among the surveyed objects. For this reason, statistics about the opening of sports and dance courses in schools are made, as shown in Table 3.

Table 4 is the ranking comparison of the main constraints on the development of sports dance by expert judges, sports dance coaches, and students. Through the comparative analysis in Table 4, it can be seen that sports dance coaches and students are inconsistent in the ranking of constraints. From the perspective of sports dance coaches, it is the teaching staff, followed by the funding. From the perspective of students, the teaching staff is also put first, which is enough to show that students have higher requirements for teachers' teaching level and technical ability and report higher expectations. At the same time, they ranked the movements as too difficult and the class hours as the 2nd and 3rd, but the sports dance coaches ranked at the bottom, indicating that the students still have great difficulties in the learning process and lack of communication with the coaches.

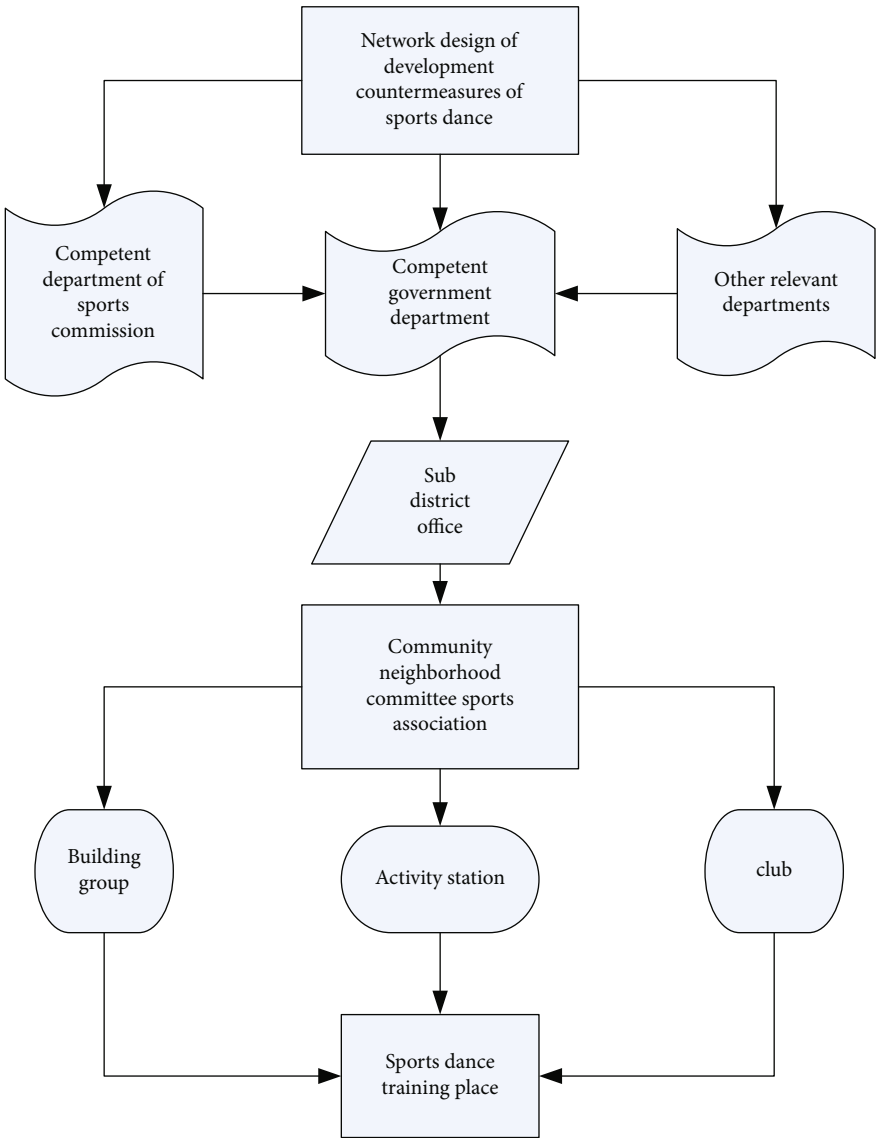

Figure 6: Schematic diagram of sports dance management network platform.

Table 1: Details of respondents.

	Sports dance instructor	Sports dance students
Number of people	20	300
Male	10	120
Females	10	180

Among the survey respondents, there are 20 coaches about sports and dance, and their technical level and learning experience are shown in Figure 8. The evaluation of the technical level consists of two parts: expert evaluation and self-evaluation.

Course content is an important factor in setting courses, and the reasons why students choose courses are generally directly related to course content. The research for this project wanted to see if the main content of the dance physical education curriculum was attractive to students. Second, the main intention of the coach to arrange the course content can also be examined, as shown in Figure 9.

As can be seen from Figure 9, in the research on sports dance coaches, more than 50% of the people believe that the most important thing in sports dance teaching is to learn and understand music. That is, the musical understanding that student develops in sports dance teaching is the most important. The second is to learn basic materials. The application of the basic movements of sports dance is the second in the study, and the third is the application of the whole movement. Three people think it is essential.

Figure 10 is the exercise frequency and period of the trainees. It can be seen from Figure 10 that the time for the respondents to perform sports dance fitness activities is basically fixed in the morning and evening, and the proportion of fitness dances during holidays is the highest, especially for women, reaching 55, while very few people

Table 2: Motivation of respondents to learn sports dance.

Motivation	Frequency	Percentage	Ranking
Shaping body shape and cultivating temperament	132	44%	1
Improve communication skills	40	13%	3
Interests	30	10%	4
Strengthening the body	90	30%	2
Family's wishes	8	3%	5

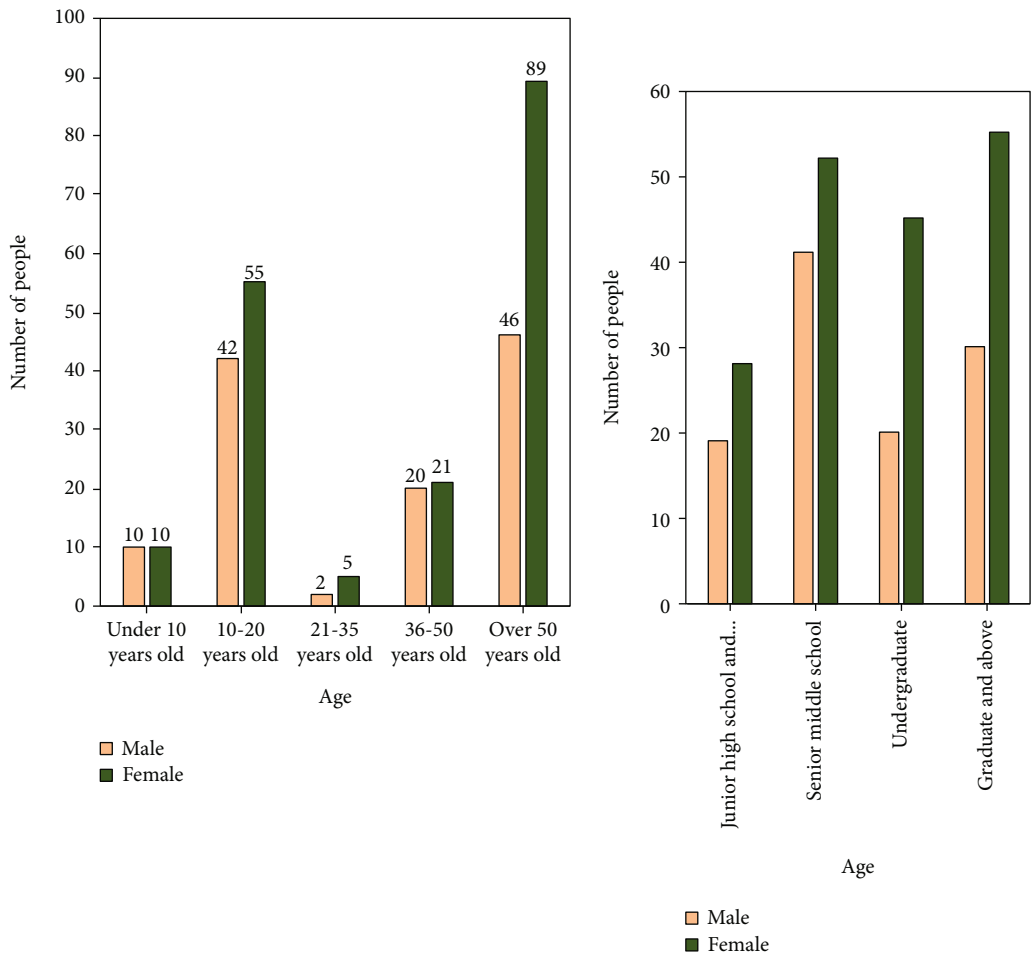

Figure 7: Age and educational background of respondents.

Table 3: The opening of sports dance courses in schools.

Survey of physical dance courses	Yes	No	Professionalism
Equipped with special teaching materials for physical dance	0	100%	55%
Covering all dance genres	40%	60%	40%
Opened a physical dance training teaching	50%	50%	55%

choose to exercise at noon. Generally speaking, residents prefer to keep the traditional morning exercise, followed by afternoon or holiday time periods. The main reason is that there is less time to exercise in the working environment, and it can only choose the afternoon or holidays. At the same time, this is also the reason residents often exercise once or twice a week, and the number of people is as high as 34%. 18% of residents use it 3-4 times a week, while only 12% of men do physical dance exercise every day. It can be seen that most residents do not think that fitness is a necessity of life.

Sports dance has a long history and a wide variety of dances, with the characteristics of rhythm, entertainment,

Table 4: Ranking comparison between sports dance coaches and students on the main restrictive factors of sports dance development.

	Lack of funding	Faculty	Textbook	Facilities	Movement is too difficult	Too little class time
Expert judges	3	2	1	6	4	5
Coaches	2	1	3	4	6	5
Trainees	6	1	5	4	2	3

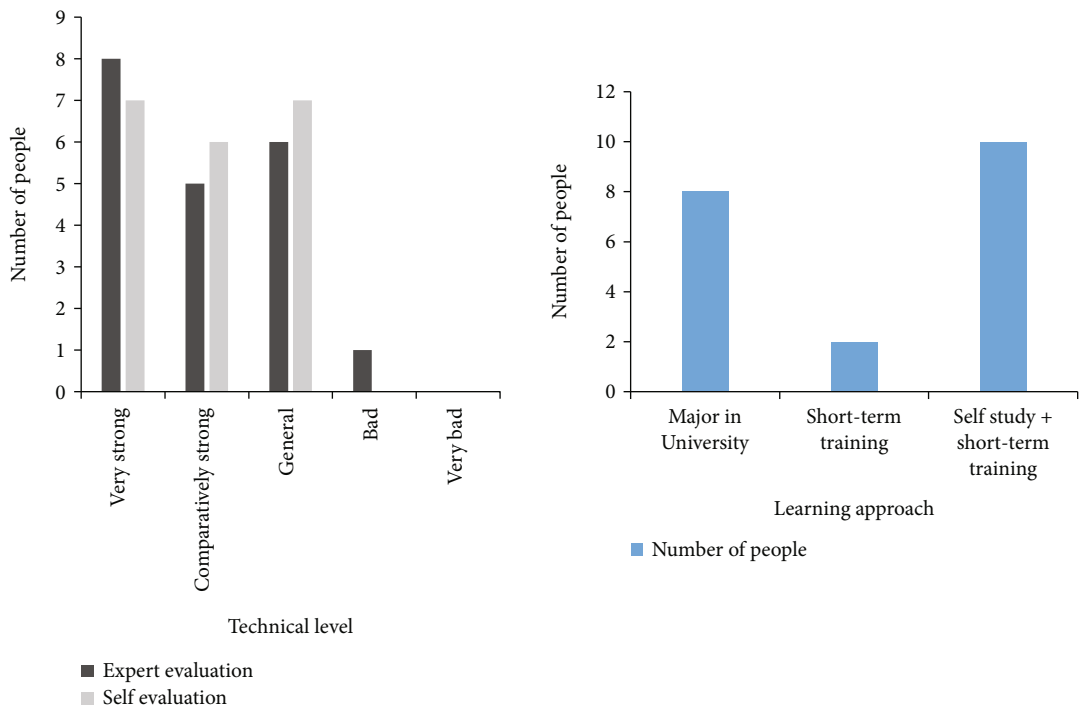

Figure 8: Learning of sports dance coaches.

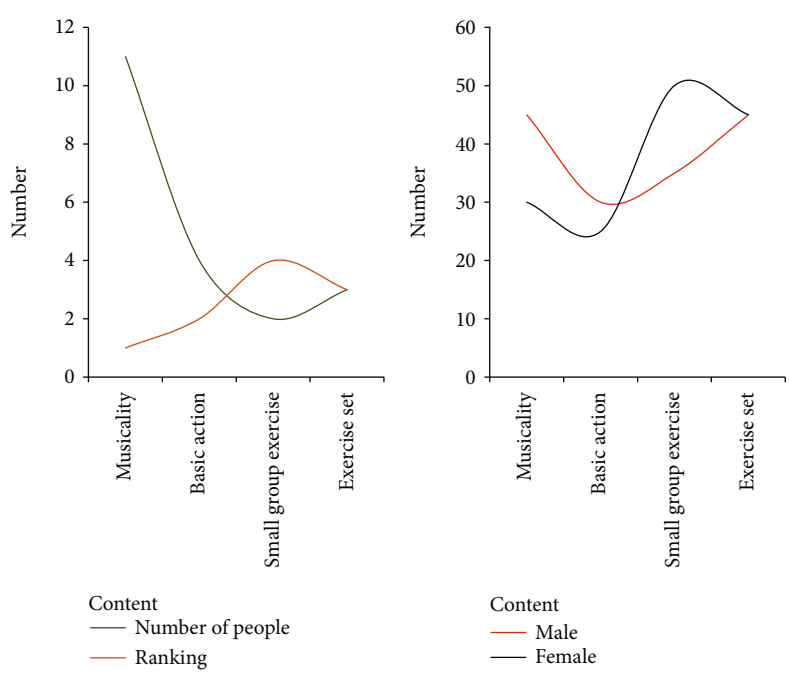

Figure 9: Ranking statistics of sports dance teaching contents.

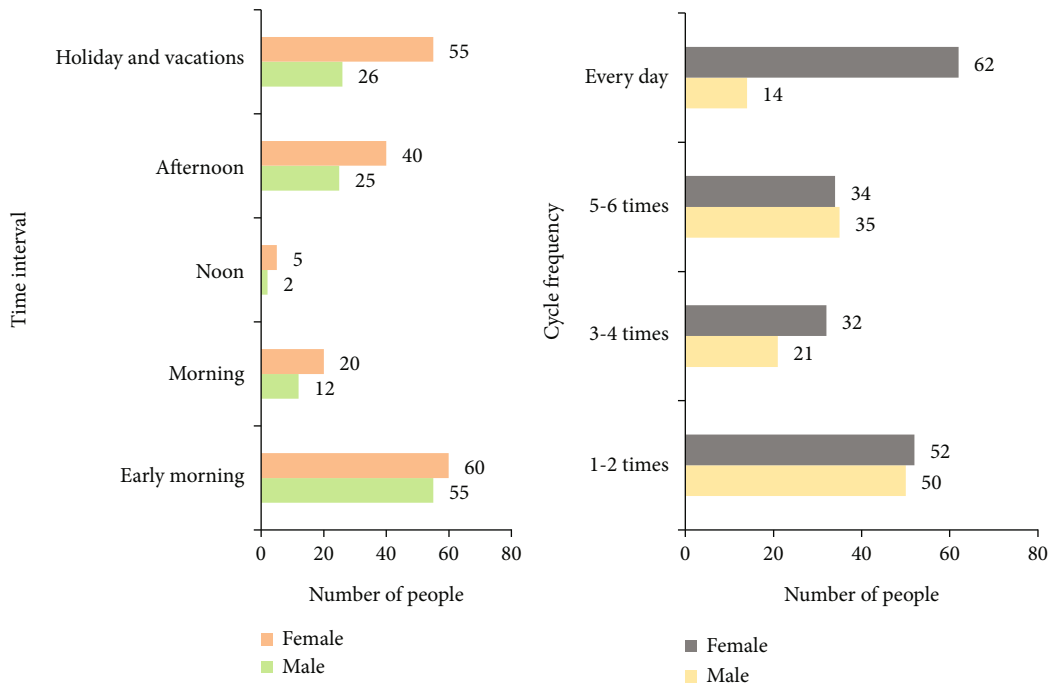

Figure 10: Fitness frequency and period of trainees.

performance, fitness, and so on. It can transform the human body, refresh the mind, improve social skills, and more. In view of the current situation and future development needs of Chinese sports dance, the following suggestions are put forward to improve the popularity of sports dance, make residents' awareness of participation sensitive, and increase activities. It takes sports and dance activities as the carrier, takes the construction of socialist civilization as the guide, and enhances the spiritual awareness of residents in an inclusive way. Administrative and community departments at all levels should include the construction of sports dance venues and hardware facilities in the agenda and scope of daily performance assessment, give due attention to policies and systems, and give strong support to ensure that customer needs are met, providing relevant materials and institutional guarantees for community residents to participate in sports dance activities. In the current situation of the construction and development of the sports dance profession in China, it is necessary to increase the reform and development, to be in line with international standards, and according to the continuous development of sports art, the existing form training courses have not been able to meet the needs of society for sports dance talent, so it is necessary to carry out teaching reform.

6. Conclusion

Healthy life and harmony are people's pursuit of immortality and an important symbol of social progress and civilization. In recent years, dance sports, an emerging sport, has become very popular. Taking lifelong sports as its purpose, the healthy and leisure sports model is being rapidly promoted. Accelerating the pace of training, sports dance professionals actively create favorable conditions, customize professional technical training for community sports dance instructors, and improve professional quality and professional skills. In this way, we can enrich the team of teachers of the sports dance community and improve the overall technical level of sports dance community activities. The content and form of community sports dance should be expanded and combined to achieve diverse forms, simple content, easy adoption, best practice, and easy development. On this basis, according to the needs of different groups of people, appropriate technical requirements for movements can be formulated to meet the reasonable needs of different audiences for sports dance. Making sports dance gradually becomes an effective medium for communication between community residents. Dance sport is a physical activity, but if it is not done well, sports injuries are more likely to occur, for example, not warming up before exercise or warming up poorly; weak skills; poor physical fitness; inexperienced learning styles, body type, and excessive exercise; inconsistency between men and women; unreasonable choice of music rhythm; physical decline during activities; and bumping into other people during activities. Therefore, security issues cannot be ignored. With the development of human society and the further strengthening of people's awareness of health and beauty, people's quality of life has improved significantly, and their spiritual pursuit has also been enhanced to a certain extent.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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