Advances in Mathematical Physics

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Contents

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Research Article

Analysis of the Relationship of Video Text and Urban Image Communication Based on the Calculation Method of Wedge Diffraction in Geometrical Optics

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City image reflects a city's comprehensive competitiveness and is also an important indicator of a city's spiritual civilization and urbanization process. A good city image is an intangible asset of a city, which can contribute to the political, economic, cultural, and social construction of a city and create more value for the city. This paper mainly discusses the research status and research methods of urban image at home and abroad. Based on the calculation method of wedge diffraction in geometrical optics, various heuristic uniform diffraction formulas of lossy wedge are compared and analyzed, and a better heuristic formula of uniform diffraction of lossy wedge is given. Finally, the selection of important channel parameters in the propagation channel is discussed, and a method for predicting the statistical parameters of the propagation channel of urban images based on the results of ray tracing is proposed. Then, the channel parameters are analyzed by using statistical parameters, and the channel parameters of the city image propagation model are analyzed.

1. Introduction

After my country entered the 21st century, science and technology continued to innovate and progress, and the era of intelligent media based on emerging technologies such as artificial intelligence, mobile Internet, and big data has finally arrived [1]. Technology authorization makes the whole process of information dissemination gradually open, and anyone can participate in the whole process of information production and release. News communication has shifted from professional groups to all groups, which makes information communication channels diversified and interwoven. The participants, media, and means of urban image are more diversified [2]. The research on urban image in the era of SMART media also shows a new trend of diversified and multidisciplinary development [3]. The connotation of urban image is continuously deepened, and the dissemination of urban image has received more and more attention [4].

Like people, each city has its own life, each city has its own development context and historical trajectory, and each city also has its own growth process and story [5]. As the foundation of human existence, cities constitute carriers and units, carrying all aspects of human life [6]. However, urban image, a vocabulary that reflects the panorama and appearance of a city, has undoubtedly become a hot issue discussed by journalism and communication scholars in recent years [7]. The competitiveness reflected in a city's politics, economy, and culture interprets the degree of development of a city's modernization, which is the inherent image of a city [8]. The construction of the city's buildings, environment, roads, etc., is the manifestation of a city's external image [9]. In recent years, there have been rankings that directly express the image of cities, such as national urban GDP rankings, national urban air quality rankings, and national urban comprehensive strength rankings [10]. With the opening of the 2008 Beijing Olympic Games and the 2010 Shanghai World Expo, the promotion of the city's image has become increasingly hot and necessary [11]. In

recent years, CCTV has interspersed the promotional films of various cities in prime time [12]. The pictures are rich, and the content is exquisite, which not only brings beauty to people but also increases the audience's understanding of cities across the country [13]. The production and dissemination of these propaganda films is based on the media as the means of dissemination, and the video text has become an important dissemination platform and carrier [14]. These contents showing the urban exterior scene comprehensively, objectively, and diversifiedly show the characteristics of each city, so as to better spread the city image [15]. Video text is a media carrier that can carry rich content and show emotion. Short videos on social platforms can effectively spread such rich objects as city images. City image is an important attraction for city tourism. The successful online promotion practices of cities can bring inspiration to other cities in China. Of course, online city image promotion is not just about creating temporary traffic. Instead, we should continue to dig deep into the connotation of the city image, combine with multiple media to carry out continuous communication, so as to form distinctive characteristics of the city to attract more investors and tourists. The communication of city image needs to build a professional communication subject, and then, its operation team studies the communication content. Then, choose the channel or platform where the current marketing audience gathers most to carry out communication, such as short video media and new media platform [16].

The relationship between communication and the city is an ancient proposition, dating back to ancient Greece [17]. Ancient Greece and other city-states were regarded as a "communication society" with a multifaceted communication as the social foundation. With the development and evolution of media, urban communication theories and their perspectives are constantly enriched and developed [18]. At present, new communication technology and the wave of globalization and urbanization are agitating each other, and the issue of constructing and disseminating the image of the city has become more prominent in the increasingly fierce competition [19]. In order to effectively recognize, understand, and deal with many urban communication problems such as changes in social relations, reorganization of communication forces, and changes in human existence due to the development and change of media technology in globalization and urbanization, there is an urgent need for more broad disciplinary perspective, more specific theoretical guidance, and more detailed media and audience research [20].

René Claire, a famous French director, said, "In a film, the picture is the only means of narration." Image is an art of telling a story with a lens. Therefore, in the narration of video texts, we must first consider the visual modeling of film and television. The relationship between image text and city image construction is actually how to express city image through lens language. So what is the image of the city? It should be composed of two parts: one is material, which is an intuitive image that can be seen by us; the other is spiritual, which is the core concept and unique culture of the city. The abstract things like ideas and spirits must be expressed with the help of certain material carriers. Symbols are the most direct carrier for expressing meaning, are visual, and are also an effective way to achieve rapid dissemination. How to better establish the image of a city through video text? The author believes that the key to the image construction of a city or region is the association of the audience. An important means of arousing associations is by means of specific symbols. Information is the unity of sign and meaning, sign is the external form or material carrier of information, and meaning is the spiritual content of information. Using distinctive and characteristic symbols to impress the audience and then establishing an association response is the key to building a city image.

2. State of the Art

2.1. Correlation between Image Text and City Image. With the theme of "City Image Communication," relevant journals and dissertations were searched and analyzed on Chaoxing Discovery System and CNKI. Various academic development trends are shown in Figure 1. Around 2008, urban image communication began to be valued by the academic community. After analyzing the content of relevant literature, it is found that the current research focuses mainly on urban culture, urban brand integrated marketing, urban image communication strategy, new media, and urban image communication.

Before analyzing video text and city image dissemination, we must first understand the relationship between video text and city image. There is a strong correlation between image text and city image. Using video text as the carrier and channel to disseminate the city image greatly enriches and improves the dissemination effect of the city image. Using the city image as the production material of the video text also expands the research field of the video text.

Video texts have played a variety of functions in the dissemination of city images. Analyzing the dissemination effects of city images from this aspect strengthens the audience's understanding of the relationship between video texts and city images. In different historical periods, the presentation and expression methods of video texts in the image of the city are also different. Nowadays, the research on video text is also becoming more and more full-fledged in the step-by-step development and expansion.

With the rapid development of today's economy and society, people's spiritual and cultural needs are also getting higher and higher. As the land where people live, the impact of cities on the entire society cannot be underestimated. This change brings about the common improvement of people's material life and spiritual life. The media is a tool for capturing new things, and the changes and development of cities are no exception and have become the objects of media communication. Video text belongs to the category of art and is the concrete expression of abstract art. What the city image is selectively extracted by the video text is the essence of the city image, that is, the content of spiritual connotation. In this way, the city image and the media have found a tacit understanding of symbiosis and coexistence. The media

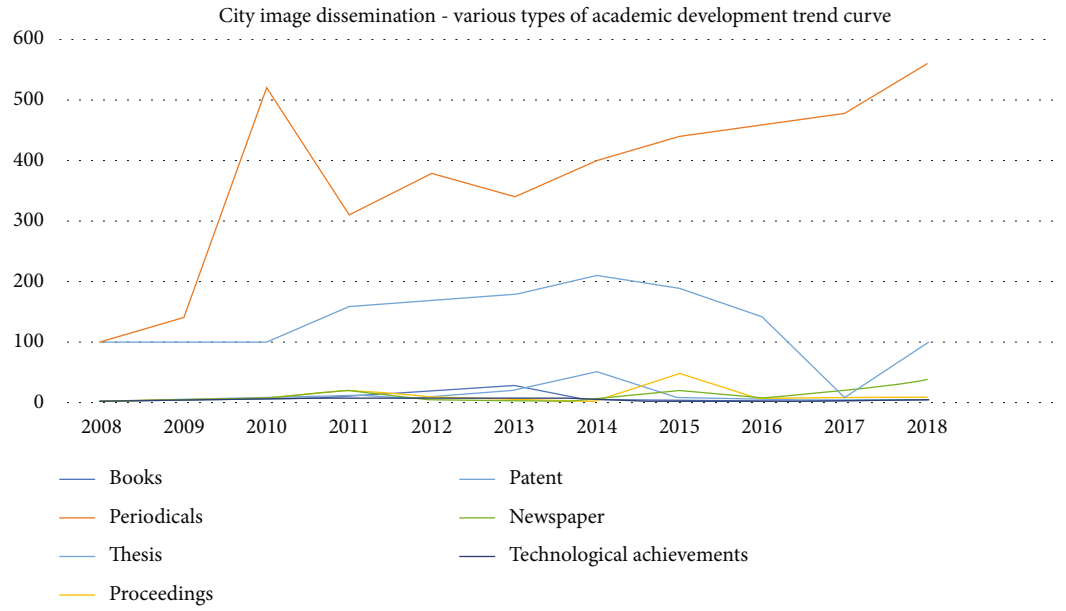

Figure 1: The academic development trend curve of urban image communication.

communication promotes and drives the expression of the city image, and the transmission of the city image also brings a larger and wider communication field to the media.

At the end of the 20th century, propaganda films related to the dissemination of urban images came out in my country. Afterwards, the government and citizens paid close attention to the information and content of the city's image. In order to open up the market for their own city image, cities also compete to research and design their own city image promotional films. With the acceleration of urbanization, more and more projects are now labeled as "urbanization." Through the urbanization seen by the media, the audience has a process from understanding to understanding of a city, thus achieving the purpose of media city image dissemination. Video text contains many levels of media (including pictures, promotional films, film and television dramas, and documentaries), which have become the most suitable carrier for disseminating the image of the city. Through the dissemination of these means, the audience can see the historical changes and real development of a city.

2.2. The Function of Image Text in the Dissemination of City Image. Media image dissemination has the characteristics of fast speed and wide range. As an effective carrier to promote the awareness of city image, video text includes propaganda films, documentaries, pictures, and other means of dissemination. There are many similarities between the means of communication and the wide range of communication channels, which has led to the promotion of the spread and effect of the entire city's image. The popularity and reputation of a city increases, and the audience has a deeper understanding and understanding of the city, which naturally enhances the city's influence. Therefore, the use of video text to spread the image of the city has a significant impact on the image of the city.

The content of the video text is mostly intuitive; the information is obvious to the audience. The picture information especially, after being processed for a short time, is quickly transmitted to the audience. In the vast sea of information, if a certain piece of information is to instantly occupy the audience's attention and catch the audience's attention, it requires the information to have a unique appeal, in order to stand out from the huge information content. Video text has the advantage in this respect, both in terms of visual perception and sound effect transmission, occupying an absolute advantage among many communication carriers. For example, in catastrophic reports such as the Wenchuan earthquake, a title summarizing a piece of text information in incisive language is obviously not as attractive to the audience as a picture that intuitively reflects the current situation of the disaster area and the conditions of the victims. The same is true in the dissemination of city images. Even if the city is written in hype, there is not a single eye-catching picture or video clip that leaves a deep impression. Therefore, in the era of all media, the rapid development of new media such as mobile phones and the Internet provides an important opportunity for the development of video texts.

In the vast ocean of information, the audience is likely to be so immersed in it that it is difficult to prioritize. As a powerful media communication channel, video text can transfer the audience's attention to the spirit that the government needs to convey with its intuitive characteristics. The video text captures the audience's attention through rich and vivid content. This is not only conducive to government decision-making but also improves the efficiency and transparency of government decision-making and provides convenience for the audience to better participate in government decision-making and enhance the interaction between the audience and the government. In other words, the image of the city

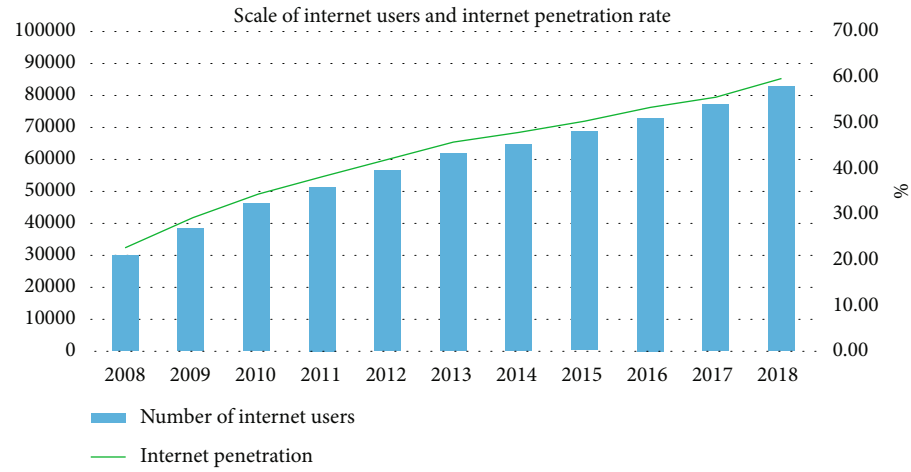

Figure 2: Scale of Internet users and Internet penetration rate in my country.

spread by video text builds a bridge between the government and the audience.

2.3. Public Communication under Smart Media. Intelligent media has the characteristics of no boundary and decentralization. From traditional media to new media, it has realized a multidimensional change from mass communication to mass communication, and from PC to mobile, it has realized the leap from portal website to social media. The time interval between technological iterative updates is shortening, media boundaries are disappearing, audience migration is intensifying, and communication channels are diversified. Various changes are rewriting the communication rules and reshaping the public communication landscape. According to "CNNIC: The 43rd Statistical Report on Internet Development in 2018" (hereinafter referred to as the report): as of December 2018, the number of netizens reached 829 million, and the Internet penetration rate was 59.6%, an increase of 3.8 percentage points compared with 2017. 56.53 million new netizens were added throughout the year. The scale of mobile netizens in my country reached 817 million, and the proportion of netizens accessing the Internet through mobile phones was as high as 98.6%. It provides an increasingly large user group and a deep audience base for the rise of mobile short video APPs. The specific data are shown in Figure 2.

In the past two years, short video consumption has experienced a rapid growth, according to the report, "As of December 2018, the number of short video users reached 648 million, and the utilization rate of netizens was 78.2%. In the second half of 2018, the user growth rate reached 9.1%." The short video thus covered nearly 80% of netizens. Combining the weekly time spent online by netizens in the report and the regular proportion of various APPs frequently used by mobile netizens, it can be estimated that the daily use of short video APPs by netizens is about 19.4 minutes (with two decimal points). Combined with the usage of Internet access devices in the report and daily experience, the actual duration of mobile Internet access will be higher than this value (see Figure 3 for details).

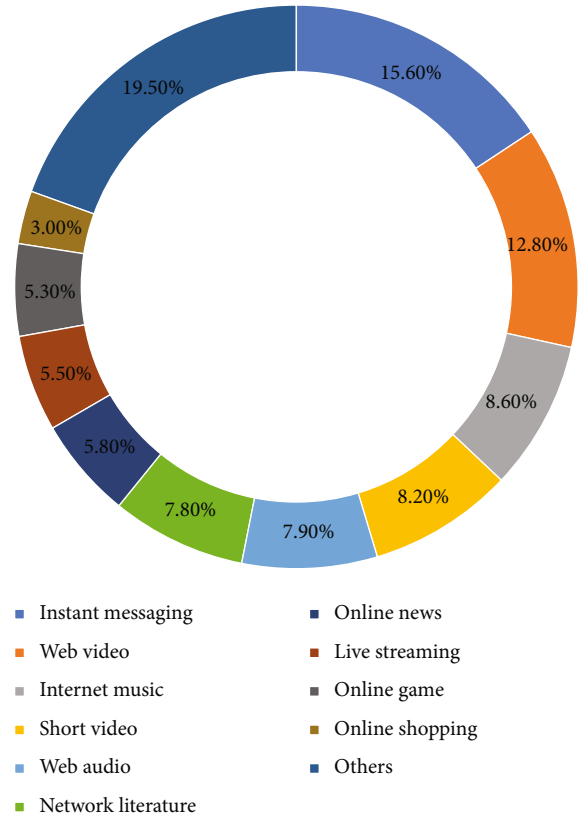

Figure 3: Proportion of usage time of various applications.

In 2016, the short video industry entered the "grassy era" of content and platform entrepreneurship. 2016 was called "the first year of short video," and many mobile short video apps such as Kuaishou, Miaopai, and Xiaokaxiu emerged rapidly, with Kuaishou as the representative. The first batch of short video platforms in China quickly seized the market and formed a super strong industry form. According to Aurora Big Data statistics, the market penetration rate of Kuaishou from January 2016 to January 2017 was higher than the sum of the market penetration rates of similar

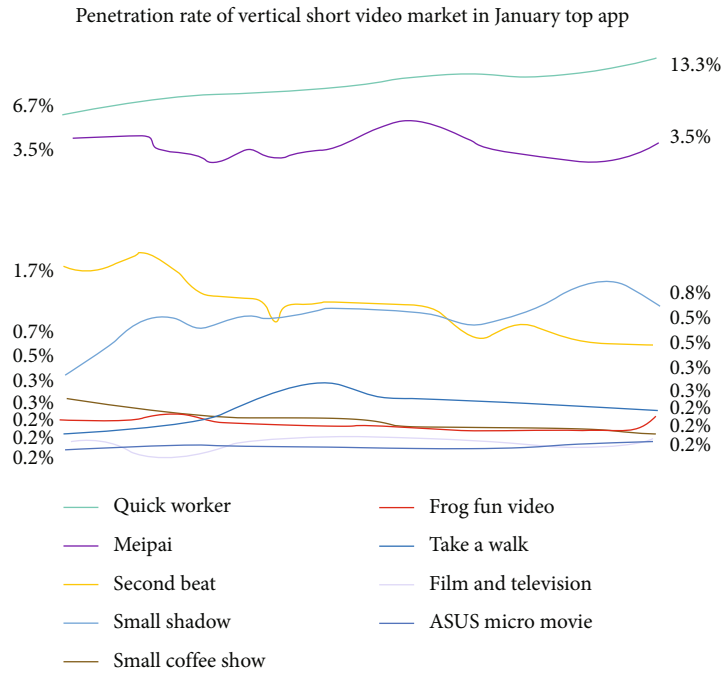

Figure 4: Laser big data 20 short video market penetration rate in January 2017.

products. It is worth noting that the "Douyin" APP incubated by Toutiao (now renamed ByteDance) was launched in a low-key manner on September 26, 2019, and quickly seized the short video APP users and market around February 2017, becoming a mobile short video app. A rising star in the video APP platform and a new force in the short video industry are shown in Figure 4.

With the development of new media technology, the boundaries of media are gradually disappearing, and media integration has become an inevitable trend. From large-screen to small-screen to multiscreen linkage, this kind of media transformation, which is constantly deconstructed and rapidly reconstructed, is providing infinite possibilities for media innovation. In this context, the means and concepts of urban image dissemination will also continue to develop.

3. Methodology

3.1. Forward Ray Urban Propagation Tracking Method. In the propagation problem of media, when the conditions of "high frequency" or "short wavelength" are satisfied, that is, when the characteristics of the medium and the parameters of the scatterers change very slowly over the distance of one wavelength, the propagation and scattering have "local" property; that is, the field in a given field of observation point does not need to be solved by the field distribution on the entire initial surface, but only by the field of a finite part of the surface. The forward algorithm is that ray tracing starts from the source point, emits a large number of ray beams uniformly to the surrounding space, traces the path of each ray beam separately, and uses the receiving sphere at the receiving point to determine whether the ray beam contributes to the field strength of the receiving point. The judging method is whether the distance between the ray beam and the receiving point is greater than the radius of the receiving sphere. If the distance is greater than the radius of the receiving sphere, it is judged that the ray beam has no contribution to the field point. The contribution of the ray beam adds to the total field at this field point. Then, continue to track the ray beam until its field strength decays to negligible. In this case, the tracking of the next ray beam is changed. Repeat the above process until all beams are traced. Its flow chart is shown in Figure 5.

One way to obtain beams of equiangular rays is to place an equi-icosahedron inside a unit sphere centered at the source point and then further divide its faces into much smaller equilateral triangles; Alternatively, the following circular column can be used to obtain beams of rays:

$$\begin{aligned} \theta &= i\delta, \\ \phi &= j\delta \csc \theta, \end{aligned} \tag{1}$$

where δ is the cone apex angle (included angle) of the ray beam and φ and θ are the included angles of each ray beam and the x-axis and z-axis, respectively.

3.2. Reverse Ray Urban Propagation Tracking Method. The reverse algorithm starts from the field point and, according to the principle of geometric optics, reversely traces every path that can reach the field point from the source point. Obviously, it is impossible to trace all the paths from the source point to the field point. Considering the attenuation of the field, with a certain precision, we can ignore those propagation paths that arrive at relatively small amplitudes. In this way, the propagation path between two points can be obtained. The model in this paper is mainly based on

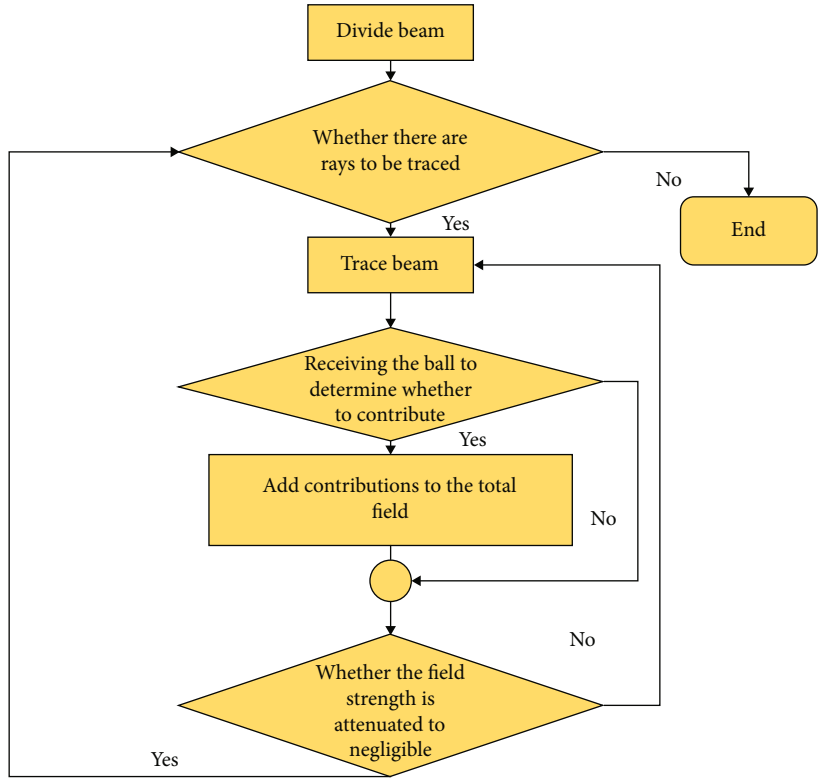

Figure 5: Flow chart of forward algorithm.

outdoor coverage prediction and channel analysis, so the transmitted rays are not considered, but only direct radiation, reflection, and diffraction are considered. When tracing a diffracted ray, first read out the common visible wedge table about the source point and the field point and then solve each wedge in turn.

$$\left(x_3', y_3', z_1' + \left(z_2' - z_1'\right) \frac{\sqrt{\left(x_1' - x_3'\right)^2 + \left(y_1' - y_3'\right)^2}}{\sqrt{\left(x_1' - x_3'\right)^2 + \left(y_1' - y_3'\right)^2} + \sqrt{\left(x_2' - x_3'\right)^2 + \left(y_2' - y_3'\right)^2}}\right). \tag{2}$$

Then, the coordinates of the diffraction point in the original coordinate system are obtained by coordinate transformation. Similarly, the diffraction point also needs to be judged to determine whether it is located within a straight edge of finite length. For the effective diffraction points, the connection and intersection judgments are made. For one reflection and one diffraction, the visible surface table of the source point and the visible wedge table of the field point should be read out, respectively. For a combination of a face and a split, the mirror point of the source point with respect to the face is first required. Then, find the diffraction point of the mirror image point and the field point about the wedge to judge its validity. If it is valid, find the intersection of the line connecting the mirror point and the diffraction point with the surface, that is, the reflection point, to judge its validity. If it is valid, the connection and intersection judgment can be performed. For the first-order diffraction and the first-reflection, the solution is similar to the solution of the first-reflection and the first-order diffraction. For a combination of a split and a surface, first find the mirror image of the field point on the surface, and then find the diffraction point of the mirror image and the source point on the split. The rest of the judgments are equivalent to the solution of one reflection and one diffraction. Although the reflection algorithm does not need to use the receiver sphere to judge the diffraction, the phase and polarization information of each ray can be calculated more accurately. But the reverse algorithm has its own drawbacks. The first is the judgment of visible faces and visible splits. The second is how to determine the order of ray tracing.

3.3. Introduction to the Acceleration Technology of Existing Ray Urban Propagation Tracking. Methods to reduce the ray beam without reducing the calculation accuracy are also

introduced in some literatures. But this method is not suitable for urban ray tracing; it is the application of ray tracing method in other aspects. In phase, less than half the ray beam is required for conventional ray tracing. In this method, the electric field of the source is set to

$$\vec{E}\left(\vec{r}\right) = \vec{E}(0) \cdot \sqrt{\frac{Q_p(z)}{Q_p(0)}} \cdot e^{j \cdot k \cdot \left(z + (1/2) \cdot [xy] \cdot Q_p(z) \cdot \begin{bmatrix} x \\ y \end{bmatrix} \right)}, \tag{3}$$

where $Q_p(z)$ and $Q_a(z)$ are the variable matrices of the phase and amplitude of the GRBF in the z-axis propagation direction, respectively, and the requirements are met:

$$Q_p^{-1}(z) = Q_p^{-1}(0) + z \cdot \begin{bmatrix} 10 \\ 01 \end{bmatrix},$$
$$Q_p^{-1}(z) \cdot Q_a(z) \cdot Q_p^{-1}(z) = Q_p^{-1}(0) \cdot Q_a(0) \cdot Q_p^{-1}(0). \tag{4}$$

The reflected rays are either in the form of GRBF. However, only reflection is considered in the calculation, and diffraction, which is a very important propagation mechanism in urban propagation, is not considered, so it is not suitable for urban propagation prediction. Spatial partitioning technology, as the name suggests, is to divide the entire area into many urban domains, and the number of faces and splits in these urban domains will be relatively small. And split to perform occlusion inspection, which greatly reduces the number of occlusion inspections. Because in the densely built urban area, the number of inner faces and splits in a microcity is quite large. If some tricks are not used, each ray will be judged to intersect with each face and each chopping in the city, and the calculation of intersection will be done, which is a huge amount of calculation. Assuming that the number of rays is N_0, the number of faces is N, and the number of splits is M; the required number of intersections is

$$\begin{aligned} &N_0(N+M)N, \\ &N_0(N+M)^2N, \\ &N_0(N+M)^3N. \end{aligned} \tag{5}$$

Obviously, such a large amount of calculation is unbearable. Therefore, it is necessary to adopt effective techniques to reduce the amount of computation. The generation of partition technology stems from this.

3.4. Research on the Calculation Method of Urban Image Dissemination Characteristics. It is well known that the problem of media propagation in arbitrary environments can be reduced to the solution of Maxwell's equations under given boundary conditions. Equations (6)–(9) give the differential form of Maxwell's equation.

$$\nabla \times \vec{H} = \frac{\partial \vec{D}}{\partial t} + \vec{J}, \tag{6}$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}, \tag{7}$$

$$\nabla \cdot \vec{B} = 0, \tag{8}$$

$$\nabla \cdot \vec{D} = \rho, \tag{9}$$

where E and H are the propagation field strength and magnetic field strength, respectively, and their units are V/m and A/m, respectively; J is the current density; p is the charge density; D and B are the electric flux density and magnetic flux density, respectively, and their units are C/m^2 and Wb/m, respectively, which satisfy

$$\vec{D} = \varepsilon \vec{E} = \varepsilon_r \varepsilon_0 \vec{E}, \tag{10}$$

$$\vec{B} = \mu \vec{H} = \mu_r \mu_0 \vec{H}, \tag{11}$$

where ε and μ are the dielectric constant and magnetic permeability of the medium, respectively; ε ε r μ and Ho are the relative permeability of the medium and the permeability of free space, respectively. When studying the wireless propagation of city image, it can be approximated that $c \approx 3 \times 108$ m/s. The calculation of such reflection and refraction coefficients already includes the calculation of reflection and refraction of lossy media. And although such reflection and diffraction coefficients are derived from the case of plane wave propagation, they can also be used to approximate the reflection and refraction of cylindrical and spherical waves due to the local nature of high-frequency problems.

In order to solve the discontinuity problem of the Keller diffraction theory in the boundary transition region, Kouyoumjian and Pathak proposed the ideal conductive wedge in the 1970s—the uniform geometric diffraction theory (UTD) r83, whose uniform diffraction coefficient is

$$D_{s,h} = \frac{-e^{j(\pi/4)}}{2n\sqrt{2\pi k}\sin\beta_1}, \tag{12}$$

where $F(x)$ is the transition function used to correct Keller's inconsistency, which is defined as

$$F(x) = 2j\sqrt{x}\exp(jx)\int_x^{\infty} \exp\left(-j\tau^2\right)d\tau. \tag{13}$$

Figure 6 shows a schematic diagram of the function change curve of the transition function $F(x)$, which includes the change curve of its amplitude and phase.

4. Result Analysis and Discussion

4.1. Visual Display of the Prediction Model of Urban Image Dissemination. One of the basic problems in ray propagation tracing of city image is the establishment of 3D model of city. To develop the urban propagation prediction calculation software module, it is necessary to visualize the urban image propagation model and ray tracing results. Now there are many popular graphics modeling software, the

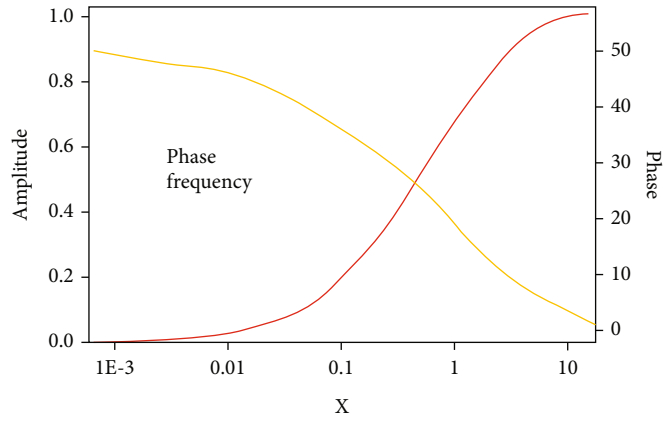

Figure 6: Propagation transition function.

description of the target mainly includes surface element, tetrahedron, and hexahedron. Different description methods address the needs of different application domains. The object of our research is mainly outdoor ray tracing, and the information to be obtained is the appearance parameters of the buildings in the city, so that our model can be built using the surface element method (pathc). In practice, we use 3Dface and 3DMax software of AutoCAD 14 for modeling.

In the visual display of the model, we use the OpenGL software. The development software uses V6C.O, which can realize the integration of the system. In this way, we use the 3Dface of AutoCAD 14 to model, output the DXF file, and the OpenGL software reads the DXF file and displays it. Graphics exchange file (DXF) is generally ASlCl code text file, a complete file consists of five segments as follows:

Header section (HEADE) R: it stores general graphic information of the DXF file, including variable names and corresponding data.

Table segment (TABLE) S: it contains the definition of command items and stores a series of tables, including line type (LTYP) E, layer table (LAYER), text text table (STYLE), view table (VIEW), user coordinate system table (UCS), window configuration table (VPORT), dimension table (DIMSTYLE), and application identification table (APPID).

Block table (BLocKS): it stores block definition entities.

Entity segment (ENTITIE) S: it stores graphic entities, including insert entities.

End of file (ENDOFFILE): it indicates the end of the file. Knowing the group code format of the DXF file can read the data in it. For our software module, just read the 3Dface data. When the ray tracing ends, the display of rays is actually the display of line segments. After the data of the model is obtained and displayed, the problem is ray tracing, which needs to extract the data useful for calculation from the known model, which requires analyzing the data structure of urban ray propagation prediction calculation. The model is composed of patches, and when we calculate the propagation, reflection, and diffraction of rays, we need not only the data of the faces but also the data of the splits and vertices, which requires the establishment of the faces containing the corresponding information.

4.2. Experimental Results and Analysis. Undoubtedly, in the urban image propagation prediction algorithm based on ray tracing, the quality of the ray tracing results determines the quality of various calculations in the future. To obtain reliable calculation results, it is necessary to have relatively accurate ray tracing results. Therefore, it is very necessary to improve the accuracy of ray tracing. The accuracy of the city image propagation model is inversely proportional to the time spent in ray tracing. In order to improve the efficiency of ray tracing, there are many high-rise buildings in the central area of the city. When the base station is located very low, a two-dimensional model is generally used. The accuracy of this model is of course not high. And when encountering the situation of high base station, this kind of model cannot be used. Therefore, in order to take into account the model accuracy and ray tracing efficiency, there are some quasi-3D models. As a verification, we use a TmPa urban area, along the street from point A to point B to compare the measurement results with the ray tracing results. The comparison between the calculated results at the same calculation level and the measured values is shown in Figure 7. Among them, the ray method 1 refers to the result of calculating only one diffraction and one reflection, and the ray method 2 refers to the result of calculating one diffraction and six reflections. We see that calculating multiple reflections can effectively improve the strength of the propagated signal, and, in general, calculating one diffraction plus six reflections is sufficient. In this way, not only the accuracy of the ray tracing algorithm is effectively improved, but also it is ensured that there is no need to spend too much computing time on the ray tracing.

And, in the actual calculation, it is also found that not all the blocks need to calculate so many layers. For nonrear blocks with direct rays, only one diffraction and one reflection need to be taken into account to meet the requirements. The reason is simple; the ray intensity of the lower level is too small relative to the direct ray, so it can be ignored. In the calculation, only one diffraction and one reflection are

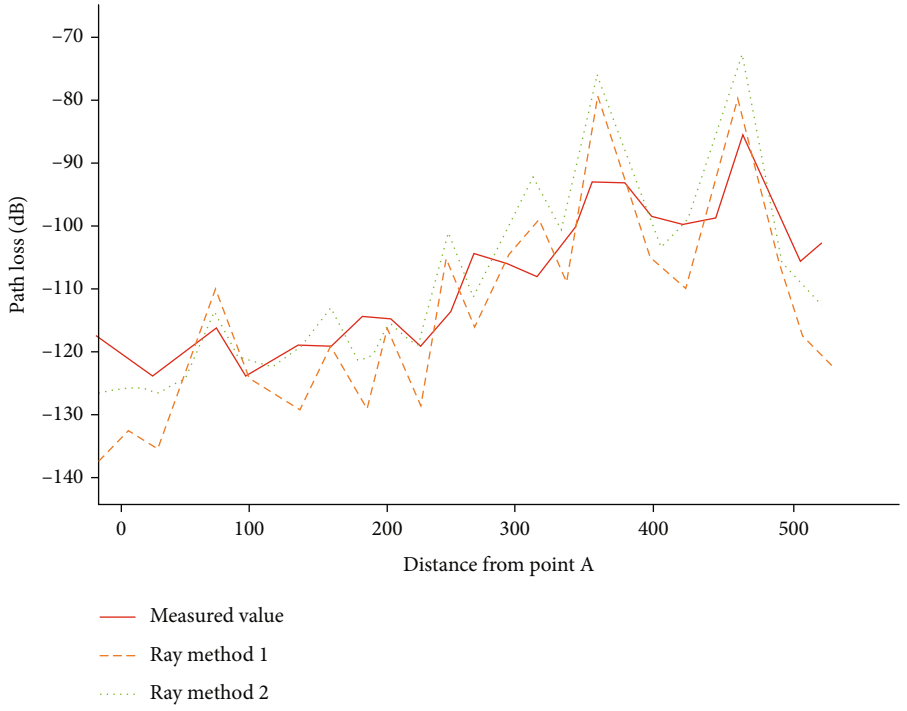

Figure 7: Comparison of ray tracing results at different levels with the measured values.

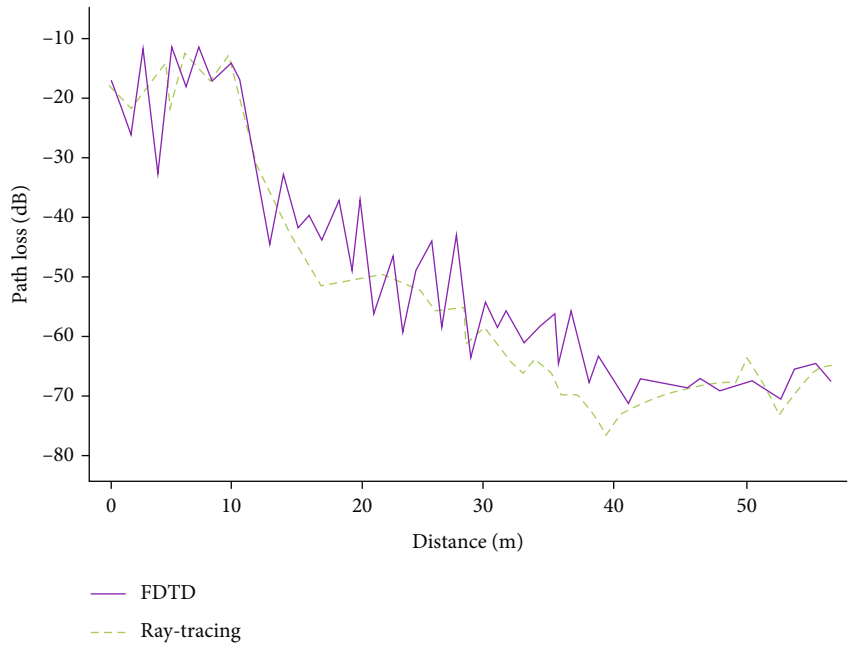

Figure 8: Propagation path loss of A-B.

calculated, and the results are compared with the calculation results of FDDT. The results are shown in Figure 8. It can be seen that this can well meet the accuracy requirements. Different blocks are calculated separately. For nonrear blocks with direct rays, only one diffraction and one reflection can be calculated, while for back blocks, one diffraction and six reflections need to be calculated. In this way, not only the efficiency of the reverse algorithm can be improved, but also the accuracy of its calculation can be guaranteed.

Figure 9 is a comparison of the diffraction results calculated by the method based on Muliuzhinets and the Pathak method. It can be seen that although the theoretical derivation is relatively strict, the calculation formula of the finite conductivity dielectric wedge diffraction field based on the

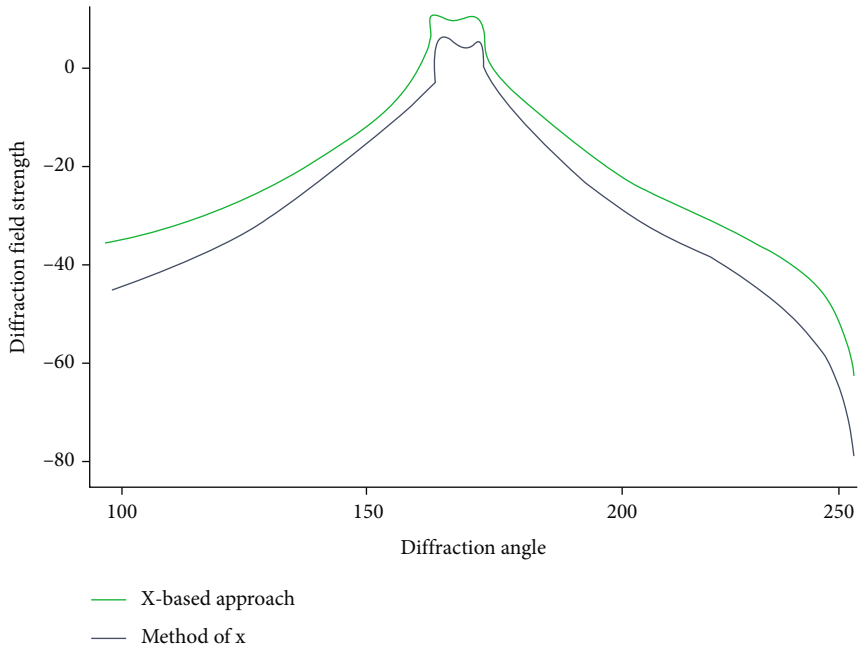

Figure 9: Comparison of diffraction results calculated by the method based on Muliuzhinets and the Pathak method.

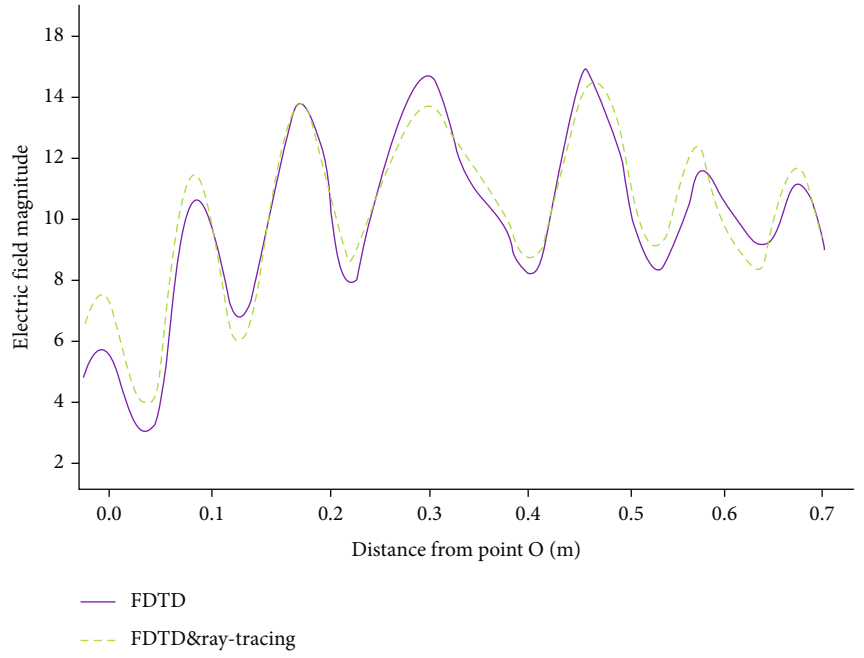

Figure 10: Comparison of mixed method and FDDT results.

Muliuzhinets method is very complicated and can only calculate the diffraction of some specific angle wedges, which is not widely applicable. For the calculation of the lossy medium wedge diffraction, another method with wider application range is the heuristic uniform diffraction coefficient formula. This heuristic uniform diffraction coefficient formula has no strict theoretical derivation, but a formula obtained by comparing the calculation results of the wedge diffraction.

The structures in the dashed box were calculated with FDTD using the recorded results as secondary sources. In the calculation, the grid size of FDDT is 20 grids per wavelength. The calculation results are compared with the calculation results of FDDT, and the results are shown in Figure 10. It can be seen from Figure 10 that the calculation results of the hybrid method are in good agreement with the results of FDTD. But it can be seen from the algorithm steps of the hybrid method that this method is only suitable for

the forward algorithm in ray tracing. For the reverse algorithm of ray tracing, this method is not applicable. The hybrid method is based on the forward algorithm of ray tracing, which also needs to introduce the receiver sphere in the calculation of the hybrid method, and also has the shortcomings of the forward algorithm such as the unclear ray path. In other words, the hybrid method cannot accurately calculate the phase and polarization information when the rays arrive at the field point.

5. Conclusion

This paper analyzes the five fields of city image communication from the perspective of video text, including promotional films, documentaries, film and television plays, communication, and marketing. Geometrical optics method, geometrical diffraction method, uniform diffraction coefficient, and heuristic wedge-shaped diffraction coefficient formula of finite conductive medium are adopted. The reverse ray tracing method is studied in detail, and a fast reverse ray tracing algorithm is given. Combined with computer graphics modeling technology and ray tracing technology, the image intelligence of the city is analyzed, and the prediction characteristics of media propagation characteristics are studied. A 3D ray tracing calculation model based on ray tracing octree method is proposed. Combining the ray tracing results with the traditional digital channel characteristic parameter analysis methods, a digital channel characteristic parameter analysis method based on ray tracing algorithm is studied. Various methods to improve ray tracing accuracy are comprehensively studied and analyzed, and the specific methods to improve the tracing accuracy of reverse algorithm are given. In short, a method for predicting the statistical parameters of urban image propagation channels based on ray tracing results is proposed. Then, the channel parameters are analyzed using statistical parameters, and the channel parameters of the urban image propagation model are analyzed.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

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Research Article

Application of Virtual Reality Technology and Unsupervised Video Object Segmentation Algorithm in 3D Model Modeling

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3D modeling is the most basic technology to realize VR (virtual reality). VOS (video object segmentation) is a pixel-level task, which aims to segment the moving objects in each frame of the video. Combining theory with practice, this paper studies the process of 3D virtual scene construction, and on this basis, researches the optimization methods of 3D modeling. In this paper, an unsupervised VOS algorithm is proposed, which initializes the target by combining the moving edge of the target image and the appearance edge of the target and assists the modeling of the VR 3D model, which has reference significance for the future construction of large-scale VR scenes. The results show that the segmentation accuracy of this algorithm can reach more than 94%, which is about 9% higher than that of the FASTSEG method. 3D modeling technology is the foundation of 3D virtual scene; so, it is of practical significance to study the application of 3D modeling technology. At the same time, it is of positive significance to use the unsupervised VOS algorithm to assist the VR 3D model modeling.

1. Introduction

VR refers to the artificial media space established by computer [1]. With VR technology, the formation of the concept of the complex or abstract system can be made possible by expressing the subcomponents of the system into symbols with exact meanings in some way [2, 3]. Among them, 3D modeling is the most basic technology to realize VR technology. VR simulates things in the real world in virtual digital space, and 3D modeling is to solve the problem of the representation of things in the real world in digital space [4]: how to use the computer to automatically analyze the 3D modeling data effectively and search the 3D modeling content efficiently, all of which bring great challenges to VR 3D modeling [5]. It is a new attempt to apply unsupervised VOS algorithm to the modeling process of the VR 3D model.

Modeling in virtual environment is the foundation of the whole VR system, and VR creates a virtual digital environment that is highly similar to the real environment in vision, hearing, and touch through the use of interactive computer technology as the core of science and technology. Users interact with objects in the virtual environment by using relevant professional equipment. It can also create an experience in the digital environment that is similar to the real environment and can span time and space. In VR, an interactive medium, users can perceive their positions and gestures in the virtual environment. It also causes a strong real sensory response, so that you can immerse yourself in the virtual world. Users rely on graphics and other technologies to feel the simulated objects and characters, so as to immerse their consciousness in the digital environment [6]. In order to create an immersive and realistic environment for users, one of the necessary conditions is to create a realistic virtual scene. When drawing such a complex model, it is often difficult to achieve real-time effect due to the restriction of machine performance, which is also difficult for people to accept [7]. Generally speaking, people need to take a compromise between the fineness of the model and the speed of rendering, which not only ensures a certain rendering quality but also does not cause the user's movement discomfort [8]. Because of the large amount of 3D modeling data and redundant information, and the general efficiency of the existing target segmentation algorithms is low, it is necessary to study and implement a fast target segmentation

algorithm. This paper proposes an unsupervised VOS algorithm, which initializes the target by combining the moving edge of the target image and the appearance edge of the target, assists the modeling of VR 3D model, and studies the integration and scheduling management of VR scene.

To develop a VR application system, we must first analyze the necessary tasks, clarify the purpose and performance index of the tasks, and then arrange appropriate hardware and software resources for the system [9]. The next step is to establish a virtual environment database and apply various physical features, motion constraints, audio, and interactive features to virtual objects and virtual scenes, including geometric modeling, motion modeling, physical modeling, audio modeling, and model segmentation.

The innovative contribution of this paper lies in the combination of the moving edge of the target image and the appearance edge of the target to initialize the target and assist in the 3D modeling of virtual reality. The application of the unsupervised VOS algorithm in 3D modeling of virtual reality technology is analyzed. This algorithm combines the moving edge of the target image and the appearance edge of the target to initialize the target and assist VR 3D model modeling. This paper introduces 3D information, that is, the depth difference between foreground objects and background areas, which can effectively improve the accuracy of object segmentation and make the segmented objects more detailed and complete. The development of virtual reality modeling technology is discussed, and the characteristics, main technical indexes, and basic contents of virtual reality modeling technology are systematically studied. It can be clearly seen that in most video frames, the segmentation results in this paper are better than other methods. In general, the algorithm has a certain practical value because of precision proofreading.

This article will be divided into five parts, and the specific contents are as follows:

The first section introduces the research background and significance and explains the organizational structure of this paper. The second section is related work. The third section analyzes the VR technology. The application of the unsupervised VOS algorithm in the 3D model modeling is discussed. In the fourth section, a lot of experimental analysis is carried out. The fifth section is summary and prospect.

2. Related Work

Soares Júnior et al. pointed out that 3D modeling is a core technology in VR [10]. It is written in 3DMax and VRML language, including pattern recognition technology and communication technology. Ko and Sim introduced the application and realization of 3D modeling technology in the joint station system from the aspects of system analysis and design, system 3D virtual scene construction, database technology, scene performance artistry, and 3D object motion simulation [11]. Zhang et al. and Yu et al. pointed out that detecting whether two polyhedra intersect can be done in linear time [12, 13]. If two point sets have disjoint convex hulls, then there must be a plane separating the two point sets. Zhuo et al. introduced the basic content of 3D technology and analyzed and studied its realization method [14]. Cao et al. used Multi Gen Creator and Vega software platform to develop a desktop virtual launch site simulation system [15]. Smith and Hamilton and Hung et al. proposed an object segmentation method using spectral clustering of layer features in images [16, 17]. On the basis of oversegmenting the image using the algorithm, the method extracts the middle-level features of each superpixel, which are edge features and color features, respectively, uses the superpixel as the basic node, fuses these two different features to construct a similarity matrix, and finally uses spectral clustering gets the final target segmentation result. Liu et al. proposed a segmentation algorithm based on finger touch. By fusing edge, regional texture, and locally collected geometric information of contact points into an appearance model, only one finger touch can identify the object of interest in the image [18]. Zhao and Kit designed a regularly sampled space-time bilateral grid to minimize long-term space-time connections between pixels [19]. Some methods segment moving objects in videos by building dense or sparse trajectories using probabilistic models. Liang et al. generated a fixed-size window with the current pixel as the center and extracted the lab color features within this window [20]. Then, this feature is compared locally with the features in other nearby windows to obtain the saliency calculation result, and the saliency value at multiple scales is combined to obtain the initialization result of the saliency target. Yilmaz et al. implemented a spatiotemporal video segmentation algorithm by combining long-term motion cues from past and future frames [21].

This paper studies the application of the unsupervised VOS algorithm in the 3D model modeling of VR technology. In this paper, an unsupervised VOS algorithm is proposed, which initializes the target by combining the moving edge of the target image and the appearance edge of the target and assists the modeling of VR 3D model, which has reference significance for the future construction of large-scale VR scenes.

3. Methodology

3.1. 3D Model Modeling. An important factor in VR system is the modeling of virtual world [22, 23]. The modeling process of VR is generally divided into the following steps: (1) describe the shape and appearance of virtual objects through geometric modeling. (2) Determine the position of 3D objects in the world coordinate system and their movement in the virtual world through motion modeling. (3) Physical modeling, which comprehensively reflects the physical characteristics of the object, including weight, inertia, and surface hardness. (4) For a large-scale simulation environment, it is necessary to model the behavior of some objects that users cannot control. The concrete process of 3D modeling operation includes data acquisition, data preprocessing, structure optimization, model creation, model optimization, scene optimization, scene integration, and scheduling management, and its application scope is wide [24]. Data preprocessing of 3D modeling is based on information collection. In the process of data collection, it is required to strictly

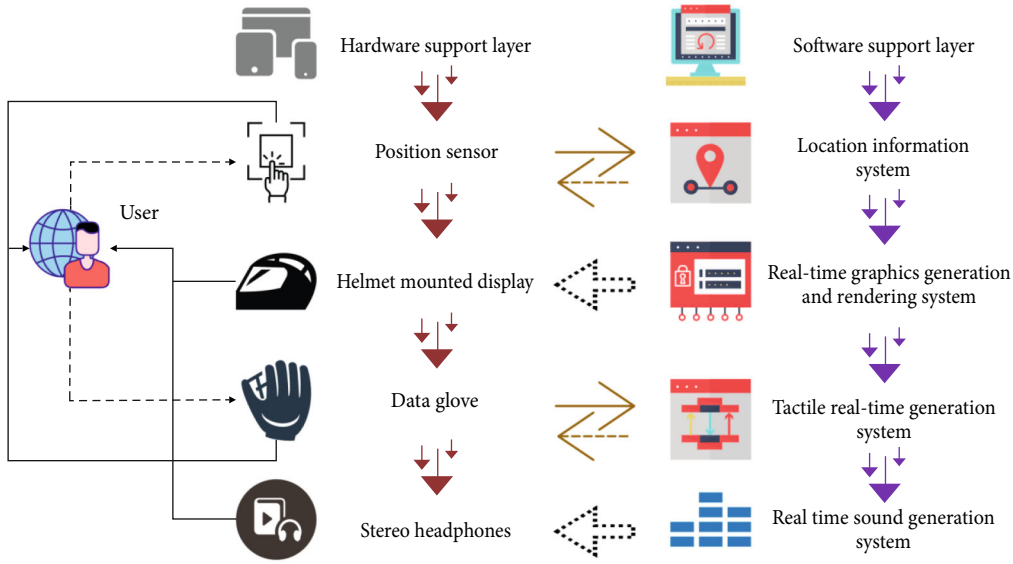

Figure 1: Architecture diagram of virtual environment.

follow the data collection specifications according to the operation process. The data acquisition process includes point control measurement, scanning station layout, spherical target layout, point cloud data scanning and acquisition, field data inspection and analysis, data export, and backup. Some filtering algorithms need to be used to filter out the point cloud data and discrete points of occlusion objects such as background during field operation and retain the main point cloud data of the object. The virtual environment architecture is shown in Figure 1.

The functions of the virtual environment framework are as follows: firstly, it supports the subscription and publication of object attributes and interactions; at the same time, it provides callback and event notification mechanisms and supports various time management strategies of HLA. Secondly, it provides services related to locating, creating and deleting various objects, and organizes and manages simulation entities with different functions and properties in a classified and unified way. Image-based modeling technology refers to the direct use of camera devices to collect discrete images of objects and other basic research materials for data processing; then, the panoramic image is generated by the combination and evolution of image processing software. Then, the panoramic image is further processed to the adaptive space model, and the VR real space is made. Because it is necessary to run 3D models in real time, its modeling method is very different from modeling-based modeling, and most of them use other techniques instead of increasing the complexity of geometric modeling to improve the fidelity [25]. There are three modeling methods for the VR system, which are mainly distinguished according to the construction methods of virtual scene: model-based rendering method, image-based rendering method, and mixed modeling method based on graphics and images. 3D graphics modeling technology mainly studies the generation and representation of 3D object information in the computer. Models describing 3D object information include geometric model, illumination model, and color model. In virtual reality hybrid modeling, users can enter the virtual scene in the form of virtual entity objects. Although the user avatar cannot interact with it, people can still obtain the depth information of the user avatar relative to the pure virtual object in the image by using binocular stereo vision technology and helmet mounted display. Because users expect that the scene objects that interact with them must be geometric model entities, hybrid modeling is required. In addition, in order to meet the visual reality, geometric model entities must be assigned with surface texture and material attributes. However, in hybrid modeling, it is difficult for user avatars to interact with virtual environment image objects established by the BMR method. The simulation requires the integration of geometric entity object and virtual environment image object, at least in vision. Although the distance or gap between virtual environment image objects can be perceived through the depth information of virtual environment image objects, however, how to smooth geometric entity objects into such space gaps remains to be solved. The mixed modeling technology based on graphics and images can integrate the advantages of both and make the best use of their strengths and avoid their weaknesses in application [26]. This not only increases the realism of the scene but also ensures real-time and interactivity and improves the immersion of users. In 3D modeling technology, there are often many problems that affect the authenticity of modeling. Therefore, in modeling technology, in order to improve the fidelity of display, the following methods are often used: blanking, shading model, and texture mapping.

3.2. Application of Unsupervised VOS Algorithm in 3D Model Modeling. Optimization technology is a crucial link in the process of 3D modeling. Usually, the basic plan is drawn by CAD using the position in the drawing, and then the plan is fully imported into the 3DMax construction model. In the process of making the model, the basic frame structure must

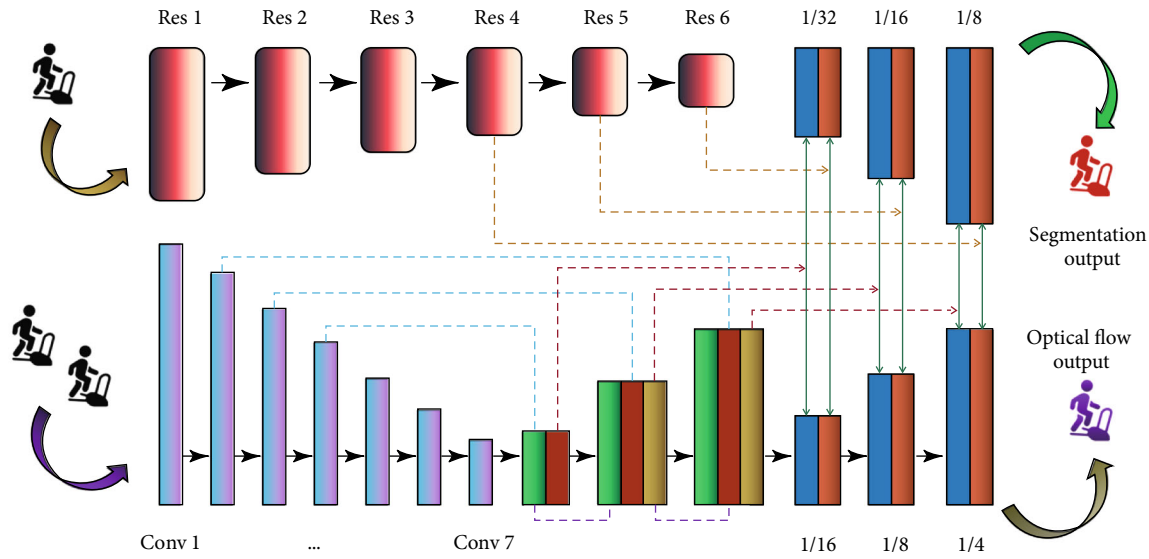

Figure 2: Network structure diagram.

Table 1: Comparative experiment of motion saliency segmentation network on DAVIS.

Method	Mean
Mp-net-motion	55.36
Uovos-motion	56.91
Fseg-motion	68.25
Epo-motion	76.58
Methods of this paper	80.36

be drawn first, and then the complete structure model can be drawn using the previous external contour. Then, each relevant model is effectively spliced, which will better optimize the overall structure of the model. Effectively map the structure after modeling. In the process of mapping, complete mapping must be carried out according to the specific structure size of the model. At the same time, different mapping scales are required for different precision models. We should deal with it effectively according to the real effect, so as to reflect the authenticity. This scene simulation system is an improvement of the traditional optimization technology, and the optimization technology used runs through the whole modeling process. The reality of an object's appearance mainly depends on its surface reflection and texture. Today's graphics hardware platform has the ability of real-time texture processing, which can enhance the sense of reality with a small amount of polygons and textures while maintaining the graphics speed. Texture can be generated by two methods, one is to interactively create, edit, and store texture bitmaps by image rendering software; the other is to take a picture of the required texture, then scan it, or take a picture directly with a digital camera. First of all, it is necessary to determine which space plane the surface patch projects on, which depends on the overall direction of the surface patch, and the plane with the smallest angle will be projected to which plane. Considering the convenience, when deciding the position of the target point, this paper calculates the error costs of two endpoints, respectively, takes out the one with smaller error, compresses it to the position of the other endpoint, and deletes the degraded triangle at the same time.

The object of segmentation is to detect the moving object. The simplest method of mask fusion is to calculate the intersection area of salient motion mask and general target mask, so as to satisfy the characteristics of motion and general target at the same time, but its accuracy is low. In order to make full use of the mask results of motion detection and target sampling, this paper adopts the method of deep learning and constructs a small fusion network to fuse the masks of the two. In unsupervised VOS, effective and full use of motion cues is crucial to segmentation performance. As a mainstream method of timing information modeling, optical flow can simulate the moving trend of the target according to the displacement changes of pixels in adjacent frames. The network structure composed of an appearance segmentation network and an optical flow prediction network is shown in Figure 2.

In the aspect of target image edge extraction, this paper obtains the moving edge of the target through the difference of the size of the motion and the direction of the motion. The specific description is as follows: first, calculate the optical flow vector value between two adjacent frames, and through formula (1), calculate the motion size b_p^m of each pixel point p:

$$b_p^m = 1 - \exp\left(-\lambda^m \left\| \nabla \vec{f}_p \right\|\right). \tag{1}$$

In the formula, $b_p^m \in [0, 1]$ is the motion size of the pixel point p, $\vec{f}_p$ is the optical flow vector value of the pixel point

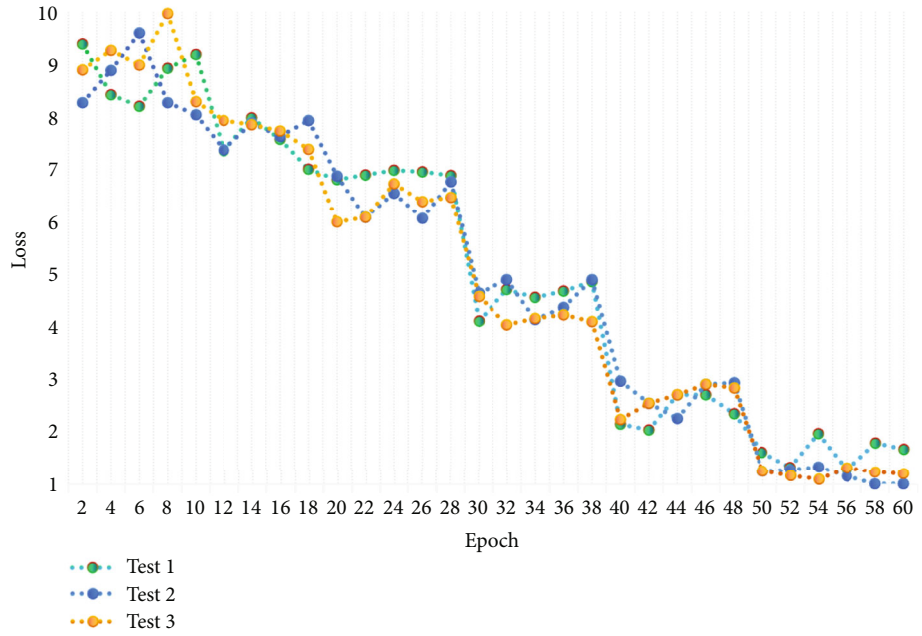

Figure 3: Training of the algorithm.

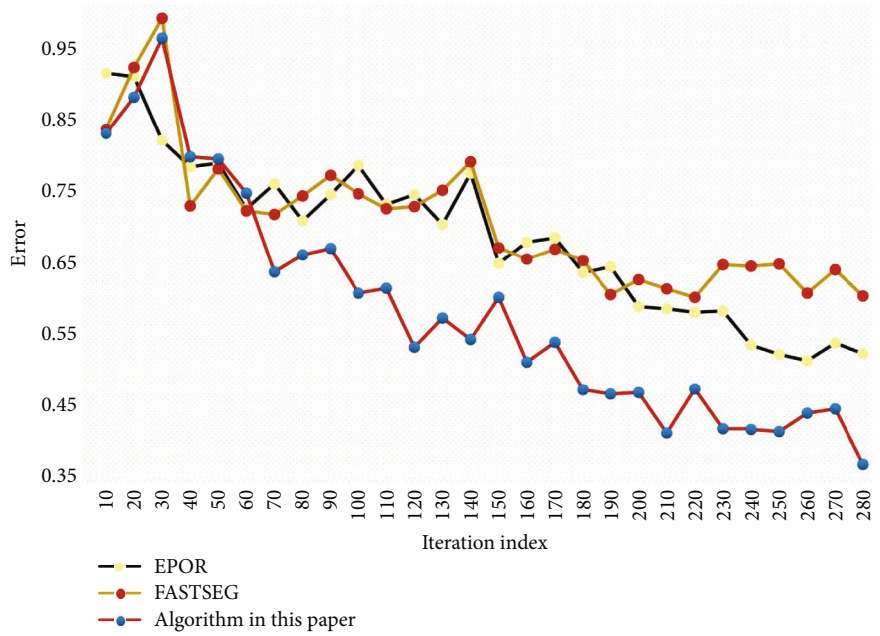

Figure 4: Error of the algorithm.

p, ∇ is the gradient value, and λ^m is the weight parameter. However, due to the shaking of the camera or following the target, the background will move violently. Therefore, this paper considers the use of the angle between the motion vectors to distinguish the target and the background, such as formula (2), to obtain the motion edge size b_p^θ:

$$b_p^\theta = 1 - \exp\left(-\lambda^\theta \max_{q \in N}\left(\delta\theta_{p,q}^2\right)\right). \tag{2}$$

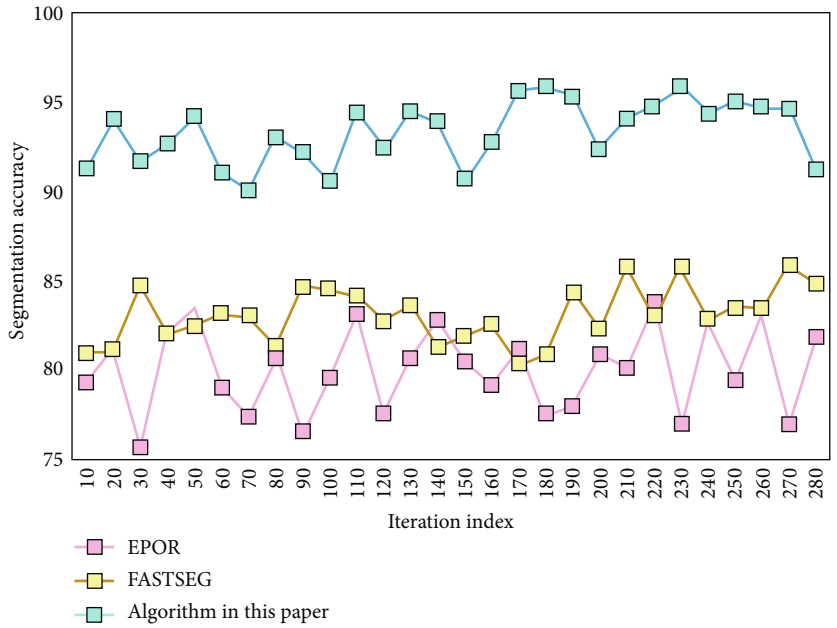

Figure 5: Segmentation accuracy of the algorithm.

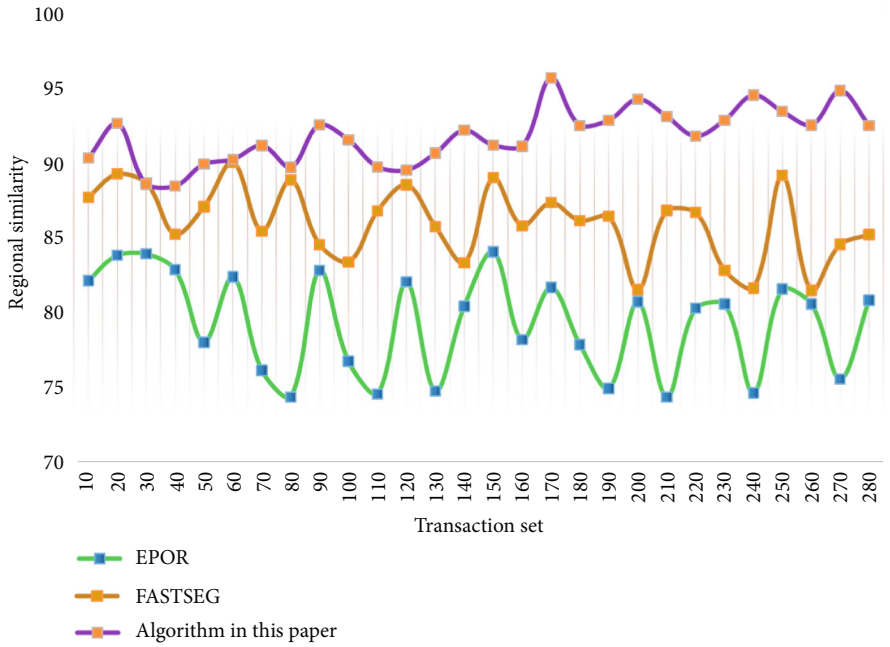

Figure 6: Experimental results of regional similarity.

In the formula, $b_p^\theta \in [0, 1]$ is the maximum angle distance between the pixel point p and the surrounding pixels and $\delta\theta_{p,q}$ is the angle size of the motion vectors $\vec{f}_p$ and $\vec{f}_q$ of the pixel points dd p and q. At the same time, the motion edge feature b_p of the target is obtained by combining the motion size and direction of the pixel, and the motion edge of the target can be obtained. The formula is as follows:

$$b^p = \begin{cases} b_p^m, & \text{if } b_p^m > T, \\ b_p^m \cdot b_p^\theta, & \text{if } b_p^m > T. \end{cases} \tag{3}$$

In the formula, T is the size of the threshold, and b_p^m and

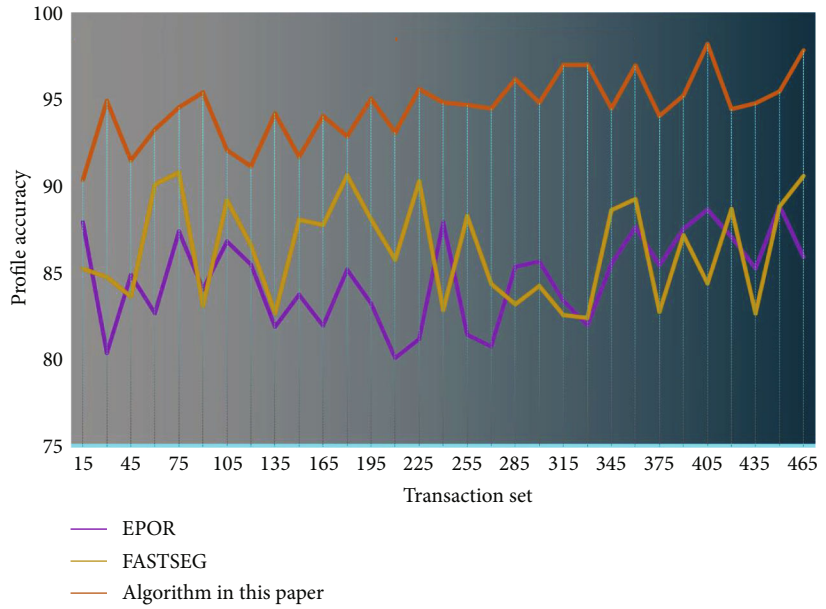

Figure 7: Experimental results of contour accuracy.

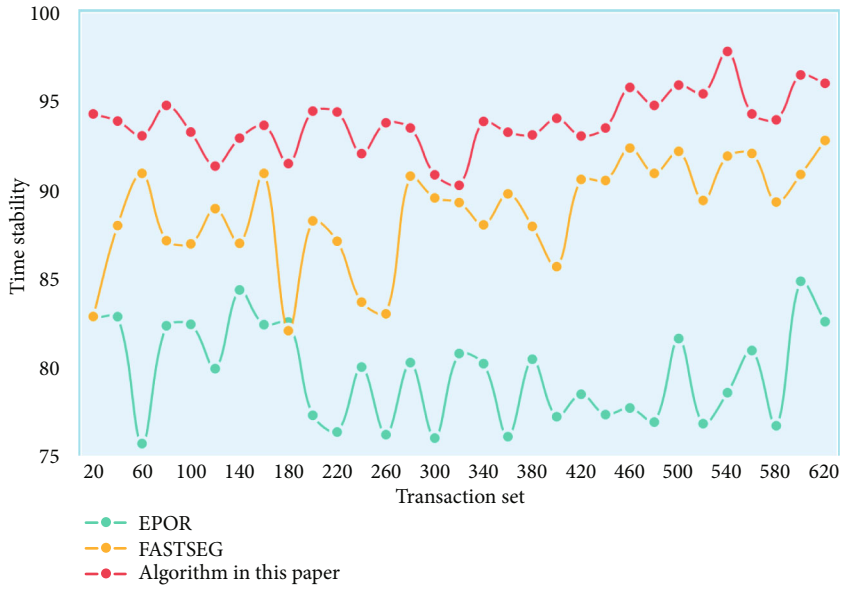

Figure 8: Experimental results of time stability.

b_p^θ represent the edge value obtained by the magnitude of the motion amplitude and the angle of the motion direction, respectively.

This paper associates each vertex with a set of planes near it, and the error of the vertex is expressed as the sum of the squares of the distances from this point to each of the planes in the set. When two vertices are compressed into a single point, the relevant plane group of the target point is the sum of the two groups of planes of the original point. Each plane can be written as the following equation:

$$n^T v + d = 0, \tag{4}$$

where $n = [n_x, n_y, n_z]^T$ is the normal vector of the plane, and d is a constant. Then, the square of the distance from point $\mathrm{v} = [\mathrm{x}, \mathrm{y}, \mathrm{z}]^{\mathrm{T}}$ to the plane is

$$D^2 = \left(n^T v + d\right)^2 = \left(n^T v + d\right)\left(n^T v + d\right) = v^T\left(nn^T\right)v + 2dn^T v + d^2. \tag{5}$$

This is a quadratic, and let

$$Q = (A, B, C) = \left(nn^T, dn, d^2\right), \tag{6}$$

$$Q(v) = v^T A v + 2B^T v + C, \tag{7}$$

Table 2: Experimental results of indicators.

Index	1	2	3	4
Regional similarity	0.959	0.951	1.971	0.968
Accuracy of contour	0.984	0.988	0.975	0.993
Time stability	0.989	0.991	0.987	0.983

Table 3: Accuracy comparison results of different segmentation methods on data sets.

Method	Vehicle	Pedestrian	Horse	Plane
VOE	5.2*E*+03	6.2*E*+03	4.2*E*+04	1.2*E*+03
EPOR	5.3*E*+03	5.0*E*+04	3.2*E*+04	7.2*E*+04
RCC	5.5*E*+03	5.5*E*+04	3.5*E*+04	4.5*E*+04
VIBE	6.2*E*+03	7.5*E*+03	3.2*E*+04	4.2*E*+04
FASTSEG	2.2*E*+04	6.1*E*+04	3.1*E*+04	4.6*E*+04
Methods of this paper	3.2*E*+03	5.8*E*+04	7.2*E*+03	1.2*E*+04

because

$$Q_1 + Q_2 = (A_1 + A_2, B_1 + B_2, C_1 + C_2). \tag{8}$$

So,

$$Q_1(v) + Q_2(v) = (Q_1 + Q_2)(v). \tag{9}$$

Therefore, to calculate the sum of the squares of the distances from a vertex to a set of planes, this article only needs to add all the quadratic formulas and finally gets a quadratic formula. After the two vertices are compressed into one vertex, the corresponding quadratic formula is also the sum of the quadratic formulas of the original two points. Therefore, the error of an edge-compression operation $(v_1, v_2) \longrightarrow v$ can be defined by the following formula:

$$Q(v) = Q_1(v) + Q_2(v) = (Q_1 + Q_2)(v). \tag{10}$$

Let $P^t = \{P_1^t, P_2^t, \cdots, P_N^t\}$ be the backward optical flow field between two frames F^t and F^{t-1}. where each element $P_i^t = [u_i^t, v_i^t]$ is the optical flow vector of pixel F_i^t in the horizontal and vertical directions; N is the total number of pixels in the frame. Let $\tilde{S}^t$ be the salient motion map in the optical flow field P^t, and the global motion contrast $\tilde{S}^t{}_i$ can be expressed as the following formula:

$$\tilde{S}^t{}_i\left(P^t\right) = \sum_{\forall P_j^t \in P^t} d\left(P_i^t, P_j^t\right). \tag{11}$$

Among them, $\tilde{S}^t{}_i \in [0, 1]$ and $d(\cdot)$ are distance measures. Let ϕ be the binary segmentation function of the adaptive threshold method, an then the salient motion mask S^t is shown in the following formula:

$$S^t = \phi\left(\tilde{S}^t\right), \tag{12}$$

where each element $S_i^t \in \{0, 1\}$ represents the binary foreground-background label of pixel F_i^t.

In this paper, a skip connection is used to connect the original features, which can preserve the predicted parts of the optical flow features in other directions without affecting the common salient regions. Similarly, this paper also performs similar operations on the backward optical flow feature and the saliency map generated by the forward optical flow. The operation of the entire structure is symmetrical. The overall process is described as follows:

$$f_{\text{bm}} = \sigma\left(\theta_1\left(f_f\right)\right), \tag{13}$$

$$f_{\text{fm}} = \sigma(\theta_2(f_b)), \tag{14}$$

$$F_{\text{forward}} = f_f \times f_{\text{bm}} + f_f, \tag{15}$$

$$F_{\text{backward}} = f_b \times f_{\text{fm}} + f_b, \tag{16}$$

$$f_m = \sigma(\theta_3(\text{concat}(F_{\text{forward}}, F_{\text{backward}}))). \tag{17}$$

The two processed features are connected, and the final optimized motion saliency map f_m is obtained through a 3 $\times$ 3 convolution and Sigmoid function. The function of the sigmoid function is to compress the element value between $[0, 1]$ and generate a probability saliency map. The larger the value, the greater the saliency probability of the position.

Because of error estimation, each vertex in the vertex table needs a unit to store the compression error of that point in addition to its three coordinate values. In addition, each record in the side table not only records the serial numbers of the two vertices of the side but also records the compression error of the side. In this paper, combined with the actual hardware and software conditions, using modern advanced technology, the collected data should be preliminarily processed, and some incorrect or redundant data should be removed. At the same time, the collected data can keep a relatively high precision, which can meet the requirements of the system to the greatest extent. Combined with the collected data, the data is preprocessed. Considering that color, material, etc. should be processed in the development of the system, and 3DS is a very common data format, and the 3D graphics files saved in this format are also very rich, so this system uses 3DS data structure to convert data. As for the conversion of data format, the main core is to convert the data of model construction and form the list of model construction of 3DS, which can be used as the display list of OpenGL to reconstruct the model. Unfortunately, not all cases apply to parametric surfaces. There are some situations that require adjacent surfaces to fit together well (no cracks or T-joints) when an object is rendered into a polygon. Also, there are many jagged objects that cannot achieve good results using parametric surfaces, because the number of surfaces required may not be less than the number of polygons. The polygon-based face reduction method is generally more useful and can work on the current type of model.

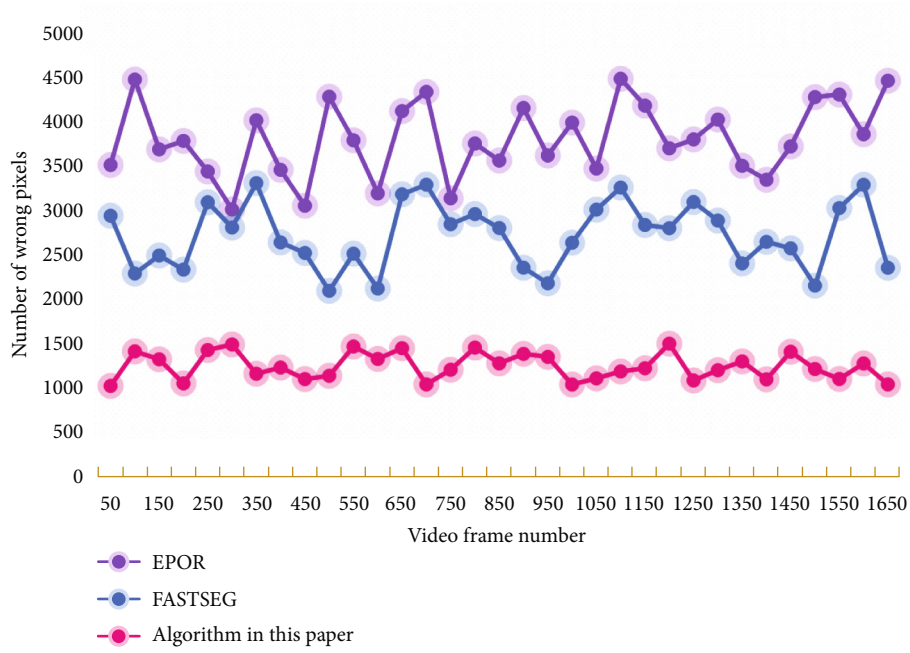

Figure 9: Comparison chart of the number of wrong pixels per frame.

4. Result Analysis and Discussion

In this section, the algorithm proposed in this paper is verified by experiments. Firstly, the data set used for the evaluation method and the corresponding evaluation indexes are introduced, and the corresponding modules proposed in this paper are tested on the specified data set. At the same time, the experimental results compared with other algorithms are introduced, and then the concrete discussion and analysis are carried out according to the experimental results. In order to further verify the effectiveness and practicability of this algorithm, several data sets in the experiment are YOUTUBE-OBJECTS public data set, DAVIS data set, and self-collected video set. Among them, a shot from the videos of airplane, horse, and motorcycle on DAVIS data set of YOUTUBE-OBJECTS public data set and the videos of pedestrians and two pedestrians in the surveillance scene taken by myself are selected. DAVIS data set is a large-scale video single-target segmentation data set, which contains 50 video sequences, including 30 video sequences in the training set and 3450 video frames in the test set, each with pixel-level labeling information. The dataset contains various challenges of target segmentation, such as scale change, fast motion, object occlusion, dynamic background, and motion blur. For the evaluation of experimental results, this section uses three evaluation indexes defined in DAVIS: regional similarity, contour accuracy, and time series stability.

Since salient object detection was introduced into the VOS field, many algorithms have directly applied salient object detection in the optical flow field and used the results of salient motion detection to perform the VOS task. Aiming at the motion saliency segmentation network, this paper mainly discusses the rationality of bidirectional optical flow and the effectiveness of the motion cue optimization module. Table 1 shows the comparative experimental results of motion saliency segmentation network on DAVIS.

It can be seen that the segmentation result of the dynamic cue optimization module on each video sequence should be completely superior to the segmentation result using only unidirectional optical flow. This fully proves the rationality and effectiveness of introducing bidirectional optical flow in this paper. The training of the algorithm is shown in Figure 3.

This paper uses the unsupervised VOS algorithm based on PyTorch to achieve target detection and segmentation. In order to verify the effectiveness of the unsupervised VOS algorithm proposed in this paper, its segmentation accuracy is compared and analyzed in the experiment, and the composition analysis is given. The experimental data in this experiment is YOUTUBE-OBJECTS, a public data set, and the collected video data. The comparison method includes the current mainstream target segmentation algorithms. Figure 4 shows the error of the algorithm. Figure 5 shows the segmentation accuracy of the algorithm.

It can be seen that the segmentation accuracy of this method is higher than that of the contrast algorithm. This is because there is often a large amount of background information in the low-level features, and the background information is further amplified by fusing the low-level features in the two branches. However, for VOS, too much background information is not conducive to the segmentation network's learning of the target area, and it will cause the segmentation network to misunderstand the background area and identify it as the foreground target area, thus greatly reducing the segmentation accuracy. In this paper, the effectiveness of deep semantic information fusion can effectively improve the segmentation accuracy of the target.

In the evaluation index, regional similarity is the intersection ratio between mask and true value. Contour accuracy divides the spatial range of the mask by treating the mask as a set of closed contours. Time stability is used to punish adverse effects such as boundary instability. In order to compare the effect of this algorithm with the current advanced algorithm, this paper uses the code and parameter settings provided by data set official website. The results of regional similarity experiment are shown in Figure 6. The results of contour experiment are shown in Figure 7. The experimental results of time stability are shown in Figure 8.

At present, most of the target segmentation algorithms use some underlying features of the target to initialize the target first and then accurately segment the target on this basis. Therefore, by fusing some underlying features such as the boundary features of the target, we can jointly model the target to further improve the segmentation accuracy and propose the corresponding fast solution algorithm to reduce the processing complexity. This paper conducted 20 experiments on each index and selected 4 of them to draw a table. The specific experimental results are shown in Table 2.

With the introduction of bidirectional optical flow in this paper, the result of motion segmentation is similar to that of truth mask, which can effectively suppress the nonsignificant regions and produce more accurate preestimation. In this paper, the performance improvement is attributed to the fact that the proposed motion cue optimization module can make full use of more motion information.

This paper collected five videos for experiments. It includes five videos: one pedestrian, two pedestrians, two people talking, running, and multiplayer football, and the target is manually marked. Table 3 shows the precision comparison results of different segmentation methods on data sets.

It can be seen that the segmentation result of this paper is obviously superior to other segmentation results.

In the algorithm, salient motion segmentation can segment the motion region, while target sampling can segment the target region. Significant motion segmentation and target sampling cannot separate moving targets in video frames; so, the purpose of fusion module is to remove potential noise, such as moving background and static targets in video. Only two-dimensional motion information cannot effectively solve the problem of motion blur, but this paper introduces 3D information, that is, the depth difference between foreground object and background area, which can effectively improve the accuracy of object segmentation and make the segmented object more detailed and complete. Figure 9 shows a comparison of the number of wrong pixels in each frame.

It can be clearly seen from the figure that the segmentation results of this paper are superior to those of other methods in most video frames. The segmentation accuracy of this algorithm can reach more than 94%, which is about 9% higher than that of FASTSEG method. On the whole, the accuracy of this algorithm exceeds that of other target segmentation algorithms.

5. Conclusions

VR modeling technology is developing rapidly, and it is welcomed by many users because of its ease of use, stability, and rapidity. At present, it has a wide application prospect in commerce, medicine, engineering design, art, entertainment, military, and so on. Based on this, this paper studies the process of 3D virtual scene construction by combining theory with practice, and on this basis, researches the optimization methods of 3D modeling. In this paper, an unsupervised VOS algorithm is proposed, which combines the moving edge of the target image and the appearance edge of the target to initialize the target and assist the VR 3D model modeling. The research shows that the segmentation accuracy of this algorithm can reach more than 94%, which is about 9% higher than that of the FASTSEG method. The segmentation results of this paper are superior to those of other methods in most video frames. At the same time, the accuracy of this algorithm exceeds that of other target segmentation algorithms. In this paper, it is of positive significance to use the unsupervised VOS algorithm to assist VR 3D model modeling. The next step will be to further improve the database management based on Web. Plan the system database reasonably and integrate different kinds and properties of data into the system database to the maximum extent. In addition, in order to make full use of the value of VR modeling, in the current social life, people from all walks of life should strengthen their own study and inquiry and strive to maximize the value of VR modeling in a reasonable system.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Video Visualization Technology and Its Application in Health Statistics Teaching for College Students

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In view of the present situation of "learning difficulty" in health statistics, this paper proposes a video visualization technology based on the convolutional neural network, which updates parameters by calculating the gradient of loss function to obtain accurate or nearly accurate loss function. Taking the students from 2014 to 2017 in a university in Henan as the research object, this paper analyzes the video visualization technology and its application effect on the teaching of college students' health statistics from the aspects of students' course awareness, learning behavior, communication between teachers and students, knowledge mastery, and course satisfaction. The results show that the external model load difference between each explicit variable and latent variable is statistically significant. Learning behavior and communication between teachers and students have a direct impact on the mastery of knowledge, and the degree of influence from high to low is as follows: learning behavior and communication between teachers and students. The teaching effect model of health statistics based on video visualization technology of the convolutional neural network has certain practicability.

1. Introduction

Health statistics is a science of applying the principles and methods of mathematical statistics to study the health status of residents and collecting, sorting, and analyzing data from the field of health services [1, 2]. It is a discipline aiming at practical application and an important tool for medical research. With the increasing attention paid to scientific research work in our country, it not only is a required course of preventive medicine but has become a popular learning course for students and medical personnel of other medical majors such as clinical medicine [3, 4]. Health statistics plays an important role in training scientific research thinking of medical talents [5].

Health statistics is a subject that uses the principles and methods of mathematical statistics and probability theory to collect, sort out, and analyze medical data. With the development of medical research, in order to meet the needs of medical research, in the current medical colleges and universities, medical statistics has become a required course. The content of health statistics is rigorous and abstract, with strong logic and a large number of complex mathematical formulas and abstract concepts. According to previous studies, although students have a positive learning attitude and strong learning needs for health statistics, they think that health statistics is difficult to learn and their application ability is poor. It is difficult for some students to fully understand the important statistical knowledge such as normal distribution and hypothesis testing [6]. It is difficult for them to correctly distinguish the difference and connection between standard deviation and standard error, reference value range and confidence interval, correlation and regression, etc. Many students cannot choose appropriate statistical methods according to the type of data [7]. A survey of graduate students majoring in health statistics and epidemiology in a university also shows that how to correctly choose and use statistical methods is the biggest trouble that students face in the process of learning. Students do not have a thorough understanding and solid grasp of health statistics knowledge, which will lead to unsatisfactory statistical

practice in the future work. The reason why it is difficult to study in detail is not only the difficulty of understanding the knowledge but also the difficulty of obtaining high-quality resources. At present, the existing network resources of health statistics are simply listed and lack of logic and some learners find it difficult to find learning materials suitable for their own level [8]. In sharp contrast, health statistics teachers have accumulated a large number of high-quality teaching resources in the long-term teaching; but limited by the teaching method of face-to-face teaching, these contents are only used in the class or within the college and the high-quality resources are not effectively promoted and fully utilized [9, 10].

In addition, as an important applied discipline, health statistics needs to form a systematic and high-quality knowledge system, so that medical workers can quickly acquire corresponding knowledge according to their work needs. Therefore, it is urgent to build an intelligent learning tool of health statistics by means of video visualization technology in close combination with the subject characteristics of health statistics, so as to achieve the following effects: to help learners to independently learn health statistics knowledge in fragmented time and improve their practical application ability of health statistics methods.

Section 2 introduces the video visualization technology and its related research status in the teaching of health statistics for college students. In Section 3, the construction of the key technologies of video visualization based on the convolutional neural network is studied. Section 4 is the research object and research method of this paper. Section 5 is the result and discussion, and Section 6 contains the conclusions.

2. Related Work

With the rapid popularization of the Internet and the accelerated promotion of educational informatization, the scale of online education expands rapidly, which is expected to promote educational fairness and improve the quality of learning [11]. However, the common form of traditional online education is to move offline classroom to online, providing homogeneous and template learning resources for students with different characteristics, which also weakens students' interaction in the learning process, resulting in an unsatisfactory learning completion rate and learning satisfaction.

In recent years, the concept of "student-centered" education has been widely accepted, from "teaching" to "learning," from educators to learners, and from lifelong education to lifelong learning. But this kind of change has put forward brand-new challenge and request to the learning way [12]. At the same time, just as "there are no two identical leaves in the world," each student's knowledge level and learning attitude are different and their perceived knowledge difficulty will also be different. If we treat all learners only in a mode of "one size fits all", and provide the same learning guidance and help for them, which may cause learners who have high study ability feel bored because of small study challenges while learners whose study ability is low feel confused without help, leading to low learning engagement. To solve these problems, it is necessary to provide help according to the actual needs of learners [13, 14], that is, to provide personalized help and guidance. Under this background, the video visualization technology system emerges as The Times require. Video visualization technology is committed to understanding the personalized characteristics of learners through the mining of student education data and pushing learning resources to meet the needs of personalized learning, breaking the traditional group learning structure. The professional reports "2017 Horizon Report (Basic Education Edition)" and "2018 Horizon Report (Higher Education Edition)" both point out that video visualization technology plays a key role in promoting the development of online education, helping to achieve efficient and meaningful personalized learning.

The video visualization technology system is to provide learners with appropriate learning activities and the best video visualization system according to their learning characteristics such as knowledge and skill level and learning style. Through the real-time analysis of the learning process, it is constantly revised and improved to achieve personalized learning. The video visualization technology system needs a powerful knowledge model as a support. From the knowledge characteristics of health statistics, health statistics has strong logic and clear knowledge relationship in each chapter, which is conducive to the construction of knowledge model, which is the basis of knowledge visualization push [15–17]. Some scholars have explored the construction of knowledge models and learning systems by taking mathematics and mathematics subjects such as high school mathematics [18], calculus [19], and high school physics [20] as the research subjects, which has a reference value for this study.

With the rapid development of wireless communication technology, video visualization technology has become a beautiful scenery in university health statistics. The communication mode of "video visualization technology + university education" has promoted the fashion communication of health statistics. It "has helped the fashion communication of nonlegacy culture. According to the survey, if students can solve health statistics problems through extracurricular resources, it will be of great help to improve the learning effect. We can summarize and extract the key points of health statistics, carry out a visual display of difficulties of knowledge, analyze the vital cases, differentiate the concept and classification in different materials and build a diversified, multi-level and systematic knowledge system according to the degree of learners' demand for health statistics. It is helpful to consolidate students' basic knowledge of health statistics and improve students' practical application ability of statistical methods. Especially in the context of "Internet+," it is a very positive attempt to apply "video visualization technology + platform education" to health statistics. This study hopes to use information technology to share excellent resources and promote the learning of health statistics through video visualization technology software.

Therefore, whether the matching use of the video visualization technology system has a positive impact on students,

teachers, and the interaction between teachers and students, how to correctly use the wireless network communication technology in enterprises, and how to improve the quality of health statistics teaching for college students are all problems worth exploring and studying.

3. Analysis of Key Techniques of Video Visualization Based on the Convolutional Neural Network

By learning and training the intrinsic nature and representation features of the sample data, the neural network obtains the important information such as the voice, text, and image, which has the explanatory function, so that the machine has the same analysis and learning ability as human, and can carry out activities such as voice and text recognition and object detection. At present, neural networks have achieved remarkable results in speech and image recognition [21, 22].

If the neural network structure is regarded as a network, its core ideas are as follows:

(1) Each layer of the network uses unsupervised learning

(2) An unsupervised learning only trains one layer of the network and takes its training results as the input of its higher layer

(3) All network layers can be adjusted by supervised learning

Among the neural networks, the common networks with good performance include AlexNet, VGGNet, ResNet, SqueezelNet, and DarkNet. The reason why this paper chooses to use the neural network is to use its powerful learning and training function to analyze the clipped airport video images including visual features such as color, texture, shape, and statistical features and combine with real-time visibility data to realize the detection of airport visibility. However, with the increase of user needs and the development of computer technology, the disadvantages of high cost and heavy computation workload of general neural networks are becoming more and more prominent. In addition, the processing objects of this paper are mainly images. If there is no convolution operation in the deep neural network model, the number of learning parameters will explode catastrophically.

3.1. Properties of Convolutional Neural Networks. The convolution neural network consists of one or more of the convolution and the whole connection at the top of the layer (the layer can be 1×1 convolution as the final output) composed of a feedforward neural network, consisting of partial correlation of neurons in the hidden layer of the local small area which can be used as the underlying input data, make the network have the characteristics of local awareness, and can obtain the edge information [23–25]. In addition, the network shares the same convolution kernel in all images through weight sharing and retains the original position relationship. Meanwhile, the network automatically trains and extracts the features of each layer for many times, so that the network can fully explore the local features of the image while effectively limiting the number of parameters and preventing overfitting [26].

No matter what kind of convolutional neural network, there must be five layers of input, convolution, activation, and pooling and fully connected in the structure, as shown in Figure 1. And each layer has a specific role [27, 28]. Among them, the input layer can input the data within the three-dimensional dimension. The airport image data processed in this paper belongs to 3D, because generally color images contain R, G, and B channels.

Generally speaking, for a model with the same level of accuracy, the smaller the architecture, the more advantages it has: ① smaller communication requirements, ② less parameters and data, and ③ easier to be applied on devices with limited memory, such as the field-programmable gate array (FPGA). The lightweight convolutional neural network (LCNN) can greatly reduce the operating parameters and improve the computational efficiency under the condition of keeping the performance unchanged after changing the convolution mode. At present, the common lightweight convolutional neural network models include SqueezeNet, MobileNet, ShuffleNet, and Xception.

3.2. Structure of Convolutional Neural Networks

3.2.1. Analysis of the Convolution Layer Structure. Convolution operation is the most critical technology in the structure of the convolutional neural network. By this operation, the convolution layer can extract various features of the input signal. For example, the shallow convolution layer can obtain the low-order features of the target, while the deep convolution layer can extract the high-order features of the target. The convolution operation passes through a series of fixed-size convolution kernels and performs sliding and inner product operations on the input signal of the convolution layer according to the set step size, resulting in a brand-new feature map. The convolution layer is the core of the network, and feature extraction is realized in the process of translation on the original image. It consists of many filters, including the size and depth. There are usually odd-sized windows such as 3×3, 5×5, and 11×11, and the depth is the number of convolution kernels [29, 30]. The specific operation process is shown in Figure 2.

In the specific convolution operation, there are two situations: the first one is as shown in Figure 2. Due to the convolution kernel window and sliding step size, the generated feature map is inconsistent with the size of the input signal. The second method can make the output characteristic map keep the same size as the input signal by filling 0 at the boundary of the input signal.

After the convolution operation, a nonlinear activation function is usually adopted. The main reason is that the introduction of nonlinear factors can make the output of the network no longer just a linear combination of inputs but can approximate any complex function and effectively improve the ability of the network to learn complex things [31–33]. At present, commonly used nonlinear activation functions include saturated nonlinear functions sigmoid,

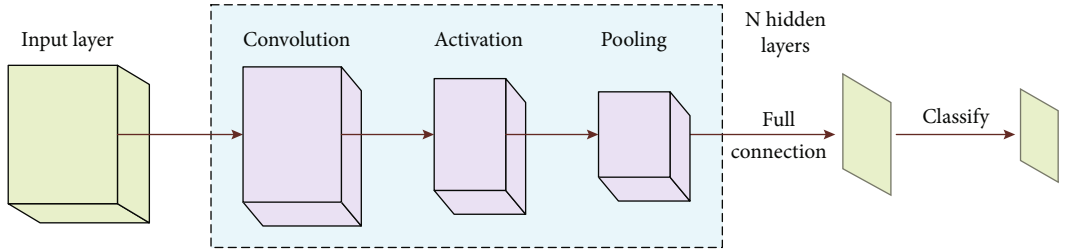

Figure. 1: Convolutional neural network structure diagram.

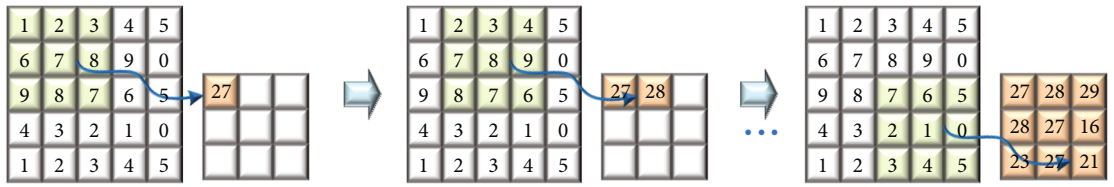

Figure. 2: Schematic diagram of the convolution process.

tan h, etc. and unsaturated nonlinear functions ReLU, etc., shown as follows:

$$\begin{aligned} \text{Sigmoid}(x) &= \frac{1}{1+e^{x}}, \\ \tan h(x) &= \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}, \\ \text{ReLU}(x) &= \max(0, x). \end{aligned} \tag{1}$$

The main difference of the above activation functions lies in that the unsaturated nonlinear functions can effectively avoid the problem of vanishing gradient or explosion in the network because there is no saturated smooth region in the saturated nonlinear functions, so that the network can converge more quickly and stably. To sum up, the operation carried out by the convolutional layer can be described as follows:

$$\mathbf{X}_{\text{out}} = f(\mathbf{X}_{\text{in}} \otimes \mathbf{W} + \mathbf{b}). \tag{2}$$

$\mathbf{X}_{\text{in}}$ and $\mathbf{X}_{\text{out}}$ are the input and output of the convolution layer, respectively, f is nonlinear activation function, and $\mathbf{W}$ and $\mathbf{b}$ represent convolution kernel weight and bias, respectively. This symbol of $\otimes$ is the basic symbol for mathematical operations and represents the tensor product. This can be applied in different contexts such as vectors, matrices, tensors, vector spaces, algebras, topological vector spaces, and modules. The meaning of this sign is the same in all cases: the most general bilinear operation, also called an external product in some contexts.

3.2.2. Structural Analysis of the Pooling Layer. The pooling layer is usually connected in series after the convolution layer, which is essentially a downsampling operation, and the main purpose is to make the features have certain spatial invariance. At present, the commonly used pooling operations include maximum pooling and average pooling, which obtain results by calculating the maximum and average values of local areas, respectively. Maximum pooling can retain the most important feature information in a local area [34], especially for very sparse features. The calculation process is shown in Figure 3. The average pooling can well summarize the overall spatial information of the local area.

In that pool process of the input image, the pool cores are moved according to the pool step size. Common pooling methods include average pooling and maximum pooling. The maximum value is used to represent the local area for maximum pooling, which makes the overall characteristics of the image more significant. The average pooling method uses the average value to represent the local area, which makes the overall characteristic information of the image smoother. When training the model, the pooling layer can help the network to focus on learning the pixel features of the image, help improve the generalization and robustness of the network, and avoid the overfitting of the network.

3.2.3. Batch Standardized Analysis. As the network becomes deeper and deeper, there will be a very obvious gradient dispersion problem, which will change the distribution of input signals and affect the learning ability and performance of the network. In order to effectively alleviate this problem, Sabanci et al. proposed **BN** to overcome the internal covariate offset problem and the main process can be divided into the following two steps [35–39].

(1) To calculate the mean and variance of input signals for data standardization processing, the calculation expression is as follows:

$$x_i' = \frac{(x_i - \mu)}{\sqrt{\delta^2 + \theta}}, \tag{3}$$

where μ and δ^2 represent the mean and variance of the input signal, respectively, and θ is a constant that ensures numerical stability

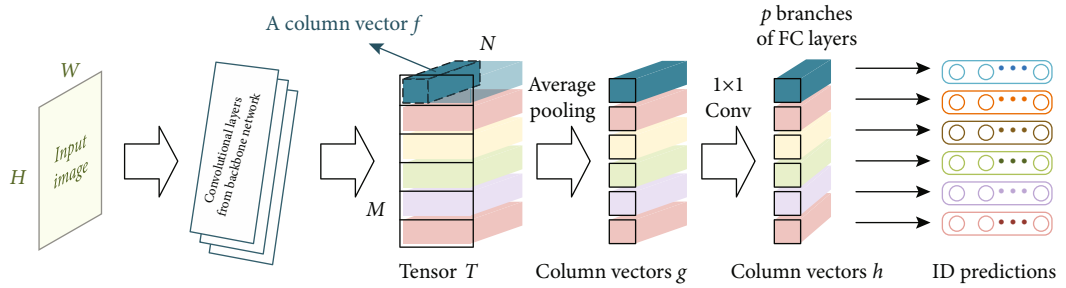

Figure. 3: Schematic diagram of the pool layer structure.

(2) A linear transformation is used to recover the normalized data, and its calculation expression is shown as follows:

$$y_i = \alpha x_i' + \beta, \tag{4}$$

where α and β represent learnable parameters of two networks.

BN has many advantages: (1) it allows us to use a higher learning rate to improve network training speed without the risk of gradient dispersion, (2) it is not necessary to consider the initialization of network parameters too much, which reduces the dependence of gradient on parameters, (3) the dropout operation can be removed from the network in some cases, (4) it reduces the risk that the network will fall into a saturated state when the saturated nonlinear activation function is used, and (5) it effectively improves the generalization ability of the network.

3.3. Loss Function and Parameter Learning. At present, the parameter learning methods adopted by convolutional neural networks are all based on the gradient descent algorithm, which is an algorithm that updates parameters by calculating the gradient of the loss function. The specific process is shown as follows [40–42]:

(Step 1) Forward propagation process

Assuming that the input signal is x and the output value of its input layer is a^1, then, the corresponding outputs of the subsequent layers ($l = 2, 3, \cdots, L$) can be calculated as follows:

$$z^l = w^l a^{l-1} + b^l, \tag{5}$$

$$a^l = \sigma\left(z^l\right), \tag{6}$$

where w^l and b^l are the corresponding parameters of each layer, that is, the parameters to be updated by the network, and σ is the activation function adopted by each layer of the network.

(Step 2) Calculate the error of the output layer

According to the definition, the output layer L error can be calculated as follows:

$$\delta_j^L = \frac{\partial C}{\partial z_j^L}, \tag{7}$$

where C is the loss function adopted by the network. In order to establish a connection between it and the activation value of the output layer $a^L{}_j$, equation (7) is simplified to (8) according to the chain rule.

$$\delta_j^L = \frac{\partial C}{\partial a_k^L}\frac{\partial a_k^L}{\partial z_j^L}. \tag{8}$$

Since, when $k \neq j$, $\partial a_k^L / \partial z_j^L = 0$, equation (8) is simplified to the following:

$$\delta_j^L = \frac{\partial C}{\partial a_j^L}\frac{\partial a_j^L}{\partial z_j^L}. \tag{9}$$

According to equation (6), the final calculation formula of output layer error can be obtained as follows:

$$\delta_j^L = \frac{\partial C}{\partial a_j^L}\sigma'\left(z_j^L\right). \tag{10}$$

(Step 3) Backpropagation error

Similarly, the calculation expression of errors in other layers except the output layer is as follows:

$$\delta_j^l = \frac{\partial C}{\partial z_j^l}. \tag{11}$$

In order to establish a relationship between it and the output layer error, equation (12) can be obtained by using the chain derivative rule for equation (11).

$$\delta_j^l = \sum_k \frac{\partial C}{\partial z_k^{l+1}}\frac{\partial z_k^{l+1}}{\partial z_j^l} = \sum_k \frac{\partial z_k^{l+1}}{\partial z_j^l}\delta_k^{l+1}. \tag{12}$$

According to the calculation expression (13) between adjacent layers of the network, the calculation expression (14) for all layer errors except the output layer can be derived.

$$z_k^{l+1} = \sum_j w_{kj}^{l+1}\sigma\left(z_j^l\right) + b_k^{l+1}, \tag{13}$$

$$\delta_j^l = \sum_k w_{kj}^{l+1} \delta_k^{l+1} \sigma'\left(z_j^l\right). \tag{14}$$

(Step 4) Update parameters

Since the main purpose of the network is to update parameters w^l and b^l at each layer, the expression of the parameter update value can be derived as equation (15) by using the error of backpropagation at each layer.

$$\begin{aligned} \frac{\partial C}{\partial w_{jk}^l} &= \frac{\partial C}{\partial z_j^l} \frac{\partial z_j^l}{\partial w_{jk}^l} = a_k^{l-1} \delta_j^l, \\ \frac{\partial C}{\partial b_j^l} &= \frac{\partial C}{\partial z_j^l} \frac{\partial z_j^l}{\partial b_j^l} = \delta_j^l. \end{aligned} \tag{15}$$

Finally, the parameters are updated according to the rules of the gradient descent algorithm and the formulas are as follows:

$$\begin{aligned} w'l &= w^l - \eta \frac{\partial C}{\partial w_{jk}^l}, \\ b'l &= b^l - \eta \frac{\partial C}{\partial b_j^l}. \end{aligned} \tag{16}$$

The loss functions widely used in the target semantic segmentation algorithms include the mean square error and cross-entropy. The mean square error reflects the difference between the prediction result a and the label data y at each pixel, as shown in (17).

$$C(w, b) = \frac{1}{2n} \sum_x \|y - a\|^2. \tag{17}$$

When this function is used for back propagation, its parameter update expression is as follows:

$$\begin{aligned} \frac{\partial C}{\partial w} &= \frac{1}{n} \sum_x (a - y) \sigma'(z) \frac{\partial z}{\partial w}, \\ \frac{\partial C}{\partial b} &= \frac{1}{n} \sum_x (a - y) \sigma'(z). \end{aligned} \tag{18}$$

It can be found that the above parameter updates are closely related to $\sigma'(z)$. If the activation function is sigmoid, it will appear when the network is trained to a certain period and the neuronal output approaches 1 [43, 44]. When $\sigma'(z)$ is close to 0, it will lead to the slow update of network parameters, which is not conducive to the overall network learning process. To solve this problem, more and more networks adopt cross-entropy instead of the mean square error and the expression of cross-entropy is shown as follows:

$$C(w, b) = -\frac{1}{n} \sum_x [y \ln a + (1 - y) \ln (1 - a)]. \tag{19}$$

Similarly, the expression of its parameter update value can be derived as follows:

$$\begin{aligned} \frac{\partial C}{\partial w} &= \frac{1}{n} \sum_x (a - y) \frac{\partial z}{\partial w}, \\ \frac{\partial C}{\partial b} &= \frac{1}{n} \sum_x (a - y). \end{aligned} \tag{20}$$

In this case, the parameter update is related to the error between the network output and the label. The larger the error, the faster the update speed will be, and it will not be affected by the activation function, which can well avoid the problem caused by the smaller gradient in the mean square error.

4. Objects and Methods

4.1. Respondents. From 2014 to 2017, students in a university in Henan province of China were selected as the research objects. The investigator who had received unified training conducted a questionnaire survey in an anonymous way in the extracurricular time when the subjects were learning health statistics, through actual surveys and interviews, from December 2021 to April 2022. On the questionnaire platform, we conducted a random questionnaire investigation on the application of video visualization technology in the teaching of health statistics for college students in the form of an electronic questionnaire. A total of 402 questionnaires were distributed and 366 were recovered, with a recovery rate of 91.04%. 360 questionnaires were effective, with an effective rate of 98.36%. The 360 questionnaires effectively collected this time were randomly divided into two groups, one group of data (180 copies) was used to establish the model, and the other group of data (180 copies) was used to evaluate the model and explore the influencing factors. Among the 180 random samples used in this model evaluation and influencing factor analysis, as shown in Figure 4, there were 74 boys and 104 girls, with 2 missing. There are 31 students in the class of 2014, 41 in the class of 2015, 63 in the class of 2016, and 45 in the class of 2017. The average age was (20.83 ± 0.98) years. The consent of all the surveyed students was obtained before the questionnaire was conducted.

4.2. Research Tools. The questionnaire was designed by literature and interview, and the presurvey was conducted before the formal survey. The questionnaire included 19 items from 5 dimensions including course awareness (3 observed variables, A1~A3), learning behavior (4 observed variables, B1~B4), teacher-student communication (5 observed variables, C1~C5), knowledge mastery (4 observed variables, D1~D4), and course satisfaction (3 observed variables, E1~E3). Each item was scored on the Richter 5-level scale, with scores from 1 to 5 indicating "strongly disagree" to "strongly agree." A teaching model of "health statistics"

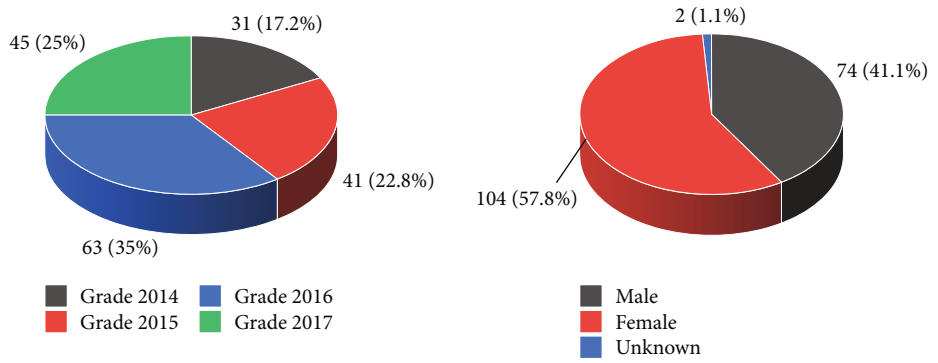

Figure. 4: The statistical analysis of samples.

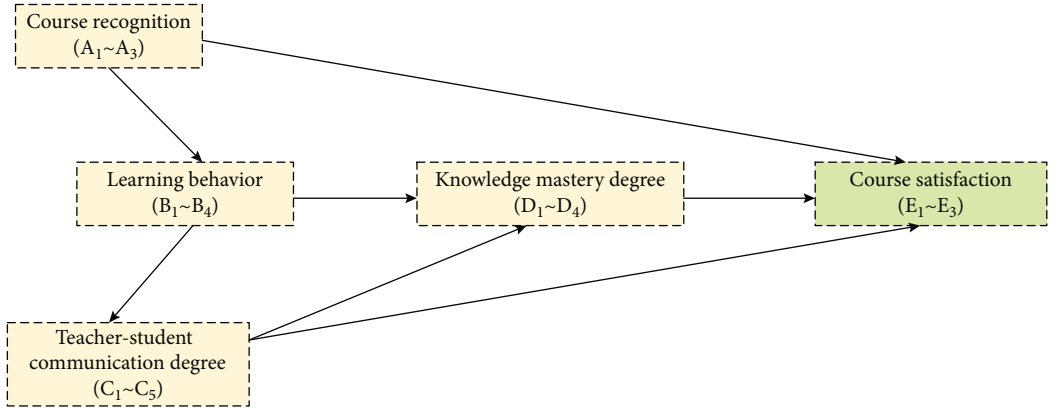

Figure. 5: Schematic diagram of the teaching model of health statistics.

was built according to the dimensions and items of the questionnaire, as shown in Figure 5. It is proved that the model has good reliability, validity, and explanatory ability.

4.3. Statistical Method. The database was established using Epidata3.1, and data entry for two people and two places was performed. SPSS21.0 was used for data collation and description of the basic situation of the survey subjects. The SmartPLS3.1.2 software developed by Ringle et al. of the University of Hamburg in Germany was used for PLS-SEM model construction, model evaluation, and influencing factor analysis.

5. Results and Discussion

5.1. Score Analysis of Each Latent Variable. For the convenience of comparison and viewing, the total score of each latent variable was linearly transformed by 0~100. After linear transformation, the average scores of each latent variable were as follows: course cognition (90.33 ± 10.34). The score of learning behavior was 70.22 ± 13.09, communication between teachers and students 54.71 ± 14.88, and knowledge mastery 65.44 ± 12.51); the score of course satisfaction was 80.22 ± 12.66.

5.2. Model Construction Analysis. The results are shown in Table 1 and Figures 6–8. Cronbach's α values of the five latent variables in Figure 6 ranged from 0.705 to 0.864, and CR values ranged from 0.828 to 0.904, all greater than 0.7. AVE values ranged from 0.551 to 0.759, all of which were greater than 0.5, and the square root of AVE was higher than the correlation coefficient of each latent variable. In Figure 7, the external model loading values of all explicit variables and latent variables showed statistically significant differences ($P < 0.001$). The path coefficients of each latent variable in Figure 8 are also statistically significant ($P < 0.05$), indicating that the model was established.

5.3. Analysis of Influencing Factors. The results of path analysis can directly reflect the direction and degree of influence of each latent variable on knowledge mastery and course satisfaction. As shown in Figures 8 and 9, it can be seen that all latent variables have a positive effect on knowledge mastery and course satisfaction. The influence degree of latent variables on knowledge mastery from large to small was as follows: learning behavior (path coefficient = 0.442, $P < 0.001$), communication degree between teachers and students (path coefficient = 0.422, $P < 0.001$). The influence degree of each latent variable on course satisfaction from large to small was as follows: teacher-student communication degree (path coefficient = 0.277, $P < 0.001$), course awareness degree (path coefficient = 0.249, $P < 0.001$), and knowledge mastery degree (path coefficient = 0.229, $P < 0.001$).

5.4. Analysis of Direct and Indirect Effects. Table 2 lists the direct and indirect effects, total effects and R^2 values of

Table 1: Correlation coefficient of latent variables in the model.

Latent variables	(1)	(2)	(3)	(4)	(5)
Course recognition (1)	0.742*				
Learning behavior (2)	0.484	0.796*			
Teacher-student communication degree (3)	0.561	0.313	0.805*		
Knowledge mastery degree (4)	0.679	0.437	0.670	0.762*	
Course satisfaction (5)	0.629	0.435	0.508	0.523	0.871*

*The square root of AVE. The data below the square root of AVE is the correlation coefficient between latent variables.

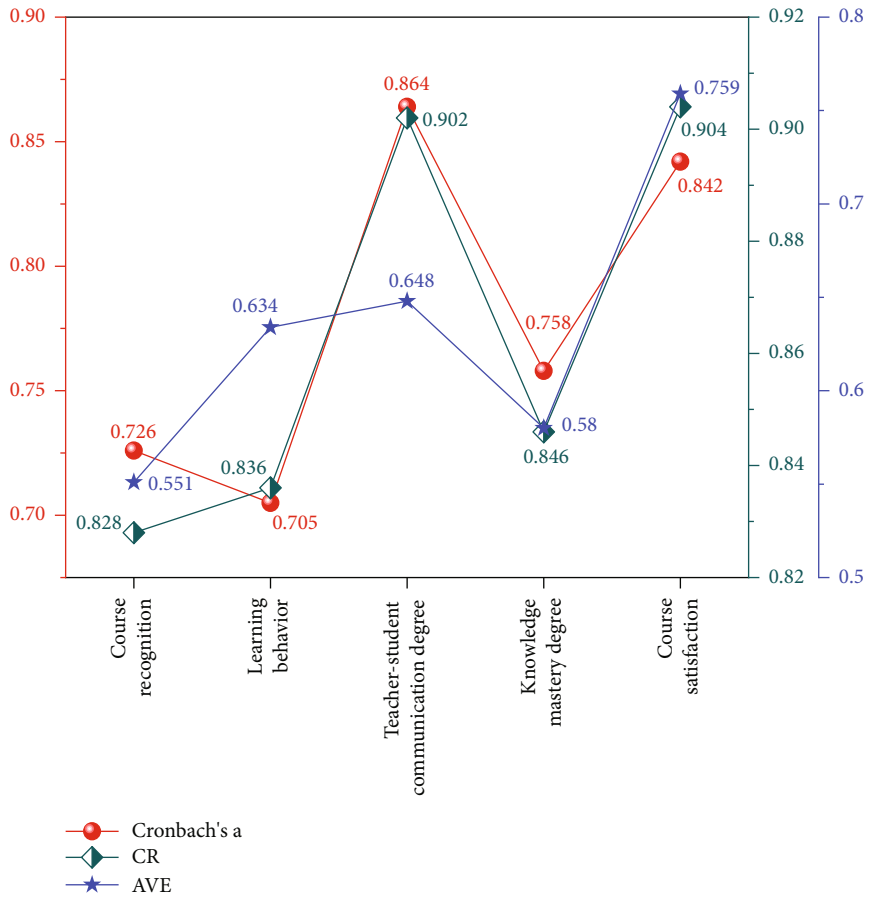

Figure 6: Correlation coefficient of latent variables in the model.

explicit variables on learning behavior, teacher-student communication, knowledge mastery, and teaching satisfaction. The differences of direct, indirect, and total effects of each predicted variable on dependent variables are statistically significant ($P < 0.05$) [45]. Curriculum cognition can explain 23.4% variation of learning behavior. Course cognition and learning behavior can explain the variation of communication between teachers and students by 31.4%. Course cognition, learning behavior, and communication between teachers and students can explain 58.3% variation of knowledge mastery. Course awareness, learning behavior, communication between teachers and students, and knowledge mastery can explain the variation of teaching satisfaction by 36.9%.

5.5. Application Effect Analysis. As shown in Figures 8 and 9, the results show that curriculum awareness, learning behavior, and communication between teachers and students explain the variation of knowledge mastery by 58.3%. Learning behavior and communication between teachers and students have a direct impact on knowledge mastery, while curriculum awareness has an indirect impact on knowledge mastery, both of which are positive. According to the scores of each latent variable, after the linear transformation of 100 points, the scores of each latent variable are (90.33 10.339) points of curriculum cognition. Those of learning behavior are (70.22 13.094), communication between teachers and students are (54.71 14.875), and knowledge are (65.44 12.510) points. The results show that the overall score of

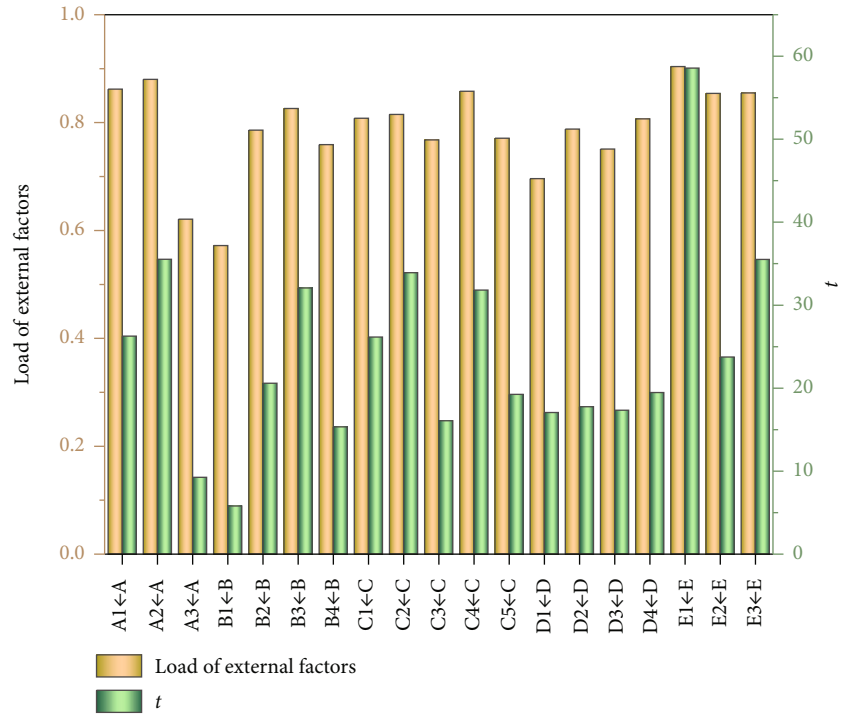

Figure 7: External model loads between explicit variables and latent variables of the model.

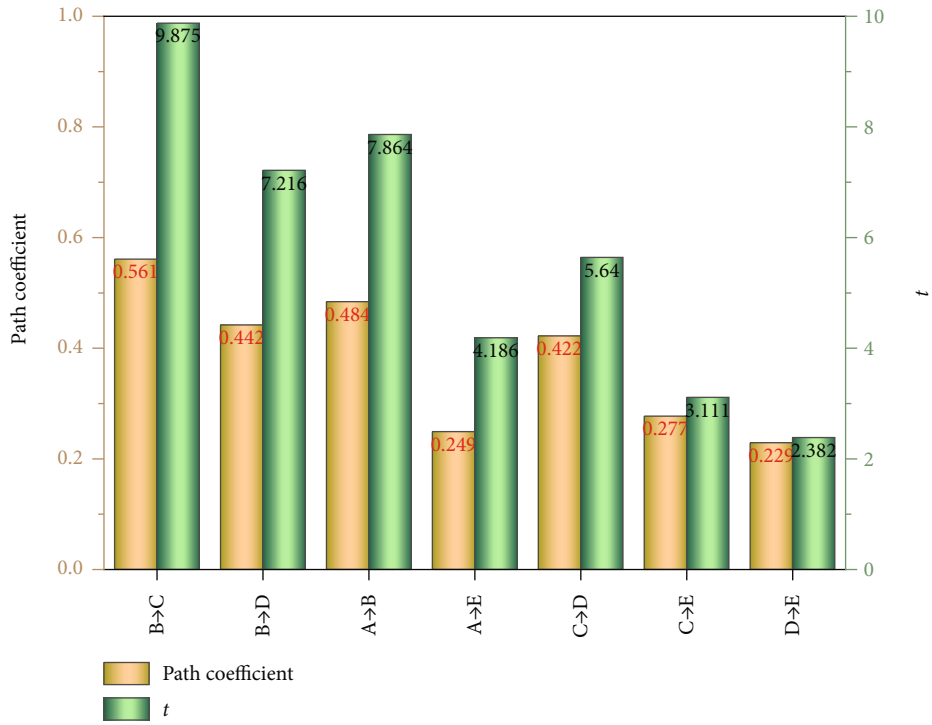

Figure 8: Path coefficient between latent variables.

students' cognition of the course of health statistics is high, indicating that students have a good understanding of the importance of this course. However, the scores of students' learning behavior, communication between teachers and students, and knowledge mastery are low, which indicates that students are not active enough in the study of health statistics, and the communication between teachers and students is lacking, which leads to poor learning effect. Among the direct latent variables that have influence on knowledge mastery, the path coefficient of learning behavior is the

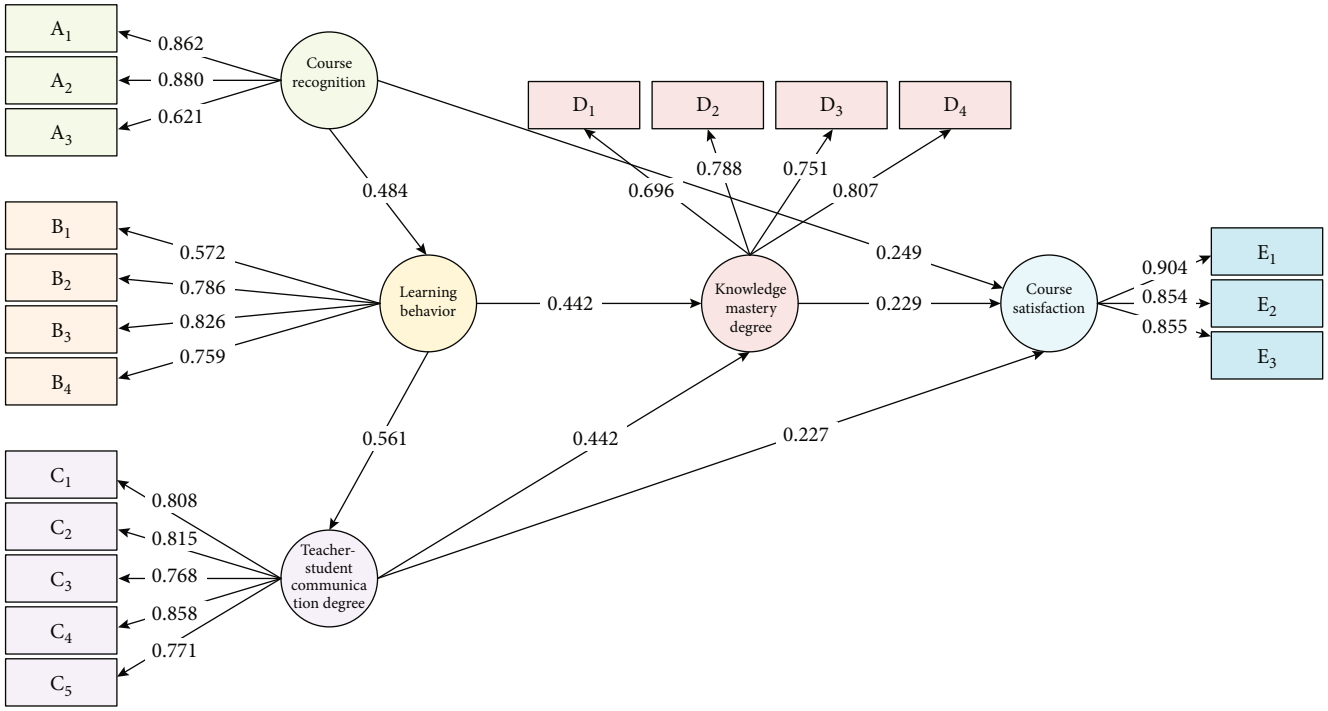

Figure. 9: Path coefficient of the teaching model of health statistics.

Table 2: Direct and indirect effects of the model.

Dependent variable	Observable variable	Direct effect	Indirect effect	Gross effect	R^2
Learning behavior	Course recognition	0.484	—	0.484	0.234
Teacher-student communication degree	Course recognition	—	0.271	0.271	0.314
	Learning behavior	0.561	—	0.561	
Knowledge mastery degree	Course recognition	—	0.328	0.328	0.583
	Learning behavior	0.442	0.237	0.679	
	Teacher-student communication degree	0.422	—	0.422	
Course satisfaction	Course recognition	0.249	0.15	0.399	0.369
	Learning behavior	—	0.311	0.311	
	Teacher-student communication degree	0.277	0.097	0.374	
	Knowledge mastery degree	0.229	—	0.229	

highest, which is 0.442, suggesting that it has the greatest influence on knowledge mastery. Secondly, the communication between teachers and students, whose path coefficient is slightly lower than that of learning behavior, is 0.422, which indicates that the degree of communication between teachers and students also has a great influence on knowledge mastery.

Therefore, in order to improve the knowledge of health statistics, students should give full play to their subjective initiative and strive to improve their learning behavior. As a teacher, we should interact and communicate with students in the teaching process and timely answer the students' confusion in the process of learning health statistics. At the same time, teachers should encourage and guide students to participate in various scientific research topics, so as to achieve the purpose of warming up the past and learning new things and applying what they have learned. Schools, colleges, etc. should continue to do a good job of guidance, enhance students' emphasis on this subject, and correct their learning attitude. The results of path analysis also show that students' awareness of subjects, communication between teachers and students, and knowledge mastery have a direct positive impact on course satisfaction, while the learning behavior has an indirect positive impact on course satisfaction. However, the four latent variables can only explain the variation of 36.9% of course satisfaction and the overall average score of course satisfaction is (80.22 12.663) after the linear transformation of 100 points, which indicates that the course satisfaction is also greatly influenced by other unknown latent variables, and further research is needed.

6. Conclusions

Based on the video visualization technology of the convolutional neural network, this paper evaluates the teaching model of health statistics and analyzes the factors that affect knowledge mastery and teaching satisfaction, so as to improve the teaching method of health statistics. This paper draws the following conclusions:

(1) Cronbach's α and Cr values of five latent variables in the model are all greater than 0.7; AVE values are all greater than 0.5. The square root of AVE is higher than the correlation coefficient of each latent variable. The differences of external model loads between explicit variables and latent variables are statistically significant ($P < 0.001$). The path coefficients of all latent variables are statistically different ($P < 0.05$)

(2) Learning behavior and communication between teachers and students have a direct impact on the mastery of knowledge, and the order of influence is as follows: learning behavior (path coefficient = 0.442, $P < 0.001$) and communication between teachers and students (path coefficient = 0.422, $P < 0.001$). Subject recognition, teacher-student communication, and knowledge mastery have a direct positive impact on course satisfaction, and the order of influence is as follows: teacher-student communication (path coefficient = 0.277, $P < 0.001$), course recognition (path coefficient = 0.249, $P < 0.001$), and knowledge mastery (path coefficient = 0.229, $P < 0.01$)

(3) For learning behavior and communication between teachers and students, the teaching effect model of health statistics based on video visualization technology of the convolutional neural network has certain practicability

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Comprehensive Evaluation Method of Supply Chain Logistics System Quality Based on 3D Image Processing Technology

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With the rise of manufacturing informatization, many transactions are conducted on the Internet, but the final form of transaction completion is the transaction of actual products, which makes the logistics industry emerge as the times require. How to achieve the optimal allocation scheme and the fastest efficiency in the supply chain has become an urgent problem to be solved. This paper considers the characteristics and advantages of 3D image processing technology, describes the characteristics of 3D image processing supply chain (SC), and analyzes the channels that 3D image technology affects SC. Combining the respective characteristics of fuzzy theory and grey theory, the two theories are combined to develop strengths and circumvent weaknesses to form grey fuzzy theory. Comprehensive evaluation of supply chain logistics capability can achieve better evaluation results. The application of grey theory in this chapter includes constructing the factor set of the evaluation index system and determining the weight matrix of the factor set with the game method. The grey fuzzy evaluation weight matrix (i.e., single index evaluation result) is determined with the grey theory, and the fuzzy comprehensive evaluation result is finally calculated. This paper studies the supply chain logistics capability evaluation and optimization system from the aspects of system analysis, system function module design, and system architecture design and analyzes the overall goal, demand, feasibility, system business process, and data flow of the system construction. At the same time, this paper designs the supply chain logistics capability evaluation and optimization system and shows some functional interfaces. It is of great significance to improve the responsiveness, total inventory level, total cost level, supply chain performance, agility, and flexibility of the supply chain in the new environment.

1. Introduction

The competition in the 21st century will not be between enterprises, but between SC. Those supplier enterprises with unique advantages will become the object pursued by large enterprises [1]. The traditional reliability analysis method for system SC generally refers to the reliability calculation of its SC model, among which the calculation theory based on model tree is becoming more and more mature, but it is difficult to simplify it. Because the components in the system SC are uncertain, other reliability calculation methods are also difficult to apply in the SC reliability calculation [2]. 3D image processing technology can optimize the design and produce customized parts on demand. As this technology can digitize the complex processing process, it has the advantages of high precision, high speed, and low cost [3]. In the mass manufacturing of manufacturing industry, traditional subtractive manufacturing technology has always been based on production, standardization, and extensiveness. However, with the continuous improvement of people's material and cultural level, customers prefer to have personalized products. The extensive application of 3D image processing technology will change the production mode of traditional subtractive manufacturing technology before, and its unique advantages of personalized customization, environmental protection, energy saving, convenience, and

high efficiency have changed the production mode of traditional manufacturing. Personalized customization will soon become the mainstream in future manufacturing [4].

The development of the new environment requires that the SC not only pay attention to products but also to the needs of users. The process of creating benefits is based on product flow. Improving product mobility in the SC to improve agility and flexibility is an effective means to improve the performance of the SC under the current environment [5]. Logistics energy, which exists in a specific logistics system, exists in the whole process of receiving, processing, refining, transporting, and delivering orders and goods. It is the response speed, customer's demand, cost, and guarantee of order realization punctuality and reliability [6]. Logistics operation ability refers to the ability to optimize resource utilization by means of management plan, organization, and control, in order to improve efficiency and reduce costs [7]. Compared with static logistics element capability, logistics operation capability is a dynamic capability formed on the basis of static capability. Compared with other capability viewpoints, the SC logistics capability has its own characteristics: the formation factors are more complex, the capability exists in every link of logistics activities, and the organization and management capability of logistics management can affect the functions of the entire logistics system [8].

With the rapid growth of logistics service outsourcing and the continuous improvement of its integrity and complexity, logistics service providers need to continuously penetrate into the upstream and downstream fields such as production and sales to meet the changing needs of logistics end customers. On this basis, the logistics service supply chain (LSSC) model that integrates the functions of each stage of logistics service has evolved [9]. Today, with the great change of production mode and the rapid intensification of commercial competition, the service quality provided by logistics service SC enterprises to customers, the relationship with customers, and the benefits obtained by serving customers are increasingly becoming the key factors for logistics service SC enterprises to improve profits [10]. Collaborative logistics takes cooperation and collaboration as the premise, combines advanced technology, focuses on personalized service, efficiency, and collaboration among enterprises, and creates a collaborative logistics information system that fully shares logistics resources and obtains on demand, so as to promote the collaborative operation of all links in the SC and the collaborative operation among enterprises. In order to solve the problems of high complexity of product structure, long manufacturing cycle, and high cost of early mold development, 3D image processing technology has been widely applied and studied. If the response process of the SC is regarded as a flow, in the whole flow of the SC, the production time of customers' demand products accounts for 5% of the total flow time, while it takes 95% of the total flow time to deliver the produced products to customers. This change from "internal audit" to "external view" has prompted the logistics service SC managers to make subversive changes in the logistics service SC from the aspects of management concepts, management methods, and management means. Only by penetrating the realization of customer value into all aspects of daily management of enterprises and actually implementing it in market behavior can logistics service SC enterprises achieve sustainable development and maintain long-term advantages in the industry.

The research innovation lies in constructing the performance evaluation index system of logistics service supply chain based on customer value. Combining the respective characteristics of fuzzy theory and grey theory, combining the two theories to develop strengths and circumvent weaknesses to form a grey fuzzy theory to comprehensively evaluate the logistics capability of the supply chain can achieve better evaluation results. Extract the data of logistics capability, logistics cost, logistics processing capability, and logistics innovation capability of supply chain enterprises. The data is preprocessed, and the logistics capability is optimized and evaluated by combining the model data form of optimization analysis and evaluation analysis. This paper studies the results of the empirical analysis and puts forward countermeasures to improve the overall performance of the logistics service supply chain, so as to achieve the optimal allocation scheme and the fastest efficiency in the supply chain.

2. Related Work

Supply chain management is no longer a closed and lonely way to deal with business activities such as procurement, production, and sales of enterprises. Instead, it regards suppliers, producers, distributors, and consumers as an organic whole and harmonizes the information flow, logistics, and capital flow of all members through collective goals. Production planning and control under supply chain management take more uncertainty and dynamic factors into account, so that enterprises can react quickly to market changes. The traditional production planning decision-making mode is a centralized decision-making, while the decision-making mode under the supply chain management environment is distributed, group decision-making. In the traditional production planning decision-making mode, the information of planning decision-making comes from two aspects, one is demand information, and the other is resource information. Information diversification is the main feature of supply chain management. In essence, supply chain management is based on the concept of cooperation and win-win, transforming the demand of the final consumer into the collective activities of all participants, improving the quality of cooperation among many enterprises, and maximizing the overall benefits. At present, there are many researches related to SC management in China. In order to carry out targeted research, the author collected and combed the relevant research literature and found that the research results mainly include the research on green SC management, the research on supplier evaluation index system, and the evaluation method of supplier selection.

Yang and Liu believe that big data technology is the basis of SC collaborative decision-making. As far as big data is concerned, they combine SC collaborative mechanism with collaborative theory and game theory to explore the significance and realization process of SC collaborative mechanism

[11]. Agrawal and Pal created the selection method and implementation process of collaborative management and control system for the first time based on the company's resolution operation mode, resource allocation, crisis assessment, and benefit contract [12]. Entezaminia et al. believe that "ability" refers to the ability and talent, which is the means for the main body to accomplish the set goals. Therefore, they believe that logistics is an enterprise or a SC, and in order to accomplish its logistics goals, it uses its own skills and talents, which is also an indicator of comprehensive evaluation and analysis [13]. Ju et al. first defined the concept of logistics capability and at the same time analyzed the characteristics of SC logistics capability in China's social industry environment and thought that SC logistics capability embodied several different main aspects [14]. Tu et al. quantitatively estimated the potential impact of 3D image processing technology on the global SC [15]. Yu et al. put forward a system and custom production is completely customer-centered, providing customers with 3D image processing services [16]. Bai et al. obtained the supplier evaluation criteria and corresponding weights by using analytic hierarchy process and considered that the supplier evaluation factors were delivery, quality, facilities, technical capability, financial status, management, discipline, and response in order of importance [17]. Liu et al.'s research shows that on the one hand, 3D image processing can improve the efficiency of SC by timely manufacturing and eliminating waste. On the other hand, customized production of 3D image processing is helpful to implement the production-to-order strategy [18]. Wang analyzed the definition of logistics capability. She believed that logistics capability is the ability of an enterprise to acquire and utilize various internal and external resource elements and to deliver the required items of users to the destinations required by users [19]. Woo et al.'s research and development starts from different kinds of SC and determines the capability elements that have a great impact on their benefits through the characteristics of various SC. They also summarize the calculation methods of each element [20].

3. Methodology

3.1. Basic Theory of SC Capability. Supply chain is a management concept and content that has been concerned by entrepreneurs in recent years. It is precisely because of the keen attention, research, and discussion of the theoretical and business circles that people generally believe that it is a very abstract and academic topic. In fact, the content of supply chain is something we may encounter every day. To be more precise, it should be attributed to a kind of management experience. It is just that there are different priorities in different industries. Logistics capability refers to the operational capability of an enterprise in the process of creating economic value and social value to design logistics plans, carry out logistics activities, and control the logistics process with the help of certain measures and schemes. The measurement object of logistics capability is the entire process of enterprise logistics activities. In addition to product distribution and transportation capabilities, it also covers external resource acquisition capabilities, internal materials, and semifinished product management capabilities. From the perspective of constituent elements, the logistics capability elements of the supply chain are divided into tangible and intangible parts. The logistics capability encountered in the actual work is tangible, while the intangible elements refer to the enterprise's equipment processing capacity, warehousing capacity, etc.

In the current academic circles, the research on customer value is very rich, and the research directions are roughly divided into two categories. The second type is to take the enterprise as the evaluation subject and the customer as the evaluation object. The enterprise conducts in-depth research on the relative importance and contribution value of the customer, so that the enterprise can provide products, services, and solutions for customers with different values in order to maximize long-term benefits. Here, collaborative logistics is the focus of research. The realization of collaborative logistics mode of supply chain based on cloud manufacturing needs to be based on a certain business scale. Only when the purchase, inventory, and delivery of logistics have an appropriate scope can we share data and resources as the basis, promote the integrated control and collaborative delivery of products, and reduce the cost of SC system. The SC system adopts the collaborative logistics form based on cloud manufacturing, which requires full sharing of the manufacturing news of suppliers, the demand news of manufacturers, the delivery news of cloud platform, the in-transit news of trucks, etc. Therefore, the Internet and information system are very important to realize the collaborative logistics mode of SC. Research fields related to SC management pay attention to enterprise SC management. To sum up, SC management mainly refers to fully coordinating the internal and external resources of enterprises and, according to customers' diversified consumption needs, treating each process in the SC as a virtual enterprise interface management problem, in which each enterprise is a main body in the virtual enterprise alliance, and the internal management problem of enterprise alliance is SC management. Generally speaking, the logistics system, while accepting all kinds of resources outside the system, uses some basic functions to assemble these resources in various ways and then uses certain ways to turn the assembled resources into output systems. A subset of each assembly mode of the logistics system is shown in Figure 1.

At present, many of them take the typical three-stage SC as the research object. The premise of SC capability analysis is SC system, and the analysis in this paper is based on the typical H-stage SC, analyzing its logistics system structure, which includes suppliers, manufacturers, and distributors, with the SC logistics system of manufacturing industry in the economic society as the typical representative, as shown in Figure 2.

The research background of SC logistics capability is the research of SC management and logistics management. This paper will analyze and define the connotation of SC logistics capability through comparative analysis with SC management, logistics management, logistics, and capability. Since the logistics service integrator is at the core of the logistics

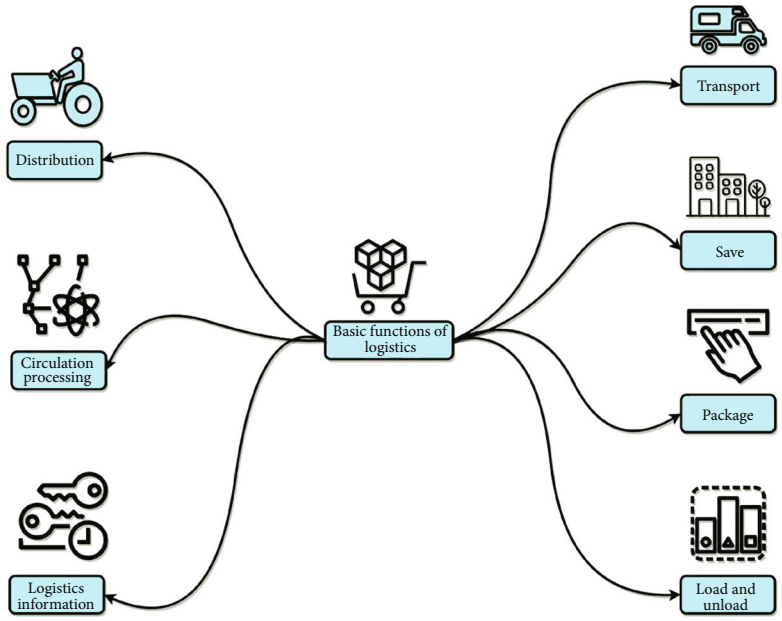

Figure 1: Basic functions of logistics system.

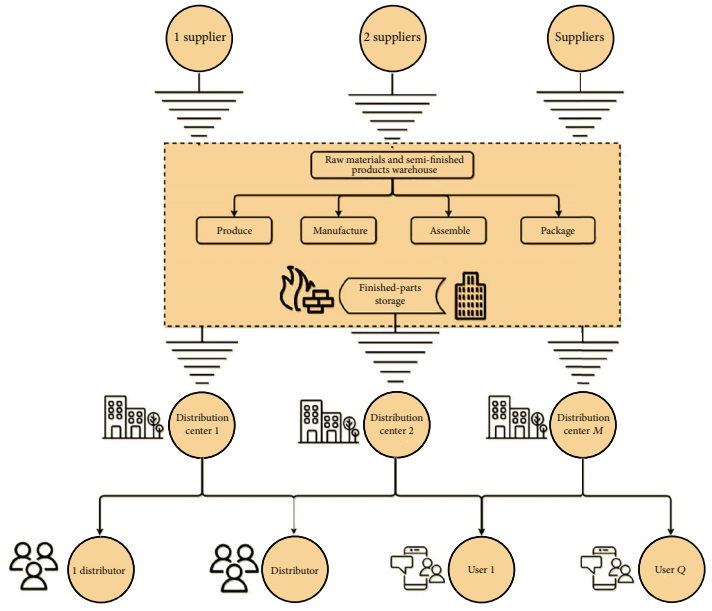

Figure 2: Supply chain logistics system structure.

service SC, it is generally assumed by enterprises with strong financial support, strong information processing capability, good industry reputation, capable of personalized customization, integration and networking, and a certain scale of logistics services. Logistics service providers are a collection of many logistics service providers. A single enterprise generally only undertakes one or several types of logistics business, such as logistics transportation, logistics warehousing, and logistics consulting, and its service scope is limited. Logistics service consumers include not only individual consumers but also various enterprises that need logistics services, such as manufacturing enterprises and catering enterprises.

Under the cloud manufacturing mode, this transfer process can be divided into e-commerce cloud, logistics cloud, and customer cloud, forming cloud services from e-commerce to customers. The business ability of e-commerce cloud can be realized through its favorable rating and credibility. The ability of e-commerce to comprehensively utilize customer demand, product varieties, and logistics channels has formed its advantages in business ability. The degree of standardization of the payment platform under supervision and the security of information provide necessary guarantees for customers to purchase. Logistics enterprises reduce their operating costs by increasing the

Table 1: Comparison of cloud manufacturing systems and logistics services.

Characteristic	Cloud manufacturing system	Logistics service
Resource reorganization	Cloud manufacturing system can intelligently reorganize information according to users' needs to meet their individual needs.	Logistics services can recombine logistics resources to form personalized logistics services according to the needs of customers.
Resource virtualization	The cloud manufacturing system virtually encapsulates manufacturing resources and capabilities in the cloud platform, and users can obtain them on demand through the terminal.	The logistics platform virtually encapsulates logistics information and resources in the cloud platform, and customers can obtain corresponding logistics services according to their own needs.
Payment on demand	Pay as you go according to your needs.	Customers pay according to the logistics services they receive.

number of distribution centers, expanding their scale, and sharing commodity information and infrastructure. Optimize its transportation path, improve transportation efficiency, and form a logistics cloud that cooperates with e-commerce. When obtaining goods, customers will comprehensively consider the accumulated cost of product purchase and logistics and the convenience of purchase compared with physical stores. And form the final online shopping satisfaction with the service experience. Comparing the collaborative logistics service of SC with cloud manufacturing system platform, it is found that there are many similarities between collaborative logistics service and cloud manufacturing, as shown in Table 1.

As shown in Table 1, it is imperative to build a SC collaborative logistics cloud platform based on cloud manufacturing with reference to the cloud manufacturing system platform, SC integration, and logistics network. The SC collaborative logistics cloud platform is a network-based and highly shared logistics cloud service platform. The platform virtually integrates logistics resources and supplier product information into the cloud to form a virtual logistics resource cloud pool and encapsulates it according to customer requirements, bringing more efficient, low-cost, and high-quality personalized logistics services to users. In addition, you can also create functional modules under the platform to focus on the whole process of enterprise production and operation, including site selection, transportation and distribution, loading and unloading, and storage.

3.2. Design of Logistics Information Collection Software Based on Mobile Phone Platform. The distributed cluster database system is composed of multiple computers, and any of these computers can be placed in a single place. Because any computer in the system has a complete database, each computer has its own database. Even in different places, as long as computers are connected through the network, a complete large database can be formed. For the distributed cluster system, the system is a database as a whole in terms of logic. The database has the following three properties: consistency, integrity, and security. These three properties are used to control and manage the logic as a whole. The shared data is managed uniformly by distributed cluster servers. However, if it is a nondatabase processing operation, it can be completed through the client. The logistics information collection system based on mobile phone platform uses the image processing technology of digital and English characters and puts forward a convenient and safe solution. The staff of the logistics company use the mobile phone equipped with logistics information collection software to take pictures of the local goods list and process the photographed images with the identification software in the mobile phone to extract the information such as the location and current time of the goods and then send them to the database of the logistics head office through SMS. Finally, the head office sends the circulation information of the goods to the customers' mobile phones in real time, so that the customers can know the circulation of the goods conveniently. With the progress of science and technology, the pixels of mobile phone cameras are getting higher and higher, and the resolution of images taken by mobile phone cameras is higher, which is beneficial to feature extraction of mobile phones. Although the image pixel standards adopted by mobile phones are different, the mobile phone images of various pixel standards are used in the same way. First, the color image is grayed, and then processed by binarization, smoothing, denoising, thinning, normalization, etc. This makes a good job for the next step of image information extraction of goods list. In the handwritten character image preprocessing module, the video image input by the camera is first collected, and the software can automatically detect the image area range. Then, the collected color image is subjected to black-and-white binary processing, and a single word is marked with a rectangular box in the image display window. Then, the image preprocessing is performed on the single word, and the image features are extracted. Image preprocessing includes smoothing, denoising, thinning, and normalization introduced in Chapter 2. The image preprocessing flow is shown in Figure 3.

After 3D preprocessing, the mobile phone extracts the features of the captured 3D by using the feature extraction methods introduced above (moment center feature, pixel distribution feature, discrete Fourier feature, and line feature value) and finally gets an 82-dimensional feature vector. Thus, 82-dimensional feature vectors are obtained. And it is convenient for the identification of the 3D identification module. After preprocessing the 3D image, the mobile phone uses the feature extraction methods introduced earlier (moment center feature, pixel distribution feature, discrete

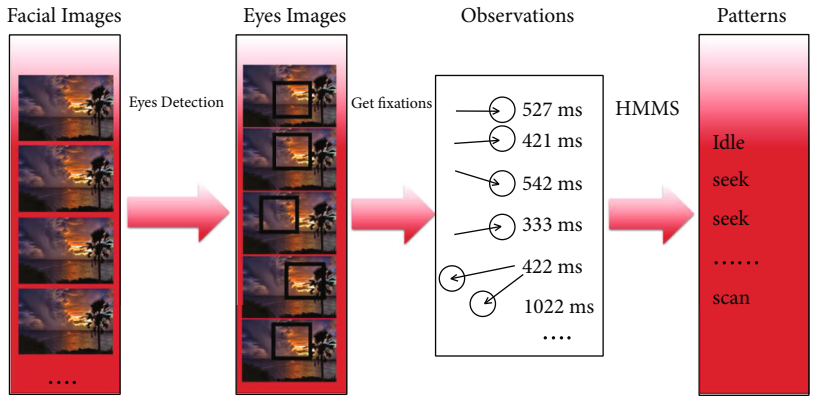

Figure 3: Flow chart of image feature extraction.

Fourier feature, and line feature value) to extract the features of the captured 3D and finally gets an 82-dimensional feature vector. Thus, 82-dimensional feature vectors are obtained. And it is convenient for the identification of the 3D identification module. Different classifiers corresponding to the same feature from different angles map the feature to the decision space, so it is possible to comprehensively reflect an object by combining different features and different classifiers, thus obtaining a better classification result.

Assume that the original image is $F(x, y), x = 1, 2, \cdots, M, y = 1, 2, \cdots, N$ and the normalized image is $G(i, j), I = 1, 2, \cdots, I, j = 1, 2, \cdots J$.

Geometric moments of general two-dimensional functions are defined as

$$M_{mn} = \iint_{x,y\in\Omega} x^m y^n f(x, y)dxdy. \quad (1)$$

In formula (1), M_{mn} is the original lattice of image $(m, n)(m, n = 0.1, \cdots)$, which can be regarded as the projection of image $f(x, y)$ on a set of basis functions, and this moment has translation invariance.

The character image $f(x, y)$ is divided into $\Omega_i(i = 0, 1, \cdots, 15)$ areas of 4×4, assuming that the sum of black dots in each area is $A(i)$ and the black dots in the largest black dot area and the smallest black dot area are $A_{\max}$ and $A_{\min}$, respectively. Then,

$$A(i) = \sum_{(x,y\in\Omega_i)} f(x, y), \quad (2)$$

$$A_{\max} = \max_{i\in(0.15)} A(i), \quad (3)$$

$$A_{\min} = \min_{i\in(0.15)} A(i). \quad (4)$$

Take $F_s = ((A(i) - A_{\min})/(A_{\max} - A_{\min}))(s = 2, \cdots, 17)$ as a set of features with values between [0,1], which reflects the distribution characteristics of black spots in sample 1 to $f(x, y)$.

Fourier transform is widely used in pattern recognition to extract features, which not only has translation invariance but also can describe the image boundary. Image $f(x, y)$ is a binary matrix point set with P rows and Q columns. Its corresponding two-dimensional discrete Fourier transform can be defined as

$$G(u, v) = \frac{1}{\sqrt{PQ}} \sum_{u=0}^{P-1} \sum_{v=0}^{Q-1} f(x, y) \exp\left[-j2\pi\left(\frac{ux}{P} + \frac{vy}{Q}\right)\right]. \quad (5)$$

Type $u = 0, 1, \cdots, P - 1$; $v = 0, 1, \cdots, Q - 1$, expressed by matrix:

$$[G] = \begin{bmatrix} G(0,0) & G(0,1) & \cdots G(0,N-1) \\ G(1,0) & G(1,1) & \cdots G(1,N-1) \\ \cdots & \cdots & \cdots \\ G(M-1,0) & G(M-1,1) & \cdots G(M-1,N-1) \end{bmatrix}. \quad (6)$$

And the large-value coefficient of $G(u, v)$ is concentrated in the low-frequency region, that is, around the upper left, upper right, lower left, and lower right corners of the matrix. In this experiment, $P = Q = 16$, 32 modulus values of discrete Fourier transform are selected and extracted from the above four low-frequency regions as feature vectors.

3.3. Evaluation Model of Two-Level SC of 3D Image Technology. Consider establishing a two-level SC of 3D image processing composed of 3D image processing technologists and manufacturers, and analyze the decision-making and profit issues of the two-level SC of 3D image processing. Since the SC conditions of various industries will vary according to the actual situation of the industry, the SC logistics capacity of each industry will show its own characteristics due to the difference in SC conditions; for example, the SC logistics capacity of hataocao industry pays attention to the safety assurance ability, the power coal SC pays attention to the relative stability of the power coal SC logistics capacity, and the SC logistics capacity of traditional manufacturing industry pays attention to the integrity. However, there are commonalities in the logistics capacity

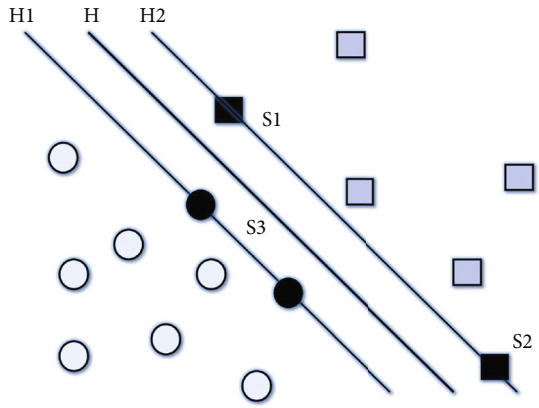

Figure 4: Optimal classification surface.

under the structure of the SC logistics system, which is determined by the commonalities of the SC of various industries. In the distributed control SC, each member enterprise in the SC first cares about its own profit and then pays attention to the overall profit of the SC. In the SC supervision, the secondary chain composed of suppliers and producers must meet the application conditions of Stackelberg game, and both suppliers and producers pay attention to their own profits. Support vector machine is derived from the concept of optimal classification hyperplane, which is the extension of classification hyperplane. Consider the two-dimensional two-class separable case shown in Figure 4.

The circular ("O") sample and the square ("□") sample are linearly separable, and we can see from the figure that there are many linear functions that can completely separate the two types of samples, not only H but also many others, so we will not cite them one by one here.

The so-called optimal classification line is the general form of the linear classification function in the dimensional space which is $g(x) = w \cdot x + b$, and the classification surface equation is

$$w \cdot x + b = 0. \tag{7}$$

Normalize the classification function so that both types of samples meet $|g(x)| \geq 1$, that is, $|g(x)| = 1$ of the samples closest to the classification plane, so that the classification interval is equal to $2/\|w\|$. Therefore, to maximize the classification interval is to make $\|w\|$ or $\|w\|^2$ minimum. If it is required to classify all samples correctly, it must meet the following requirements:

$$y_i[(w \cdot y) + b - 1] \geq 0, \quad i = 1, 2, \cdots, n. \tag{8}$$

Thus, the classification plane that satisfies the above conditions and minimizes $\|w\|^2$ is the optimal classification plane.

According to the general theory of reliability design, $\Phi(X) = 0$ can be set as the limit state of the system as the system stability criterion. Among them, $X = \{X_1, X_2, X_3, \cdots\}$ can be set as qualified and unqualified according to the discrimination requirements of system response and can be calculated:

Table 2: Nine-scale table of 0.1~0.9.

Scale value	Explanation
0.1	Indicator I is as important as indicator J
0.3	Indicator I is slightly more important than indicator J
0.5	Index I is obviously more important than index J
0.7	Indicator I is stronger and more important than indicator J
0.9	Indicator I is more important than indicator J
0.2, 04, 0.6, 0.8	Index I is compared with index J, and the result conclusion corresponds to the middle value of 0.1-0.9 scale

$$Z^m = \{X : \varphi(X) < 0, X \in R\}, \tag{9}$$

$$Z^r = \{X : \varphi(X) > 0, X \in R\}, \tag{10}$$

wherein

$$\varphi^m = \{Z^m, Z^y, m \in 1, 2, \cdots, \gamma \in 1, 2 \cdots N\}, \tag{11}$$

$$\varphi^y = \{Z^y, \gamma \in 1, 2 \cdots\}. \tag{12}$$

If the system completes the response calculation and gets the system response data, according to formula (12), if $P > 1$, relative to $\forall X \in \{X = 1, 2 \cdots X \in R\}$, all $\varphi(X) > 0$, all the system responses exist in the safety zone and there is no failure probability, which proves that the system structure is reliable: when $P < 0$, for $\forall X^l \in X_i^l$, all $\Phi(X) < 0$, then At $0 < P < 1$, aiming at $\forall X^l \in X_i^l$, it is proved that $\Phi(X) > 0$ and $\Phi(X) < 0$ have two possibilities, the system has reliability and unreliability, and the sample delivery value of P indicates the reliability probability of the system, that is, reliability. If the value is larger, the system is more reliable; if the value is smaller, the system is less reliable.

Similarly, formula (12) can be changed to obtain the failure probability:

$$\eta = 1 - p = \frac{\varphi^r - \varphi^m}{\varphi^r}. \tag{13}$$

When the subordinate relationship between the upper and lower levels of each index is determined, it is necessary for the expert group to judge the relative importance of each level according to the evaluation information of the evaluation index established in this paper. The quantitative judgment method is 0.1~0.9 nine-scale method, as shown in Table 2.

The fuzzy vector $a_{ij}^k = (l_{ij}^k \quad m_{ij}^k \quad u_{ij}^k)$ means that the k expert compares the index $1i$ with the index to get the judgment result of importance. Among them, m_{ij}^k is the actual score of the expert's judgment on the relative importance of the evaluation index, and l_{ij}^k and u_{ij}^k, respectively,

correspond to the minimum and maximum values of the relative importance score of the evaluation index.

According to the operation properties of triangular fuzzy numbers,

$$M_1 \oplus M_2 = (l_1, m_1, u_1) \oplus (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2), \tag{14}$$

if

$$M_i = (l_i, m_i, u_i), M_i^{-1} = \left(\frac{1}{u_i}, \frac{1}{m_i}, \frac{1}{l_i}\right). \tag{15}$$

After normalizing $d_n(x_i^t)$, you can wait until the weight of each index:

$$w_h^t\left(x_h^t\right) = \frac{d_i x_i^t}{\sum_{i=1}^{n} d_i\left(x_i^t\right)}, \tag{16}$$

where x_i^t is the t index of layer i and w_h^t is the weight obtained by ranking t index levels in layer $t-1$ in layer h, which is the index weight of the required solution.

4. Result Analysis and Discussion

From the current research, the quantitative analysis of SC logistics capacity is mostly based on a specific field or industry. The comprehensive evaluation methods used in the research mainly include fuzzy AHP, AHP, and fuzzy comprehensive evaluation methods. Each evaluation method has its own advantages and disadvantages and scope of application. On the other hand, the focus of the grey system theory is to process some fuzzy and indistinct information and determine the nature of things through the feature changes between different levels. This method can be seen from the beginning, but the accompanying problem is low resolution. In this paper, considering the respective characteristics of fuzzy theory and grey theory, combining the two theories, developing their strengths and avoiding their weaknesses, and forming a grey fuzzy theory to comprehensively evaluate the logistics capability of SC can achieve a better evaluation effect. The application of grey theory in this chapter includes constructing the factor set of evaluation index system, using gambling method to determine the weight matrix of the factor set, using grey theory to determine the grey fuzzy evaluation weight matrix (i.e., single index evaluation result), and finally calculating the fuzzy comprehensive evaluation result. Regardless of the distance and cost from the source point to the delivery point, suppose a company has five user demand points, and the delivered goods are a product, and design a site selection scheme to determine from the five user demand points that the goods must be delivered to each demand point. According to the proposed five dimension balanced scorecard of supply chain, this paper has selected different key performance indicators as the performance evaluation indicator set of dynamic supply chain. On the premise of meeting the demand, ensure the fixed cost of establishing the distribution center at the selected location, and the total cost of transportation expenses flowing through the distribution center is the lowest, as shown in Table 3.

Table 3: Distance from distribution center to users.

Distance (km)		Alternative distribution center				
		1	2	3	4	5
User/demand point	1	0	65	85	100	101
	2	62	81	32	125	123
	3	88	95	0	100	105
	4	98	125	102	0	28
	5	102	130	105	33	0

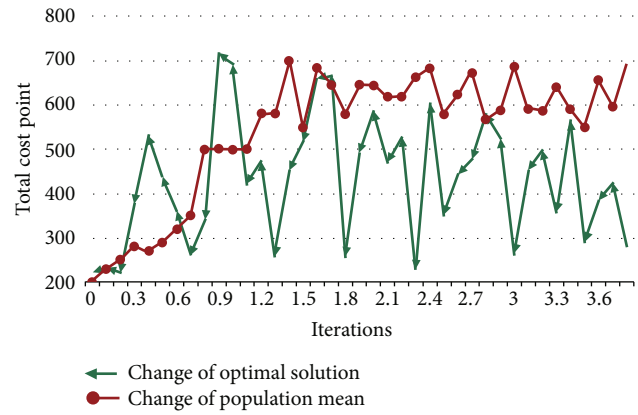

Figure 5: Iterative results of the algorithm of the distribution center location calculation example.

The calculation example is solved by genetic algorithm. The variation of the optimal solution/mean value with the number of iterations is shown in Figure 5.

It can be seen that when the number of iterations is 60, the total cost has reached the optimal value, with the minimum value of 1260 yuan, and the distribution is also the demand point 3 among the demand points.

The business of SC capability evaluation and optimization system includes system users logging in to the system. After the identity information is verified, the logistics capability optimization module and the logistics capability evaluation module can be used to analyze the SC logistics capability. The analysis results can be obtained by using operational research methods, heuristic algorithms, and grey fuzzy theory, which can provide decision-making basis for system users, as shown in Figure 6.

The logistics capability evaluation and optimization system takes the typical H-level supply chain as the research object. The structure of the logistics system includes suppliers, manufacturers, and distributors (including end customers). The inflow data includes the logistics capacity data sheet of suppliers, distributors, and retailers. This paper extracts the data of logistics capability, logistics cost, logistics processing capability, and logistics innovation capability of commonly used supply chain enterprises. The data is preprocessed, and the logistics capability is optimized and evaluated by combining the model data form of optimization analysis and evaluation analysis.

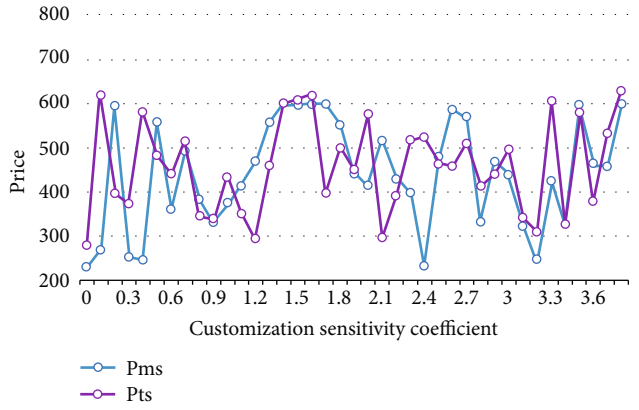

Figure 6: The influence of customer customization sensitivity coefficient on price under the SC of 3D image processing technology.

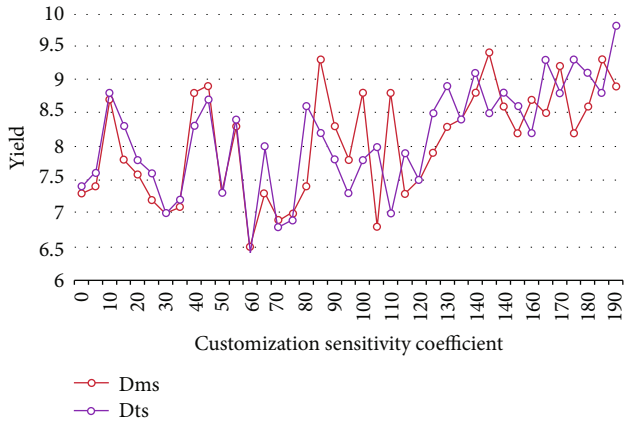

Figure 7: Influence of customer customization sensitivity coefficient on output under the SC of 3D image processing technology.

Figure 7 shows the effect of the customer customization sensitivity coefficient on the output of the two models. It can be observed from the figure that the output of the two models increases with the increase of the customer customization sensitivity coefficient. When the customized sensitivity coefficient of the customer is less than Δ 2, the output in the technician-dominated model is greater than that in the manufacturer-dominated model. When the customized sensitivity coefficient of the customer is greater than Δ 2, the output in the manufacturer-dominated model is greater than that in the technician-dominated model.

As can be seen in Figure 8, in the two models, the price of 3D image processing products decreases with the reduction of the cost-saving coefficient. The price of 3D image processing products in the manufacturer-led model is always not less than that in the technology provider-led model. When the cost-saving coefficient is larger, other conditions remain the same, the production cost decreases, and the manufacturer does not change the price of 3D image processing products, which can increase the income of unit 3D image processing products. However, the enterprise pursues profit maximization. In order to make more profits, it

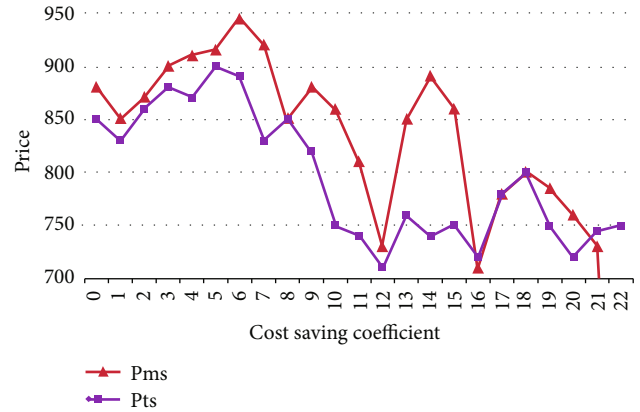

Figure 8: Effect of cost-saving coefficient on price under the SC of 3D image processing technology.

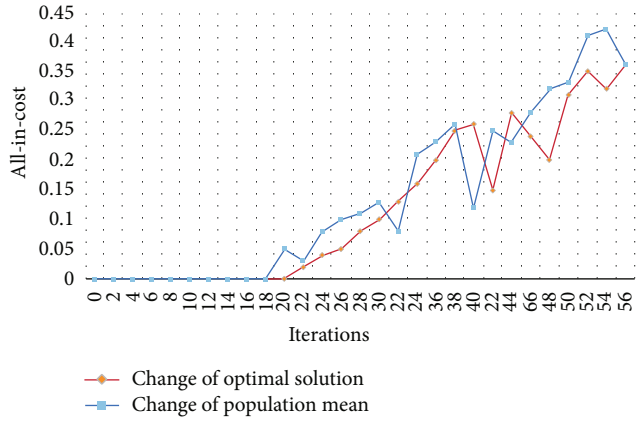

Figure 9: Distribution center location optimization results.

will choose to lower the product price and attract more customers.

In Figure 8, it can be observed that no matter how the cost-saving coefficient changes, the profit obtained by the technologist in the technologist-led model is always not less than that in the manufacturer-led model. Therefore, manufacturers will choose to fight for or give up the dominant power according to the situation, while technology manufacturers will always actively fight for the dominant power in order to make greater profits.

After calculating the subjective weight, objective weight, and comprehensive weight of all indicators, this section will calculate the comprehensive value of performance evaluation of logistics service SC, solve the evaluation values of all levels of indicators in turn, and analyze the results in detail. Similar to the evaluation module, the logistics capability optimization module can add, modify, and delete logistics nodes, routes, and networks to the optimization algorithm and also pays attention to the forward-looking and expansibility of the evaluation and optimization system. By calling genetic algorithm to optimize the distribution and location, the optimization results are obtained. The interface of example calculation results is shown in Figure 9.

Through the above analysis, we can find that in the logistics service SC dominated by company C, we attach great

importance to the improvement of our own business capability and internal link control. For example, we strive for excellence in service quality at any stage, spare no effort to expand market share, and increase investment and customer income, but there is still much room for improvement in customer relations.

The logistics process cooperation of parts suppliers is based on the general SC cooperation of the industry. Among them, purchase, manufacturing, and delivery are important processes of the SC centered on the value chain. First, the collaborative process of SC logistics has been changed. The supplier handles the purchase, preparation, manufacturing, and real-time delivery according to the assembly of the manufacturer provided by the SC collaborative logistics cloud platform. Second, the supplier connects with the supplier above through the collaborative logistics system, eliminating the persistent planning originally sent to the superior supplier. The supplier manages the inventory in the corresponding parts manufacturing. Finally, professional intermediate logistics companies will realize more and more business services and create appropriate supplier control and evaluation models. On the whole, the SC management is attributed to the strategic management of enterprises, so in the SC management, the problem itself should be analyzed based on the strategic development of enterprises. The development of SC management covers the ideas of enterprise management in content and specifically includes the contents of enterprise culture shaping, organizational strategic management, technology development and utilization, performance management, and other fields under the guidance of business ideas. Therefore, the integration of supplier management in company A under the green SC and the introduction of its information support system, technology development, and performance management must conform to the company's future management strategy. It can be seen that information management is one of the very important contents of SC management, and the foundation of information management mainly lies in the construction of information platform. Therefore, under the green SC, company A should focus on the comprehensive sharing of SC information. The SC logistics capability evaluation and optimization system is constructed from the aspects of system analysis, system function module design, and system architecture design. The overall objective, demand analysis, feasibility analysis, business process, and data process analysis of the system construction are described, respectively, and the overall design and subsystem design of the system are carried out. Relevant enterprises in the logistics SC need to devote special energy to collecting and sorting out the feedback information in these channels and study the mathematical relationship between the number of customers and customer feedback, dig out the real needs and ideas of customers, formulate targeted solutions and respond to them in time, and at the same time examine and improve their own service mechanisms and processes. Compare the correlation between the growth of economic indicators such as corporate profits and market share and this investment, discuss the weak links reflected and formulate corresponding solutions, and output a comprehensive summary with guiding significance to point out the direction for future investment.

5. Conclusions

With the rapid development of e-commerce and logistics industry, the competition between enterprises has evolved into the competition between SC. The SC logistics capability is one of the main bottlenecks to improve the performance of the SC, which fundamentally determines the logistics performance of the whole logistics activity process in the SC and its impact on the overall competition of the SC. Creating value for customers is an important condition for enterprises to survive and develop. Therefore, this paper proposes to study the performance evaluation of logistics service SC from the perspective of customer value, which has certain theoretical and practical significance for promoting the service level of logistics service SC and improving the overall performance level of logistics service SC. The performance evaluation method of logistics service SC based on customer perspective is proposed. A performance evaluation method of logistics service SC based on customer perspective is proposed. Taking the collaborative logistics system as the core, it organically combines the actual needs of users, product information of suppliers, and platform operators. Users' needs can be quickly responded by suppliers, thus providing a collaborative working environment for the next product distribution, thus realizing SC integration. The combination of 3D images and software needs further research, development, and implementation. However, there is a lack of research on the results of empirical analysis, and it is necessary to propose targeted countermeasures and suggestions to improve the overall performance of the logistics service supply chain. Further analysis and supplement are needed in the future.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

The Cross-Postgraduate Training Mode Driven by Intelligent Signal Processing Technology: Taking the Major of Finance as an Example

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At present, various economic and social problems have become more complex, requiring a multidisciplinary perspective to seek solutions, and thus more complex and innovative talents are needed. Deepening the reform of postgraduate interdisciplinary education, improving the quality of postgraduate interdisciplinary education, and cultivating high-level technical talents with a multidisciplinary background, innovation ability and comprehensive quality have also become the core issues to be solved urgently in postgraduate education. This paper takes the interdisciplinary training mode of postgraduates in finance as the research object and uses interdisciplinary education theory, systems science theory, and higher education theory to explore the components and main characteristics of the postgraduate interdisciplinary training mode. On this basis, this paper investigates the current situation of interdisciplinary training of postgraduates in finance in Chinese universities and then analyzes and discusses the problems existing in the current mode of interdisciplinary cultivation of postgraduates in finance in my country. Finally, based on the above research results, relevant suggestions for improving the interdisciplinary training of postgraduates in finance in my country are put forward. The research results show that postgraduate interdisciplinary training is a new form of talent training that readjusts the source and composition of each training link after introducing the concept of interdisciplinary education. The components of the postgraduate interdisciplinary training model include interdisciplinary support elements and postgraduate training elements. The former provides interdisciplinary external support for postgraduate training, and the latter constitutes the main content of postgraduate interdisciplinary training. The research results can be used to guide the interdisciplinary educational practice of other types of postgraduates and provide certain theoretical and empirical references for cultivating more high-level compound talents urgently needed by society.

1. Introduction

The financial market is the center and link of the operation of the macroeconomic system [1, 2]. Financial talents are an important force to promote the continuous development of the financial market. Improving the comprehensive ability of students majoring in finance is of great significance to the continuous development and improvement of my country's financial market [3, 4]. Finance is an important major in China's higher education discipline system; almost all colleges and universities that offer economics and management majors have finance majors. Taking the major of finance as an example to study the integration of interdisciplinary education into the curriculum system, the quality of education is of higher value. At the same time, finance is also a comprehensive major [5, 6]. It not only offers management courses such as management, finance, and accounting, but also economic courses such as economics, currency and banking, and investment, as well as mathematics, statistics, probability theory, econometrics, and other mathematics courses. Exploring the interdisciplinary education curriculum system for finance majors has high reference value for the teaching of other economic management majors and related mathematics and physics majors [7, 8]. As the top end of

financial education and an important source of high-level innovative talents, postgraduate education in finance majors, while being highly valued, is also facing enormous pressure for change from practical needs [9, 10]. The rapid development of science and technology, economy, and society has had a profound impact on the interdisciplinary structure. Various disciplines are highly differentiated and also highly integrated and gradually form a new interdisciplinary field [11]. In addition, China is facing economic transformation and industrial structure upgrading, requiring modern technology to transform traditional industries and vigorously develop high-tech industries, which requires the reserve of more high-level compound technical talents [12, 13]. Many economic and social problems and conflicts have also become extremely complex, showing the characteristics of the intersection of various fields, which transcend the boundaries of traditional single disciplines, and require a new vision of interdisciplinary to seek solutions [14, 15]. Various changes in today's era indicate that the cultivation of compound and innovative talents are of great significance, which means that the talent training model should be reformed from an interdisciplinary and multifield perspective [16, 17]. Postgraduate education is an important part of higher education, which should adapt to the times, trends, actively respond to the call of interdisciplinary, break professional boundaries, integrate disciplinary resources, realize cooperation between departments, etc. [18], to cultivate a large number of compound outstanding technical talents for scientific and technological progress, industrial upgrading, and social progress [19, 20].

Effective prediction and analysis of financial markets is a long-term goal [21, 22]. However, the financial market is a complex system with many unpredictable factors, unstructured, nonlinear, and chaotic phenomena [2, 23]. The behavior of the financial market is typically a nonlinear chaotic dynamic system with local randomness and global determination, the coexistence of periodic and aperiodic phenomena [24]. Therefore, it is difficult for people to express and obtain this nonlinear and unstructured data relationship, and it is difficult to grasp its high-risk changing trend. Under the new circumstances emerged modern financial theory, which stemmed from the work of Nobel Prize winner Markowitz. Intelligent information processing technology has established modern data analysis theory and model system for modern financial theory. From the concept of information processing, intelligent information processing is the use of computer and engineering methods to understand human intelligent behavior [25]. Financial data analysis and intelligent information processing technology is the use of artificial intelligence, artificial neural networks, chaos, genetic algorithm, intelligent decision support system, data mining, database knowledge discovery, and other methods [26]. In the globalized financial environment, the various factors that affect the behavior of the financial market are modeled, to predict and analyze the data with many unstructured and unpredictable factors in the financial market; and carry out resource development, management, service, and knowledge discovery [27]. Factors affecting financial market behavior include relevant market behavior (such as gold market, foreign exchange market, bond, and stock market, and interest rate market), macroeconomic conditions, politics and policies, industrial structure, international situations and affairs, and human psychology factors. The financial industry is an industry that highly needs information resources, and the intelligent information processing technology of financial data analysis provides the theoretical framework of data analysis for modern financial theory [28]. Therefore, it is of great significance to integrate the intelligent signal processing system into the training of graduate students in finance.

Although the economic and social demand for high-level interdisciplinary technical talents is extremely urgent, because the interdisciplinary education for postgraduate finance in my country is still in the initial stage of exploration, there are still problems to be solved in terms of concepts, systems, and mechanisms. Therefore, in order to understand the problems more clearly and solve them effectively, it is necessary to strengthen the investigation and grasp the current situation of interdisciplinary training of finance graduate students and to improve and innovate the existing financial institutions in our country in a targeted manner by learning from the mature experience and practice of foreign universities. Learn the interdisciplinary training mode of postgraduates, and cultivate high-level compound technical talents who meet the actual needs of our country. This paper investigates the current situation of interdisciplinary cultivation of postgraduates in finance in my country, analyzes the problems existing in the current interdisciplinary cultivation model, and draws lessons from the experience and practice of interdisciplinary cultivation of postgraduates and applies the theoretical results of the research to the actual cultivation work. In this paper, relevant measures and suggestions for improving the interdisciplinary training mode of postgraduates in my country are put forward, which have certain practical significance for improving the interdisciplinary training of graduates in my country and improving the training quality of high-level compound talents. The technical route of this study is shown in Figure 1.

2. The Significance of Intelligent Signal Processing in Financial

2.1. Financial Data Analysis by Artificial Intelligence Technology. Artificial intelligence is a technology based on knowledge representation, acquisition, and reasoning, and an expert system is an important technology in the field of artificial intelligence [29]. The main elements of the expert system are knowledge representation, knowledge acquisition, and knowledge base. The structure of the expert system is knowledge base, that is, the knowledge of experts in specific fields, which is generally expressed by rules and facts; reasoning engine, that is, the reasoning tool that processes the expert domain and realizes the reasoning of the knowledge base; and the interpretation system, which expresses the deduced results.

The financial data analysis expert system includes a real-time monitoring system, which provides monitoring and control of various data (such as various transaction data in the financial market and various changes) and various

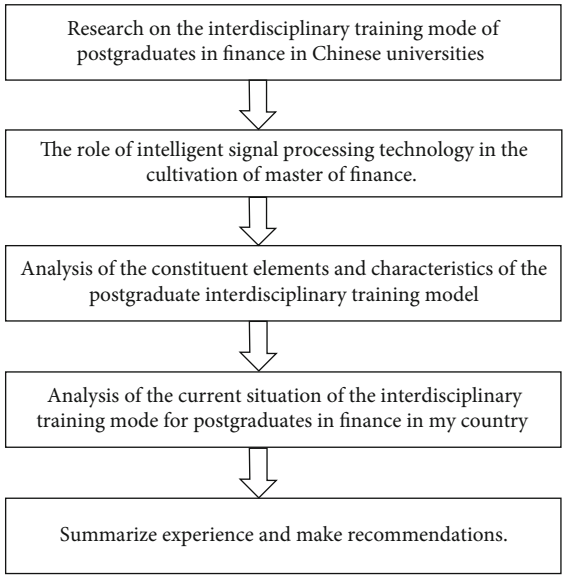

Figure 1: Research technology route.

changes (such as changes in financial market transactions) in the financial market [30]. Make corresponding responses according to changes in the environment; the data interpretation system establishes an effective model based on a large amount of data from various aspects of the financial market, provides an interpretation of various data, and enables it to understand the operation of the financial market.

The new generation of financial data analysis expert system integrates neural network, genetic algorithm, and other technologies. At this time, if a financial data analysis expert system is established, it is only necessary to give the expert system some data, including sample data and databases, and the expert system will effectively extract rules and develop knowledge from the training samples, add them to the knowledge base, and enable experts system more efficiently. Using this technology, the experience, insights, and skills of the world's best financial analysts will be available to more people. The characteristics of this new generation of expert systems are through effective methods; on the one hand, it acquires the knowledge of the expert domain, and on the other hand, it discovers the knowledge from the database and produces expert-level diagnosis for the given problem.

At present, the artificial intelligence technology of financial data analysis has been applied to the evaluation of company credit rating, risk assessment, engineering management and investment strategy analysis, financial and economic forecasting, forecasting of securities price changes, and forecasting of bankrupt bank failures. The development process is shown in Figure 2.

2.2. Financial Data Analysis by Artificial Neural Network Technology. During the eight years from 2011 to 2018, the nonperforming loan balance of my country's commercial banks increased from 427.9 billion yuan to 1,957.1 billion yuan, of which the nonperforming loan balance in June 2018 increased by 357% compared with December 2011; the nonperforming loan ratio increased from 1% to 1.86%, showing an overall upward trend [31]. Judging from the trend in recent years, traditional financial institutions have many problems in risk management due to insufficient attention to system and process construction, insufficient ability to monitor default risks in a timely manner, and the lack of a systematic risk early warning mechanism. At the same time, under the environment of the implementation of the central bank's macroprudential assessment system (MPA) and the increasingly strict supervision, financial institutions need to change their previous management ideas and continuously enhance their active risk management and control capabilities by using artificial intelligence and other new technological means in order to cope with future risks. Figure 3 shows the NPL balance and NPL ratio of Chinese commercial banks from December 2011 to June 2018.

The artificial neural network is a directed network composed of a large number of processing units (that is, nodes representing the characteristics, concepts, patterns, etc. of different objects) that are based on the structure and characteristics of the human brain [32]. Each edge corresponds to a real number, called the connection weight. The artificial neural network is a parallel system dynamics model, which is a development of traditional statistics and statistical pattern recognition methods, especially suitable for simulating human intelligence in pattern recognition, associative memory, clustering, and classification activities. It has two characteristics: large-scale distributed structure and learning and adaptive capabilities.

The artificial neural network technology of financial data analysis is to predict, analyze, and manage financial data through data selection (data separation and processing) and learning methods [33], such as predictive analysis of stocks and securities, forecast and analysis of capital gains, risk management, and credit rating assessment. When artificial neural network technology is applied to the prediction analysis of financial data, it first selects historical records from the financial market and selects data from all the data obtained from the internet and then divides the data into training sample sets and test data sets and transforms the data. In order to be suitable for the input and output processing of the artificial neural network, the artificial neural network is trained with the training sample set, the training results are tested with the test data set, and the relevant neural network model and learning method are selected for financial data analysis. The learning algorithm is one of the core issues of artificial neural network technology for financial data analysis. It needs to study learning theories, such as self-reinforcing learning and self-organizing learning, to discover effective learning processes so that neural networks can construct the internal representation of financial markets. The weights are adjusted so that these internal representation units can express the important characteristics of the problems in the financial field. Because neural network reflects association, memory, and learning, has the characteristics of adaptability and nonlinear dynamics, and has the ability to approximate nonlinear functions, it is a potentially powerful tool for dealing with complex systems such as

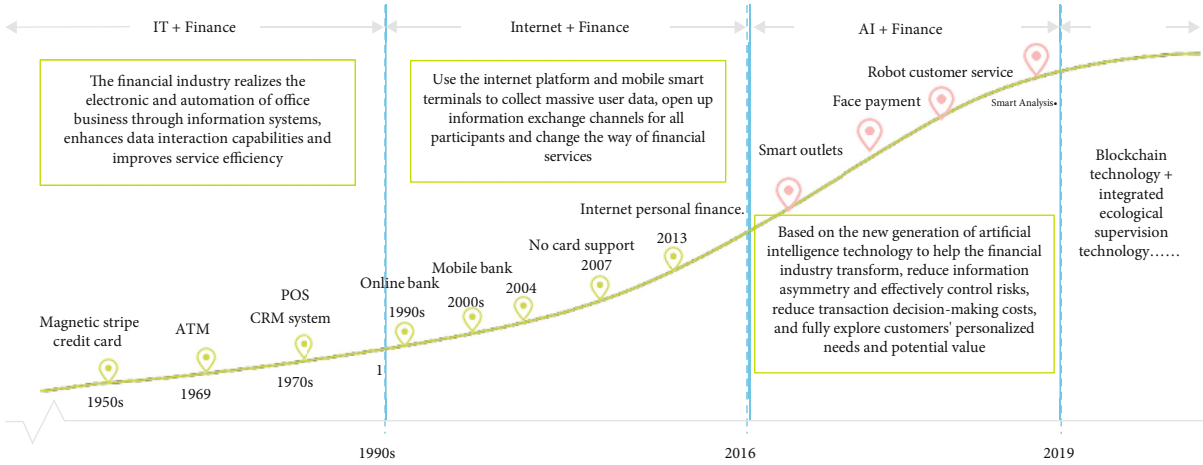

Figure 2: The development process of the technology-enabled financial industry.

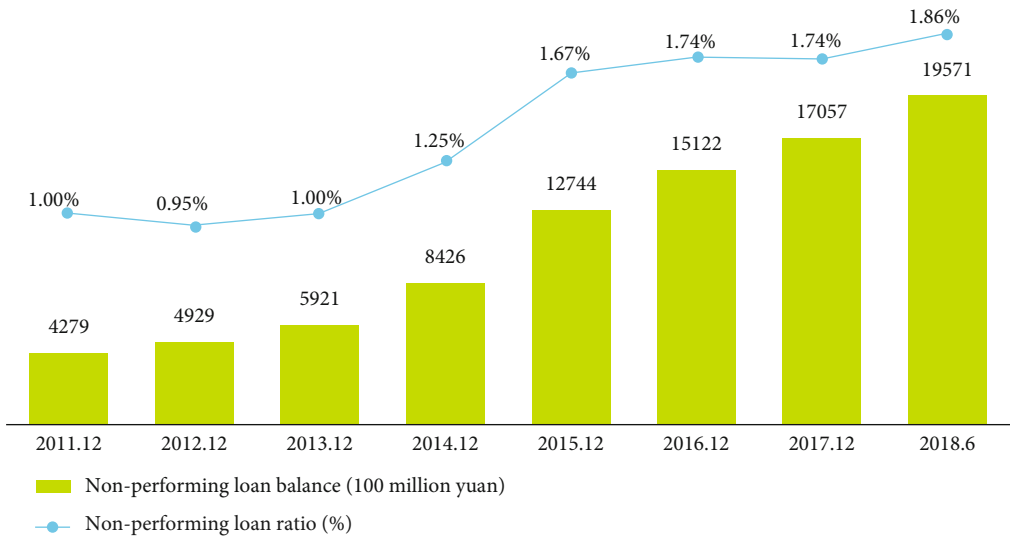

Figure 3: The NPL balance and NPL ratio of Chinese commercial banks from December 2011 to June 2018 [31].

financial markets. The relationship between AI + financial industry technology is shown in Figure 4.

2.3. Financial Data Analysis Genetic Algorithm Technology. In the 1970s, Holland et al. proposed a genetic algorithm based on the principle of biological evolution, which simulates Darwin's computational model of genetic selection and natural elimination, continuously optimizes the population in the process of solving, and then finds the optimal solution and quasi-optimal solution [34]. The genetic algorithm is a search algorithm based on the principle of natural selection and natural genetic mechanisms. It is regarded as an effective global parallel optimization search tool. It is simple, versatile, adaptable, and suitable for parallel processing. Genetic algorithms can be used for selection problems such as subset selection and model selection. The genetic algorithm technology of financial data analysis is to realize the optimization and management of investment and trading strategies, the optimization of decision-making strategies, the selection of securities investment, and the selection of trend forecasting models by means of the genetic algorithm. For example, in the selection of a stock forecasting trend model, first, a binary decision tree is constructed through a genetic algorithm, and each endpoint in the decision tree corresponds to a type of data, representing a trend forecasting model; then the weight vector in the planning decision tree is selected to predict the best trend forecasting model.

The basic principle of the genetic algorithm applied to financial data analysis is to use the population of solutions as the work unit, to use the survival of the fittest principle imitating biological evolution to guide the search, and to improve the target. The quality of each group is evaluated by a value function that depends on the objective function of the problem. The search process is carried out through algebraic change (evolution), and the probability of an individual in each generation being inherited by the next generation is proportional to its fitness value. Use three base operators: copy, crossover, and mutation. Replication refers to the direct transmission of the parental individuals to the next generation in the population. This transmission is

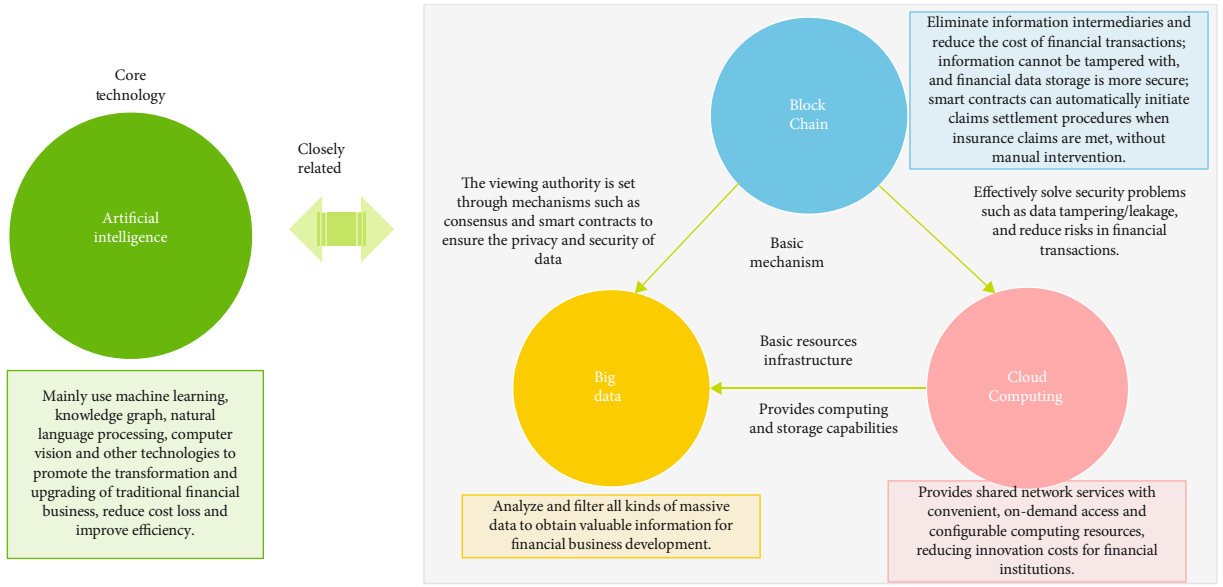

Figure 4: The relationship between AI + financial industry technology.

selective; that is, through replication, the number of outstanding individuals in the population is continuously increased, moving towards a better solution; crossover is to select two individuals from the population for mating and combine the characteristics of the two individuals to form a new individual; the new individual communicates its excellent genes through each individual and obtains a better solution structure than the parent; replication and crossover can only find the best in the existing arrangement and combination of genotypes, while mutation is to imitate mutation theory to change individual genes in a small number of individuals in the population, generate new genotypes, and expand the scope of optimization, that is, mutation. The goal is to increase the diversity of the population and obtain a wider search range.

2.4. Financial Data Analysis Data Mining System. Knowledge Discovery in Database (KDD) is the process of extracting accurate, previously unknown and potentially promising, nontrivial and valuable knowledge from the database using machine learning methods [35]. Secondary processing technology, through KDD, finds laws and patterns from a large amount of data, discovers and understands knowledge, and applies this knowledge in the decision-making process. KDD is a multistep process: (1) preparation: understand the user's requirements; (2) data selection: according to the user's requirements, use database operations to extract KDD-related data from the database; (3) data preprocessing: reprocessing selected data, processing noise data, filling missing data, etc.; (4) data compression: according to the task of knowledge discovery, use operations such as projection to compress the preprocessed data to reduce the amount of data; (5) determine the KDD target: according to user requirements, determine what type of knowledge KDD is to discover; (6) determine the knowledge discovery algorithm: according to the KDD goal, select the appropriate knowledge discovery algorithm (including appropriate models and parameters); (7) data mining: using the selected knowledge discovery algorithm, extract the knowledge needed by the user from the data, and express it in a specific way; (8) explanation of patterns: interpret the discovered patterns in order to obtain effective knowledge. In order to obtain more effective knowledge, it is common to return to some of the previous steps for repeated extraction; (9) knowledge evaluation: present the discovered knowledge to the user. The specific route is shown in Figure 5.

The biggest feature of KDD is to analyze the hidden features and trends behind the data, and finally give the overall features and trends of the data. If artificial intelligence technology is to use the knowledge and experience of experts to make decisions, then KDD is to discover the knowledge hidden in the data from a large amount of data. Discover useful data patterns, and understand the behavior of complex problems through data analysis; make effective predictions through data mining tacit knowledge.

3. The Components of the Postgraduate Interdisciplinary Training Model

3.1. Elements Analysis of Postgraduate Training Mode. The outstanding feature of interdisciplinary is to break the boundaries of single disciplines, realize the knowledge integration of two or more disciplines, and form a cross-domain, multilevel, comprehensive, and comprehensive discipline interaction situation. The postgraduate interdisciplinary training model is a horizontal training model established on the background of multidisciplinary education under the guidance of the interaction between disciplines and the law of talent training according to society's demand for high-level compound talents. According to the point of view of system theory, the postgraduate interdisciplinary training model can be regarded as a system formed by the interaction of many factors. To understand its operation mode, it is necessary to decompose its elements first.

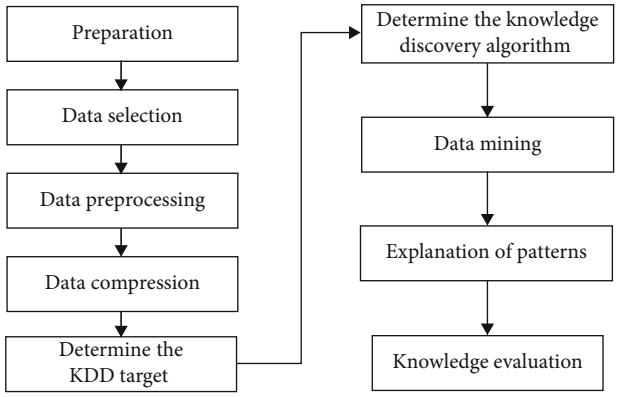

Figure 5: Process of KDD.

Graduate education has developed into the main way to train high-level talents and is an important part of the national innovation system. Each training unit has also been committed to the reform and development of graduate training. Especially since the reform and opening up, the demand for high-level talents in economic and social development has tended to be diversified. Innovating the training mode of postgraduates and improving the quality of postgraduate education has become the top priority of higher education reform. As the basic function of colleges and universities, talent training has always received the attention and research of many scholars. Among them, the talent training mode is a constraint mechanism on how to train people systematically and regularly and stipulates the specifications and methods of talent training. The postgraduate training mode is a special type of talent training mode, which has relatively high requirements on the quality of talents, and presents differences due to different standards of training objects and training objectives. In order to clarify the constituent elements of the postgraduate training model, this paper reviews the relevant domestic papers after 2000, sorts out the scholars' views on the constituent elements of the graduate training model, and categorizes them, as shown in Table 1.

Since the training process itself contains many guarantee factors for the smooth progress of postgraduate training, it can be further subdivided. From the perspective of graduate training rules and the development sequence of training work, this paper subdivides the graduate training process into five subblocks: student selection, faculty, curriculum, professional training, and graduation thesis. Scientific training and practical training are the two aspects of professional training. Figure 6 shows the selection process of the elements of the postgraduate training model.

3.2. Analysis of the Relationship between the Elements of the Postgraduate Training Mode. If the postgraduate training model is regarded as a system, its constituent elements can be regarded as the components of the system. The sum of the components and the ways in which they are related becomes the structure of the system. According to the definitions and functions of the three main links of the postgraduate training model, their relationship is as shown in Figure 7.

Among them, the postgraduate training process includes five subelements: student selection, faculty, curriculum, professional training, and graduation thesis. These subelements are divided in an orderly manner in the training process, closely linked to each other, and interrelated to jointly ensure the overall training process. According to the sequence of talent training from resource input to output, the role relationship of each subelement in the training process is shown in Figure 8.

3.3. Interdisciplinary Education Concept. The reform of interdisciplinary education is not only about opening a few more elective courses and setting up a few more interdisciplinary majors, but also involves complex and comprehensive problems in many aspects such as science, technology, society, economy, education, thinking, and traditional habits. Fundamentally speaking, it is a systematic, comprehensive, and holistic change. The deep-level interdisciplinary educational reform not only includes interdisciplinary ideas but also involves many viewpoints on the reform of the educational theoretical system. The concepts, systems, platforms, disciplines, and other factors involved in the reform of interdisciplinary education are not independent of each other but are involved in the formation of a complete interdisciplinary education system, and their interaction affects the interdisciplinary education system and normal functioning. Among them, the interdisciplinary concept leads the overall situation of interdisciplinary education, the organizational management system provides the basic institutional guarantee for interdisciplinary education, the resource integration mechanism is the main development path of interdisciplinary education, and the intersection of disciplinary fields is the core fulcrum of interdisciplinary education. Figure 9 shows the relationship between the factors involved in interdisciplinary education reform.

4. Survey of Interdisciplinary Training of Postgraduates in Finance

4.1. Questionnaire Design. Considering the disciplinary advantages and geographical distribution of colleges and universities comprehensively, according to the geographical division of Northeast China, North China, East China, Central South, Northwest, and Southwest China, 20 comprehensive and financial colleges and universities were selected, and teachers and postgraduates in the financial field of these colleges and universities were selected as the research objects. Conduct interviews and questionnaires on the current situation of postgraduate interdisciplinary training, respectively, and find out the resistance and problems of interdisciplinary training of postgraduates in finance, so as to provide useful reference for domestic universities to further explore postgraduate interdisciplinary education. After consultation and discussion with relevant experts, 37 evaluation indicators were comprehensively determined. The evaluation index system of the interdisciplinary training model is shown in Table 2.

Table 1: Literature review of the elements of the postgraduate training model.

Number of elements	Point of view
Three elements	Educational philosophy, training process, supporting conditions
Four elements	Educational philosophy, training objectives, training process, condition guarantee
Five elements	Enrollment situation, research direction, curriculum setting, practice link, faculty structure
Six elements	Training objectives, training methods, curriculum system, training process, management system, quality evaluation
Multielement	Training concept, training objectives, mentor team, training system, training organization, program implementation, platform construction, training evaluation

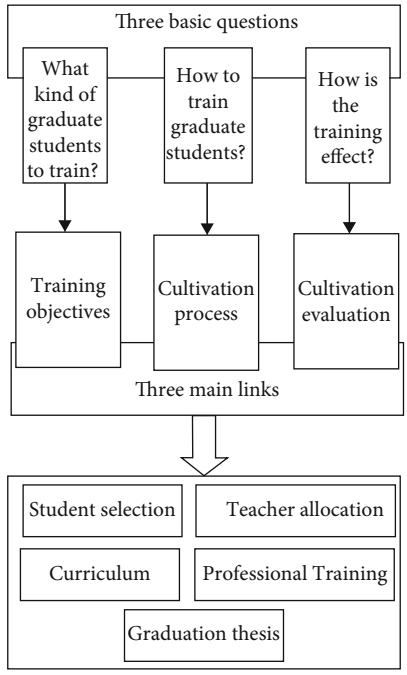

Figure 6: The selection process of the elements of the postgraduate training model.

A total of 350 questionnaires were distributed, and 328 questionnaires were recovered, with a recovery rate of 93.7%, of which 317 were valid questionnaires, with an effective rate of 96.7%. Among them, 47.79% of the respondents indicated that they had interdisciplinary study experience, and 38.05% of the respondents indicated that they had interdisciplinary research experience. The number of recommended students accounted for 37.61% of the total sample, while the number of interprofessional applicants only accounted for 16.37% of the total sample.

4.2. Data Analysis Method. Regression analysis is a scientific method for statistical analysis of the laws of quantitative changes among data. Its main purpose is to describe, explain, or predict the dependence between a dependent variable and one or more independent variables. In regression analysis, if there are more than two independent variables, it is called multiple linear regression score. The explanatory power of the dependent variable is greater. This study is based on the questionnaire sample data, using SPSS statistical software for multiple linear regression analysis.

The specific process of the multiple linear regression method is as follows:

(1) Assuming the existence of a linear regression equation, its form can be assumed as follows:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + \cdots + b_mX_m \quad (1)$$

(2) Make the values of $\hat{Y}$ and Y the closest

$$Q = \sum\left(Y - \hat{Y}\right)^2 \quad (2)$$

If the linear regression equation exists, then we ask for the coefficient b_i and the constant term b_0 in front of each term X. To make the obtained regression equation work better, that is, make the predicted value (estimated value) the closest to the sample value Y. To minimize the sum of squared errors Q, use the least squares method to avoid the problem of positive and negative cancellation. Then the problem of making the regression model most effective is transformed into the problem of finding the minimum value of Q.

$$Q = \sum\left(Y - \hat{Y}\right)^2 = \sum\left[Y\left(b_0 + b_1X_1 + b_2X_2 + \cdots + b_mX_m\right)\right]^2 \quad (3)$$

Taking the derivative of Equation (3), we get

$$b_0 = \sum\left(Y - \hat{Y}\right)^2 = \bar{Y} - \left(b_1\overline{X_1} + b_2\overline{X_2} + \cdots + b_m\overline{X_m}\right). \quad (4)$$

To find the minimum value of Q, after substituting the predicted value, obtain the partial derivative of $X_1 \cdots X_m$ to obtain a linear equation system, and solve it by the matrix method to obtain $b_0 \cdots b_m$, that is, the constant term and the coefficient value.

After each coefficient is obtained according to the above method, the significance of the equation and the partial regression coefficient should be tested, that is, whether the obtained regression equation reaches statistical significance and whether it reaches the significant level of 0.05. Unlike univariate regression, the coefficients here are called partial regression coefficients because there is more than one independent variable. Total deviation sum of squares

$$ss_0 = ss_1 + ss_2. \quad (5)$$

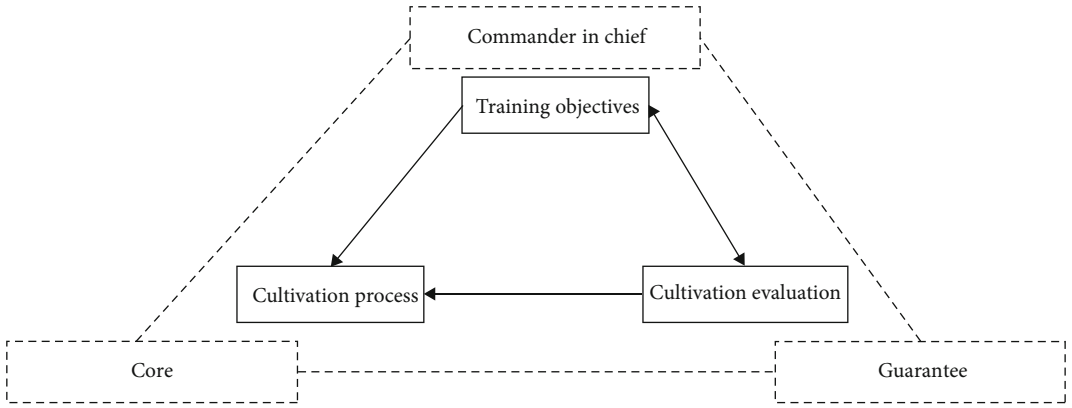

Figure 7: The role and relationship of the elements of the training model.

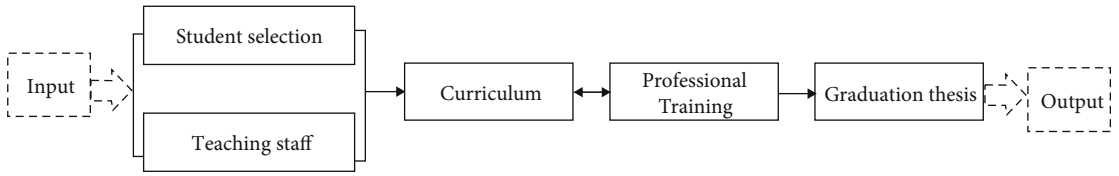

Figure 8: Cultivation process subelement relationships.

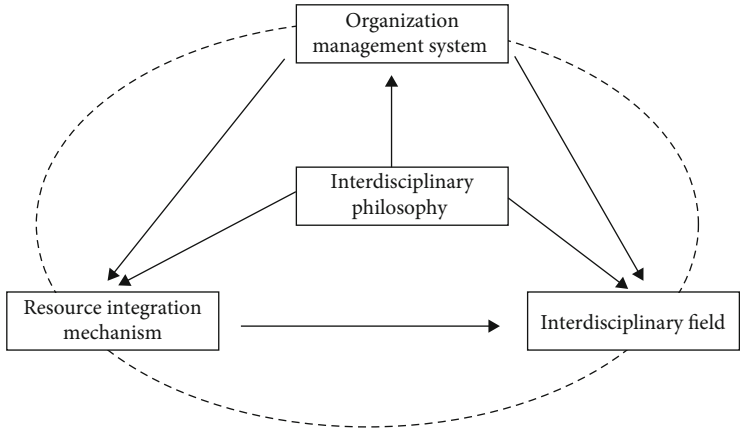

Figure 9: The relationship between factors involved in interdisciplinary education reform.

SS_1 is regression sum of squares; SS_2 is the residual sum of squares.

$$ss_1 = \sum \left(\widehat{Y} \, \bar{Y} \right)^2, \tag{6}$$

$$ss_2 = \sum \left(Y - \widehat{Y} \right)^2 \tag{7}$$

Decisive factor is

$$R^2 = \frac{ss_1}{ss_0}. \tag{8}$$

The closer the coefficient is to 1, the better the model fits the data.

4.3. Data Analysis

4.3.1. Univariate Analysis. Taking interdisciplinary concepts, training pertinence, and problem-solving awareness as independent variables and training objectives as dependent variables, by applying the multiple linear regression analysis functions of SPSS, the output results are as follows:

From the coefficients in Table 3, the standardized regression model can be obtained as follows:

$$\begin{aligned} \text{Training goal} = {} & 0.324 \times \text{interdisciplinary concept} \\ & + 0.418 \times \text{training pertinence} \\ & + 0.438 \times \text{problem} - \text{solving awareness}. \end{aligned} \tag{9}$$

Table 2: Evaluation index system of interdisciplinary training mode.

Component	Elements		Index
Supporting elements	Interdisciplinary philosophy		The connotation expression of the interdisciplinary idea, the manifestation of the interdisciplinary idea
	Organizational management		The organizational form of postgraduate education, the situation of postgraduate training management condition
	Cooperative institutions		Types of cooperative institutions and strength of cooperation
	Academic area		Disciplinary majors and interdisciplinary research directions involved in postgraduate training
Cultivation elements	Training objectives		Interdisciplinary concept, cultivation of pertinence, problem-solving awareness
	Cultivation process	Student selection	Awareness of interprofessional admissions, multidisciplinary examination questions, interprofessional admission ratio
		Faculty	The situation of teachers coming from multidisciplinary fields, the importance of teachers on interdisciplinary education
		Curriculum	The situation of the curriculum involves multiple disciplines, the use of interdisciplinary learning methods
		Professional training	Interdisciplinary research (practice) training experience, application of interdisciplinary knowledge or methods
		Graduation thesis	The selection of topics for interdisciplinary graduation thesis and the use of interdisciplinary knowledge and methods
	Cultivation evaluation		The pertinence of the evaluation system and the validity of the evaluation results

Table 3: Coefficients of the training target fitting equation.

Model	Unstandardized coefficients		Standardized coefficient	t	Salience
	B	Standard error	Beta		
(Constant)	0.024	0.106		0.223	0.824
Interdisciplinary philosophy	0.311	0.027	0.324	11.654	0.000
Cultivate pertinence	0.326	0.025	0.418	13.113	0.000
Problem-solving awareness	0.361	0.027	0.438	13.570	0.000

Table 4: Summary table of multiple linear regression analysis of training objectives.

Independent variable	B	Standard error	Beta	t
Intercept	0.024	0.106		0.223
Interdisciplinary philosophy	0.311	0.027	0.324	11.654
Cultivate pertinence	0.326	0.025	0.418	13.113
Problem-solving awareness	0.361	0.027	0.438	13.570

It can be seen from the standardized regression model that the influence of the three independent variables on the dependent variable is, in descending order, problem-solving awareness, cultivating pertinence, and interdisciplinary concepts. Since the standardized regression coefficients of the independent variables are all positive numbers, it shows that its influence on the dependent variable is positive, and the significance test t value of the regression coefficient of the independent variable is 11.654 ($p = 0.000 < 0.05$), 13.113 ($p = 0.000 < 0.05$), and 13.570 ($p = 0.000 < 0.05$), and it can be seen that the regression coefficients of all independent variables have reached a significant level.

Table 4 is a summary of the output results of the above regression analysis. It can be clearly seen from the table that the multivariate correlation coefficient between the three independent variables of interdisciplinary concept, training pertinence, and problem-solving awareness and the training target dependent variable is 0.931, and the multivariate correlation coefficient is 0.931. The square of the coefficient was 0.867, indicating that the three independent variables could explain 87.6% of the variance of the culture target dependent variable. In the standardized regression model, the three independent variables have a significant impact on the training target dependent variable, and the standardized regression coefficients of the three independent variables are all positive numbers, which means that the three independent variables have a positive impact on the training target dependent variable to influence. Among them, from the perspective of standardized regression coefficient values, among the three independent variables with significant regression coefficients, the Beta values of problem-solving awareness and training pertinence are relatively large, indicating that these two variables have higher explanatory power and better cultivating goals. The explanatory power and influence of interdisciplinary ideas are relatively weak.

Using the same method, there are 22 evaluation indicators for the elements of the training process. These evaluation indicators can be classified according to the selection of students, teaching staff, curriculum, professional training, and graduation thesis. The standardized regression model is as follows:

$$\begin{aligned}\text{Selection of student sources} &= 0.427 \times \text{awareness of inter} - \text{professional admissions} \\ &+ 0.448 \times \text{the situation that the examination questions involve multiple disciplines} \\ &+ 0.497 \times \text{inter} - \text{professional admission ratio.}\end{aligned} \tag{10}$$

Taking the situation of teachers from multidisciplinary fields, the importance of teachers on interdisciplinary education, and the degree of teachers guiding students across disciplines as independent variables and the teaching staff as dependent variables, by applying the multiple linear regression analysis function of SPSS, the output results are as follows:

$$\begin{aligned}\text{Teachers} &= 0.426 \times \text{teachers from multidisciplinary fields} \\ &+ 0.404 \times \text{teachersemphasis on interdisciplinary education} + 0.409 \\ &\times \text{teachersinterdisciplinary guidance to students.}\end{aligned} \tag{11}$$

Taking the situation of interprofessional students taking supplementary courses, the situation of cross-faculty elective courses, the situation of courses involving multiple disciplines, and the situation of using interdisciplinary learning methods as independent variables and course setting as the dependent variable, through the application of SPSS multiple linear regression analysis function, the output is as follows:

$$\begin{aligned}\text{Curriculum setting} &= 0.282 \times \text{situation of interdisciplinary students taking professional courses} + 0.302 \\ &\times \text{situation of elective courses across departments} \\ &+ 0.249 \times \text{situation of courses involving multiple disciplines} + 0.304 \times \text{interdisciplinary learning methods.}\end{aligned} \tag{12}$$

Taking the topic selection of interdisciplinary graduation thesis, the use of interdisciplinary knowledge and methods, the situation of defense experts from different fields, and the evaluation of graduation thesis from an interdisciplinary perspective as independent variables and graduation thesis as the dependent variable, through the application of SPSS, the multiple linear regression analysis function of, the output results are as follows:

$$\begin{aligned}\text{Graduation dissertation} &= 0.256 \times \text{situation of interdisciplinary graduation thesis topic selection} + 0.310 \\ &\times \text{situation of applying interdisciplinary knowledge and methods} + 0.252 \\ &\times \text{situation of defense experts from different fields} \\ &+ 0.289 \times \text{situation of reviewing graduation thesis from an interdisciplinary perspective.}\end{aligned} \tag{13}$$

4.3.2. Overall Analysis. Combining all of the above multiple regression analysis results, the main influencing factors of seven training elements, including training objectives, student selection, faculty, curriculum, scientific research training, practical training, and graduation thesis, can be obtained. The details are listed in Table 5.

For the training target elements, the two factors of problem-solving awareness and training pertinence are more influential than the interdisciplinary concept factor; for the student source selection element, the interprofessional admission ratio factor is more important than the multidisciplinary admissions test questions. Two factors, the situation and the awareness of interprofessional enrollment, have more influence on it; for the elements of the teaching staff, there are three factors: the situation of teachers from multidisciplinary fields, the degree of teachers' interdisciplinary guidance to students, and the importance of teachers on interdisciplinary education. In terms of curriculum elements, the use of interdisciplinary learning methods, the use of interdisciplinary elective courses, and the interprofessional students taking supplementary professional courses have more influence than the factors involving courses involving multiple disciplines. For the elements of scientific research training, the degree of integration of scientific research resources inside and outside the school and the experience of interdisciplinary scientific research training are far more influential than the use of interdisciplinary knowledge or methods and the effectiveness of interdisciplinary scientific research training; for practical training zelements, in terms of interdisciplinary practical training experience, the impact on it is far less than the use of interdisciplinary knowledge or methods, the effectiveness of interdisciplinary practical training, and the degree of integration of practical resources inside and outside the school. The selection of topics for graduation thesis and the situation of defense experts from different fields are two factors; the use of interdisciplinary knowledge and methods and the evaluation of graduation thesis from an interdisciplinary perspective have a greater impact on it.

4.3.3. The Inadequacies of Graduate Education in Finance. At present, these are the following problems in the interdisciplinary training of engineering postgraduates in Chinese universities: on the one hand, the interdisciplinary concept has not penetrated into the specific training links in a clear form, and the organization and management of

Table 5: Influence ranking of evaluation indicators of each training element.

Influence ranking	Training objectives	Cultivation process				Graduation thesis
		Student selection	Faculty	Curriculum	Professional training	
1	Problem-solving awareness (0.438)	Interprofessional admission ratio (0.497)	Teachers from multiple disciplines (0.426)	Use of interdisciplinary learning methods (0.304)	Use of interdisciplinary knowledge or methods (0.389)	Interdisciplinary knowledge utilization (0.310)
2	Cultivate pertinence (0.418)	Recruitment test questions involving multiple subjects (0.448)	Faculty interdisciplinary guidance for students (0.409)	Cross-faculty elective courses (0.302)	Interdisciplinary practice training effectiveness (0.340)	Evaluation of graduation thesis from an interdisciplinary perspective (0.289)
3	Interdisciplinary ideas (0.324)	Interprofessional admissions awareness (0.427)	Teachers' emphasis on interdisciplinary education (0.404)	The situation of interprofessional students taking professional courses (0.282)	Circumstances where interdisciplinary knowledge or methods are used (0.312)	Selected topics for interdisciplinary graduation thesis (0.256)
4				Cases where the course involves multiple disciplines (0.249)	Interdisciplinary practical training experience (0.206)	Responding experts (0.252)

postgraduates is still based on the demarcation of disciplines. The department is the unit, and the cooperation between the departments mainly involves scientific research projects and elective courses, and there is a lack of circulation and complementarity of teachers; if it is not high, students have less opportunities for interdisciplinary scientific research or practical training, and there is a large room for improvement in the topic selection of interdisciplinary graduation thesis, and the training evaluation pays less attention to the individual learning outcomes of students. In general, these are the following five problems: (1) interdisciplinary ideas lack policy support; (2) college-based ideology is more serious; (3) the sharing of educational resources needs to be promoted as a whole; (4) there is a lack of effective planning for interdisciplinary training; (5) a special evaluation system has not been established.

4.4. Recommendations for Cross-Graduate Training. Postgraduate interdisciplinary training is not a simple adjustment on the basis of traditional postgraduate education but a series of changes from top to bottom from concept to system to operation, which requires schools to cultivate high-level, compound top-notch innovative talents from a strategic perspective. For positioning and planning, it is necessary for the relevant departments of the school to make clear regulations on interdisciplinary admissions, training, and evaluation from the institutional level, and it also requires the cooperation of all secondary training units to negotiate and decide on specific training matters and to train them in practice. Effective resource sharing and collaborative operations are necessary for graduate education. Therefore, the interdisciplinary training of postgraduates is an overall and systematic work. The school and its functional departments, secondary units and other institutions should comprehensively plan the interdisciplinary training of postgraduates based on the overall situation.

The interdisciplinary concept embodied in educational activities refers to the educational concept of talent cultivation involving two or more disciplines. The degree of consensus reached by colleges and universities on this concept will affect the smooth development of their interdisciplinary educational activities and the quality of interdisciplinary talent training. The concept of interdisciplinary education needs to be widely understood by graduate teachers, graduate students, and related administrators. Acceptance and recognition, in practice, the interdisciplinary concept is deeply rooted in the hearts of the people, runs through the beginning and end of postgraduate interdisciplinary training activities, and plays a leading and supporting role in the various elements of training at each stage. First of all, colleges and universities must adhere to the concept of interdisciplinary, according to the needs of modern scientific and technological innovation and social development, gather relevant high-quality discipline resources, and strengthen the interconnection and interoperability of related disciplines in extension development and connotation construction, so as to plan and open up new directions for discipline development and give birth to disciplines. New growth points, nurturing interdisciplinary landing points are also necessary for graduate education. Secondly, under the guidance of the concept of interdisciplinary and relying on the new direction of disciplinary development, colleges and universities aim to cultivate excellent students. The top-notch innovative talents start and organize postgraduate interdisciplinary education activities, establish a matching management system and operation mechanism, and seize the commanding heights of interdisciplinary talent training. Third, in order to solidly promote the interdisciplinary training of postgraduates, colleges and universities have carried out structural

reorganization and resource innovation in the training links such as student selection, curriculum setting, teaching organization, and mentor guidance from the perspective of interdisciplinary concepts, so as to cope with the new challenges brought by interdisciplinary talent training. Finally, in order to test the quality of interdisciplinary talent training and respond to the society's demand for high-level compound talents, the quality of postgraduate interdisciplinary education is evaluated from the perspective of interdisciplinary learning outcomes.

5. Conclusion

By defining the constituent elements of the postgraduate interdisciplinary training model and conducting an empirical investigation on the current situation of interdisciplinary training for postgraduates in finance in universities in my country, the following conclusions can be drawn:

(1) According to the concept of interdisciplinary education and the law of postgraduate training, postgraduate interdisciplinary training refers to the postgraduate training activities involving two or more disciplines. Management system realizes the organic integration of resources, widens the caliber of subject areas, and uses this as a supporting condition to readjust the source, composition, and relationship of each basic training link and form a new situation of talent training under the multidisciplinary background

(2) The elements of the postgraduate interdisciplinary training model can be divided into two categories. One is the interdisciplinary supporting element, which includes four subelements of interdisciplinary concept, organizational management, cooperative institutions and subject, and areas. These elements provide interdisciplinary concepts for postgraduate training, organization, management, and resources support; the other type is postgraduate training elements, including training objectives, training process, and training evaluation three subelements, of which the training process is further subdivided into student selection, faculty, curriculum, and majors. There are four links of training and graduation thesis, and professional training includes two aspects: scientific research training and practical training. These elements constitute the main content of postgraduate interdisciplinary training and determine whether the goal of interdisciplinary education can be successfully achieved in training practice

(3) At present, the interdisciplinary training of postgraduates in finance in colleges and universities in my country has achieved certain results, but there are still many constraints on how to further develop, deepen, and promote postgraduate interdisciplinary education: (1) the interdisciplinary concept lacks policy support; (2) college-based thinking is more serious; (3) the sharing of educational resources needs to be promoted as a whole; (4) there is no effective plan for interdisciplinary training; (5) a special evaluation system has not been establishe

(4) In order to break through the current bottleneck of interdisciplinary training of engineering postgraduates in my country, it is necessary to reform and improve in terms of interdisciplinary concepts, educational organization forms, resource sharing mechanisms, interdisciplinary training work, and quality evaluation methods

Based on the relevant theoretical concepts and methods of interdisciplinary education theory and systems science theory, this paper takes the policy texts on postgraduate interdisciplinary education in my country and the practice of interdisciplinary education at home and abroad as the objective basis, based on the sorting out of existing research and the analysis of policy documents, and proposes and defines the constituent elements of the postgraduate interdisciplinary training model, and how the interaction between these elements remains to be further studied. This paper adopts a research method that combines qualitative and quantitative analysis, but the proportion of qualitative research is relatively large, and subsequent research may consider increasing the proportion of quantitative analysis, such as using the analytic hierarchy process to construct an evaluation index system for interdisciplinary training models.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Mathematical Modeling Methods and Their Application in the Analysis of Complex Signal Systems

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Mathematical models are effective means of answers established by humans to solve real-world problems. Complex wireless communication can establish information interaction between vehicles, in order to reduce the delay time of the coordination control optimization timing scheme in coordination delay time. For smart car driving, a complex signal system, this study first establishes a relevant mathematical model. It is used to compare three mathematical models commonly used today. The results obtained under the same conditions show that the mathematical model is better in dealing with the complex signal system in terms of transmission accuracy in all segments. A number of vehicles in different states of the traffic system are selected, and the relevant data are collected to plot ROC curves using the mathematical model. It can be concluded that the freer and more complex the movement behavior of the vehicle, the greater the load it imposes on the road and the system. The results of the confusion matrix show that the model can effectively reduce the pressure on the road and the signal system. With the starting objective of smooth operation of public transportation, the target values are optimized by layering, and finally, the regional roadway capacity is effectively converged. Then, the mathematical model optimization of complex wireless systems and intelligent transportation networks is quantitatively evaluated. The optimized timing scheme through coordinated control achieves the expected effect in coordinated control of delay time and also reduces the average delay time of all intersections of the road network.

1. Introduction

Mathematical modeling is to establish a mathematical model according to actual problems, solve and calculate the mathematical model, and then solve the actual problems in life according to the calculated results. The essence of a mathematical model is a dynamic simulation, not a fixed way of thinking. It is the use of mathematical symbols, mathematical formulas, languages, graphics, etc., to abstract, summarize, and describe the essence of the problem, so as to explain some objective phenomena and development laws in life. Mathematical modeling requires people to flexibly use the relevant knowledge of mathematics, as well as to carefully observe and analyze the real problems in life, abstract from the problems, and extract the mathematical model, which is called mathematical modeling. Since mankind began to tie ropes, mathematics, as the foundation of all disciplines, has developed significantly along with the progress of human technology. Every century of mankind has been the century of mathematics, and mathematics has emerged and developed throughout the history of human civilization [1]. In this century, mathematics has once again demonstrated its irreplaceable power because of the rapid development of computer technology, which has ushered in digitalization in all industries. Mathematics represents absolute rationality, which removes the pretense of things and represents their essence abstractly yet intuitively. That is why numbers have found deeper and wider application in many fields and joint disciplines such as biomathematics, financial mathematics, and physical mathematics have emerged [2]. And mathematical modeling, as the most useful form in the field of science and social life, has become a necessary way to apply mathematics in the context of big data [3].

Mathematicians of different eras and countries defined mathematical models slightly differently, and there are

obvious differences in the way they are expressed, but the essence is largely the same. British mathematicians considered that in a broad sense, all mathematical concepts and basic algorithms can be called mathematical models. French scientists have defined mathematical models in detail in both the broad and narrow senses. They considered that in the broad sense, all concepts in mathematics are abstractions and generalizations of real prototypes and therefore belong to the original mathematical models. In a narrow sense, a mathematical model refers specifically to a structure of mathematical relations that reflects only a specific system or a specific problem. The definition of a mathematical model given by the well-known Chinese mathematician Jiang Qiyuan is that it is a mathematical structure that makes the necessary simplifications for a specific object or purpose in the real world according to its intrinsic laws and later expresses it by applying appropriate mathematical tools [4–7]. From the above descriptions, it can be seen that different mathematicians have defined mathematical models in terms of their types, modeling processes, and modeling methods. In this study, these definitions are summarized to obtain a definition of mathematical models that is applicable to a broader scope. A mathematical model is a mathematical structure that abstractly represents a system or event using mathematical language. This mathematical structure consists of two main parts, the first part is numbers, letters, and symbols, and the second part is mathematical formulas, algorithms, diagrams and laws, etc. [8]. Simple ones such as functions, derivatives, geometry, and physical-chemical equations are mathematical models, and complex ones such as operations research, statistics, and optimal solution problems are also typical mathematical models.

In recent years, with the increasingly proficient use of mathematics, mathematical models have penetrated a wide range of industries. Together with the rapid rise of related technologies such as the Internet, deep learning, artificial intelligence, and big data, the application of mathematical models in complex signaling systems has also received increasing attention from the general public and related practitioners [9]. As the most popular means of transportation nowadays, the automobile not only carries the work of human transportation but also is the basis of the modern transportation industry. And the traditional automobile industry introduces new and high technology and carries out technological substitution, and upgrade to become a smart car is a typical complex signal system [10]. The concept of a smart city has been proposed for more than a decade, and nowadays, the intelligent transportation system is one of the first projects to be realized on the ground. And the vehicle wireless communication network has already achieved regional coverage on the city roads and highways of several large cities, which has laid a solid foundation for the popularization of the intelligent transportation network system [11]. The simultaneous development of wireless signal systems and intelligent vehicles has positive implications for enhancing road safety, reducing environmental pollution, improving traffic efficiency, and reducing manpower waste. The application of mathematical modeling in this complex signal system is very important and irreplaceable, which reflects the practical significance and great economic value of this study.

The contribution of research innovation is that the mathematical model developed in this research has better transmission accuracy in all segments when processing complex signal systems. In this study, a mathematical model is established based on the Doppler effect caused by signal propagation during vehicle operation. With the increase in the number of signal seeds in the system, the signal accuracy of the mathematical model is generally improved, which indicates that the more the number of tree layers generated for the actual transmission of signals, the higher the propagation accuracy. However, the phenomenon of a slight decrease after reaching the critical value may be due to the overflow of tree nodes caused by the excessive depth of the generated tree, resulting in the reduction of signal propagation accuracy. As the information exchange capacity of the mathematical model in this study is enhanced, the congestion during the peak commuting period is greatly reduced. The mathematical model implemented in this section next quantifies the optimization of complex wireless systems and intelligent transportation networks. The results show that the area surrounded by the yellow area is smaller than the area surrounded by the blue line, which means that the timing scheme optimized by the coordination control achieves the expected effect on the coordination delay time control and reduces the average delay time of all intersections in the road network.

2. Mathematical Model Flow and the Type of Signal Used

The process of mathematical modeling is the presentation of a way of thinking from abstraction to figuration, which is realized in the actual modeling process with numbers, letters, and conformity [12]. In the process of mathematical modeling and solving practical problems with it, there is a division of levels and hierarchical requirements, the basic flow chart of which is shown in Figure 1.

As you can see from Figure 1, when a problem is encountered in real life, it is abstracted into a mathematical problem and modeled. Compared with the oneness of other mathematical courses, mathematical modeling courses involve a wide range of knowledge. When using AHP to analyze problems, first, analyze and deal with the problems according to the principle of "organization and hierarchy" to construct a hierarchical structure model. Under this model, the complex problem is divided into several elements, which form several levels according to their attributes and relationships. The analytic hierarchy process can be roughly divided into four steps: (1) establish the hierarchical structure model, (2) construct a judgment (paired comparison) matrix, and (3) test consistency. A relative scale shall be adopted to minimize the difficulty of comparing various factors with different properties, so as to improve accuracy. After the model is built, the problem is solved by substituting it into the model, and the result is checked after the solution is obtained. If it is applicable to reality, the problem is solved. If it is different from reality or partially problematic,

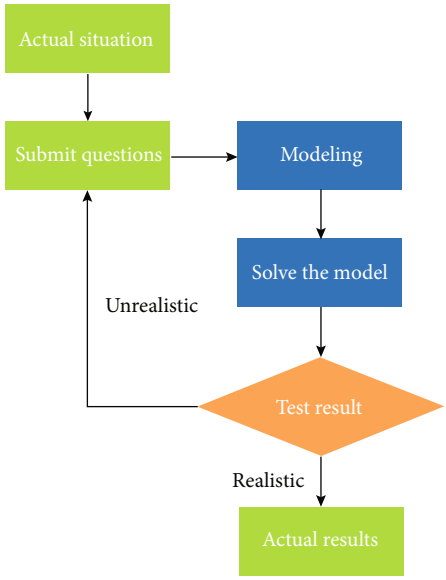

Figure 1: The basic process of mathematical modeling activities.

the model is modified and the process is cycled until the final correct solution is obtained [13]. Complex wireless communication is able to establish information interaction between vehicles and vehicles or even any physical object that can affect the operation of the vehicle, essentially IoT applications in the transportation industry.

Figure 2 represents the communication principle of a vehicle in a complex wireless information system. As a practical application of the Internet of Things in the field of transportation, the complex wireless signal system uses wireless sensing technology in communication to realize real-time interaction between the vehicle and the road and the surrounding environment information. And the collected data can be processed and shared quickly by modern sophisticated mathematical modeling and wireless communication technology, thus interconnecting the vehicle and many physical objects in the surrounding area within a certain range [14]. With the landing of 5G communication base stations worldwide, 5G wireless signals based on cellular networks have become the main technological hallmark of smart vehicles and their communication and the direction of automated driving and traffic optimization industries in the current and future decades [15]. As shown in Figure 2, there are four main types of wireless complex signal-based networked communications in the industry today. Vehicle-to-vehicle communication (vehicle-to-vehicle, V2V), vehicle-to-pedestrian or cyclist communication (vehicle-to-pedestrian, V2P), vehicle-to-infrastructure communication (vehicle-to-infrastructure, V2I), and vehicle-to vehicle-to-network (V2N) [16]. Previously, when vehicles were on the road, they usually got the latest road conditions through traffic broadcasts and other forms, while V2V communication enables vehicle-to-vehicle information exchange. It omits intermediate steps and allows all vehicles in the network to get timely information such as road congestion and traffic accidents. It also allows vehicle collision warning by transmitting and receiving sound waves, which greatly

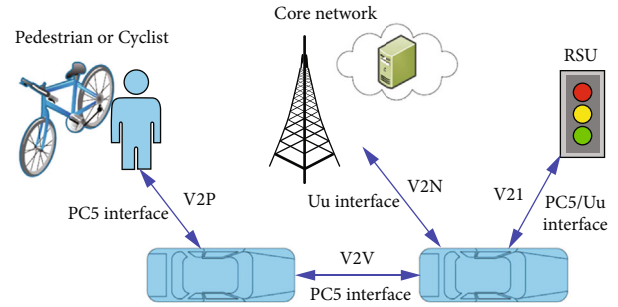

Figure 2: Schematic diagram of vehicle networking communication types and their basic flow charts.

reduces the probability of traffic accidents [17]. V2P communication provides interaction between vehicles and pedestrians or cyclists, and vehicles send collision warning messages to pedestrians or cyclists when they are too close to each other, and pedestrians and cyclists can send information such as road congestion and traffic accidents to vehicles as well as between vehicles [18]. V2I communication is an enhancement of the basic traffic network information, which enhances the information interaction and sharing between vehicles and roadside infrastructure (Road Side Unit, RSU) [19]. In recent years, with the popularity of navigation APPs, V2N communication has also developed, which realizes real-time interaction between vehicles and the core network of traffic command, making it possible to plan driving routes, real-time road condition inquiries, severe weather warnings and network cloud services, and other functions developed based on modern computer technology, which greatly improve the probability of safe driving and travel efficiency of vehicles [20].

3. Mathematical Modeling of Intelligent Vehicle Signaling System

To achieve real-time communication between intelligent vehicles, a variety of suitable anti-interference methods should be selected. The intermediate medium for communication between different groups of unmanned vehicles is the cloud server. The vehicle communication between each group can be carried out through the internal LAN. In order to ensure smooth communication between vehicles, it is generally necessary to define the data structure of vehicle information storage on the cloud server in advance. The cloud server is communicatively connected to a plurality of unmanned vehicles through a network. The cloud server may maintain a data structure or database to compile and store vehicle information of the unmanned vehicle. Some of the vehicle information may be received from the driverless vehicle while other information may be compiled and generated at the server based on the updated information received from the driverless vehicle. At present, the methods commonly used in the industry include the execution power control method, the rational allocation of resources, and the signal mode selection method. The selection of these methods has a great impact on the quality of signal transmission between intelligent vehicles. Unlike the traditional

location-fixed point-to-point cellular communication, the biggest problem to be faced by the complex signal system of intelligent vehicles is that the vehicles in the network are moving at a relatively high speed. Signal propagation between vehicles at high speed will produce Doppler effect; it refers to the wave source, and the observer has relative motion, the observer receives the frequency of the wave, and the frequency of the wave source is not the same phenomenon. The sound of a train whistle coming from afar becomes sharp and thin (i.e., the frequency becomes higher and the wavelength becomes shorter), while the sound of a train whistle leaving us becomes low (i.e., the frequency becomes lower and the wavelength becomes longer), which is the phenomenon of the Doppler effect. This phenomenon was first discovered by Austrian physicist Doppler in 1842. The Dutch meteorologist Barot had a team of horn players stand on an open train speeding past from near Utrecht, Netherlands, in 1845 and blew, and he measured the change in pitch on the platform. The Doppler effect has been used by astronomers to measure the apparent velocity of stars since the second half of the 19th century. It is now widely used to corroborate observations of the motion of celestial bodies and artificial satellites. In intelligent vehicle networking wireless complex communication systems, this phenomenon is called Doppler shift, which refers specifically to the relative motion of the transmitter and receiver causing a shift in the signal at the carrier frequency of unidirectional propagation, which then triggers distortion and rapid changes in the channel in time. If the propagation is multidirectional, it causes more kinds of Doppler shifts, which in turn makes the wireless complex signal propagation cause more errors. Because of the generation of Doppler shifts, the signal coherence time of the complex system decreases, which eventually leads to the evolution of wireless communication into time- and frequency-selective fading communication, often called instantaneous fading communication. In instant fading communication, the response on each signal transmission channel changes rapidly with time. And there is the problem of prediction delay and feedback delay in real communication, and the three together will cause a large error, and the mathematical modeling needs to focus on how to eliminate this error. A communication delay estimation algorithm is proposed for wireless sensor networks using the CSMA/Ca communication mechanism. A combined link model is established to predict link reliability based on the time and space correlation of link quality. The simplified collision probability model is used to predict the channel contention delay, and the communication delay is obtained by combining the predicted link reliability. The overhead of the algorithm is analyzed, and the channel contention delay prediction algorithm is simulated on the simulator. The results show that the prediction algorithm can accurately predict the contention delay of the network.

First, assume that the fading of all signal channels in a complex wireless signal system contains not only large-scale fading but also small-scale fading, starting with the on-board interference channel, the expression of which is

$$g_{i,j} = \left|h_{i,j}\right|^2 L_{i,j}, \tag{1}$$

where L denotes large-scale fading and h denotes small-scale fading; the overall obeys the log-positive-terminus distribution. Since the large-scale fading changes more slowly, it can be accurately estimated by the signal base station at each change interval. The small-scale fading, on the other hand, needs to be determined based on the actual situation and cannot be relied on by the signal base station for a more accurate prediction.

After that, the small-scale fading can be predicted assuming that the transmitter and receiver of the signal are relatively stationary and there is no Doppler effect if they are not moving. The small-scale fading obeys independent distribution, and its mean is zero and variance is one, which is typical of the complex Gaussian distribution. In this study, the model is defined as the ideal model, which is applicable to the time period of road congestion, when the vehicles are usually stationary or moving very slowly compared to the propagation speed of the signal. In such a scenario, the in-vehicle interference channel is given by

$$g_{i,j} = G\beta_{i,j}\varsigma_{i,j}d_{i,j}^{-\alpha}. \tag{2}$$

In the above equation, G is the loss constant of the signal in the propagation path and α is the path loss exponent. However, excluding the congestion during the peak commuting period, most of the cases are not modeled as ideal. Therefore, the next step is to model the case where both the transmitter and the receiver of the signal undergo relatively high speed motion. This situation occurs more often when vehicles and pedestrians or cyclists carry out signal transmission and is referred to as a nonideal model in this study. In this case, the small-scale fading cannot be accurately predicted, so the small-scale signal fading is modeled using a Markov process as follows:

$$h_{i,j} = \varepsilon\tilde{h}_{i,j} + \sqrt{1-\varepsilon^2}e_{i,j}. \tag{3}$$

The estimation errors obey independent identical distribution, and the small-scale fading preview errors and estimation errors in the Eq. are independent and uncorrelated with each other.

When the intelligent vehicle user uses the spectrum resource k on the idle signal channel, its transmitted data is no longer interfered with by other users, and at this time, the signal of the vehicle at the receiving end can be expressed as

$$y_{i,k} = \sqrt{p_{i,k}^V L_i}h_i s_i + n. \tag{4}$$

The corresponding signal-to-noise ratio is

$$\xi_{i,k}^V = \frac{p_{i,k}^V g_i}{\sigma^2}. \tag{5}$$

The signal transmission rate in a complex wireless system is then calculated by the formula

$$r_{i,k}^{V} = X \log_2(1 + \xi_{i,k}), \tag{6}$$

where the mean of n is 0 and X is the variance, which is calculated as follows:

$$X = \arg\min \left\{ \sum_{i=1}^{N} \sum_{j=1}^{N} x_{i,j} c_{i,j} \right\}. \tag{7}$$

When two transmission modes share the same spectrum resources, the signal interference phenomenon occurs. Considering this situation, the signals received by the vehicle are

$$y_{i,j} = \sqrt{p_{i,j}^{V} L_i} h_i s_i + \sqrt{p_{i,j}^{C} L_{i,j}} h_{i,j} s_{i,j}^{C} + n. \tag{8}$$

It corresponds to a signal-to-noise ratio of

$$\xi_{i,j}^{V} = \frac{p_{i,j}^{V} g_i}{p_{i,j}^{C} g_{i,j} + \sigma^2}. \tag{9}$$

The expression for the rate at which the signal is transmitted between is

$$r_{i,j}^{V} = X \log_2 \left(1 + \xi^{V}{}_{i,j}\right). \tag{10}$$

Assuming that the interference signal caused by transmitting is 1, the transmitting power increases for a larger number of users in a multiplexed cellular network, calculated as

$$\xi_j^{C} = \frac{p_j^{C} g_{i,B}}{\sigma^2}. \tag{11}$$

The transmission rate corresponding to the signal it generates is

$$r_j^{C} = X \log_2 \left(1 + \xi_j^{C}\right). \tag{12}$$

In this complex wireless signal system, the transmit power expression for multiplexing cellular users is as follows:

$$\eta_{i,j}^{C} = \frac{p_{i,j}^{C} g_{j,B}}{p_{i,j}^{V} g_{j,B} + \sigma^2}. \tag{13}$$

It has a transmission rate of

$$v_j^{C} = X \log_2 \left(1 + \eta_j^{C}\right). \tag{14}$$

Combining the above multiple scenarios, then the mathematical modeling ensemble formula for maximizing the utility function of smart car users in this study is as follows:

$$(X*, P*) = \arg \text{MAX} \left\{ \sum_{i=1}^{N} \sum_{j=1}^{M} x_{i,j} u(p)_{i,j} \right\}. \tag{15}$$

Finally, an activation function is selected for the mathematical model established, because if the activation function is not included in the mathematical model established in this study, then it is only equivalent to a linear regression model and cannot handle the logic of more complex signal systems. The introduction of the activation function into the dynamic system changes the monotonic processing model into a nonlinear one, which can represent and calculate more complex smart car signal transmission situations. ReLU has sparsity, which enables the sparse model to better mine relevant features and fit the training data. In the region of $x > 0$, the gradient saturation and gradient disappearance will not occur. The calculation complexity is low, and the exponential operation is not required. The activation value can be obtained as long as there is a threshold value. The main monotonic functions commonly used today are the Sigmoid function and the ReLU function, and their respective function diagrams are shown in Figure 3.

The choice of different activation functions applied to complex wireless signal systems can have an impact on training and prediction, which in turn can sway the computational results. When using the Sigmoid function to compute large-scale data, it generates large errors, while using the ReLU activation function can converge quickly, achieving computational savings and improving training efficiency. Moreover, for dynamic deep music models, the gradient of the ReLU function is constant, and there is no gradient disappearance as in the case of the Sigmoid function. As mentioned above, therefore, the ReLU function is finally chosen as the activation function for mathematical modeling in this study.

4. Application of Mathematical Modeling in the System

The mathematical model developed in this study has a high recall value and will have a strong predictive power when calculated using positive class samples, which can be used in complex wireless signal systems for smart cars. To verify the signal transmission accuracy of the mathematical model developed in the previous section, it is used to compare with three mathematical models commonly used in traffic systems today. These three models are the BinOCT model, CART model, and C4.5 model, and the results obtained from the tests conducted under the same conditions are shown in Figure 4.

A comparison with three commonly used mathematical models shows that the mathematical model established in this study has a better transmission accuracy in all segments in dealing with complex signal systems. When the number of signal leaf nodes is in the interval of 25 to 30, the signal

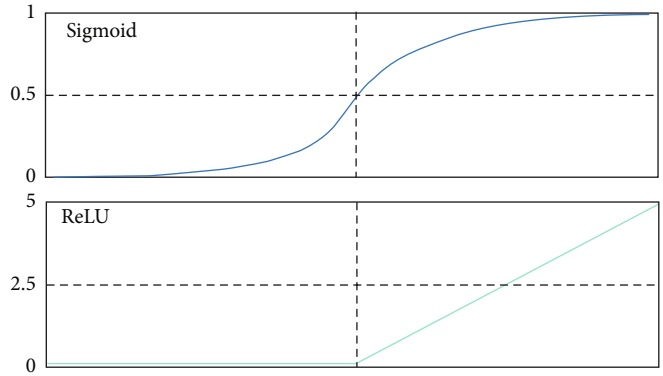

Figure 3: Schematic diagram of Sigmoid function and ReLU function.

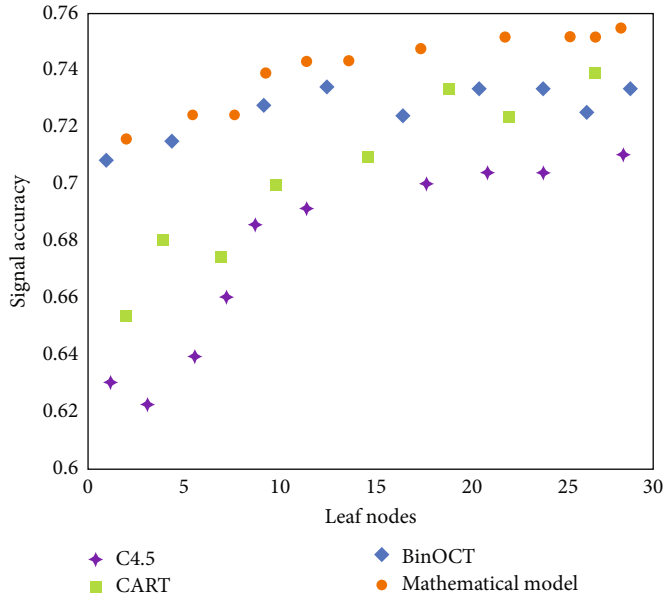

Figure 4: Comparison of signal transmission accuracy with three common mathematical models.

transmission accuracy is even the highest at 75.6%. This indicates that the use of branch boundary constraints reduces the search space and also achieves high classification prediction accuracy. In the interval 0 to 10, where the number of signal leaf nodes is small, the mathematical model developed in this study also shows good accuracy. This indicates that the model has good performance in maintaining sparsity without weakening its signal transmission accuracy.

This experiment next selects the variation of the accuracy of the mathematical model with the number of signals in the three signal patterns for different values of the number of random signals in the smart car communication system. The obtained results are shown in Figure 5.

The overall increase in signal accuracy of the mathematical model for the three signal modes with the number of seeds of the system signal indicates that the more layers of the tree generated for the actual transmission of the signal, the higher the accuracy of the propagation. However, the phenomenon decreases slightly after reaching a critical value. This may be because too much tree depth will generate overflow tree nodes, resulting in a decrease in signal propagation accuracy. Therefore, the maximum tree depth is the optimal solution for the three signal propagation modes. Then observing one by one, it can be found that the vehicle-to-vehicle signal transmission mode V2V has the highest accuracy, and the accuracy increases as the number increases. This is due to the fact that the mathematical model in this study focuses on eliminating the Doppler effect caused by signal transmission between vehicles. The V2P mode between vehicles and pedestrians or cyclists and the V2N mode between vehicles and the central network, although the signal transmission accuracy is lower than V2V2, reach a minimum of more than 85% at a signal leaf number of 11, which can fully meet the demand in practical use. The above test results show that the mathematical model established in this study can propagate signals more accurately in the case of all three signal modes, which is scientific and reliable.

A number of vehicles in different states of the traffic system are selected, and the relevant data are collected to draw

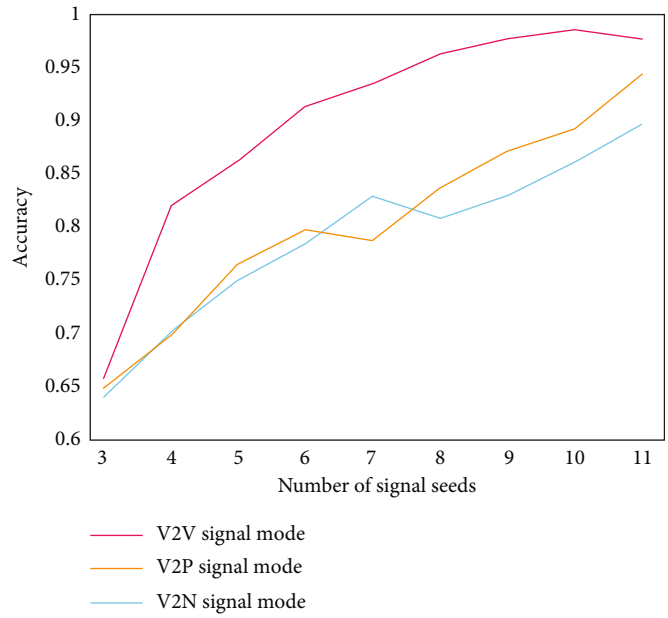

Figure 5: A line graph of the accuracy of the mathematical model in three signal modes as a function of the number of signals.

ROC curves using a mathematical model. The three main modes of vehicles on the road are selected: waiting state, free driving state, and slow driving state. Therefore, the aggressiveness of vehicles and the vulnerability of roads will be analyzed as indicators also in the field of transportation. In this study, the ROC curve and confusion matrix are used to characterize these two measures, respectively, and the results are shown in Figure 6.

The four ROC curves in Figure 6(a) reflect the degree of damage caused by the attack of the vehicles on the road in different states and also the load they impose on the complex wireless signal system that assumes the role of scheduling and communication in traffic in different states. It can be seen that the freer and more complex the movement behavior of the vehicle, the greater the load it causes to the road and the system. The initial increments in all three states are rapid and have a large slope, and this trend slows down considerably when a certain point is reached. The possible reasons for this are that the mathematical model developed for this study requires a large amount of kinetic energy to process the initial signal data, but once the system is operating smoothly, the signal data can be collected, analyzed, and transmitted in a stable manner. The results of the confusion matrix show that the rational use of the mathematical model, proper guidance and scheduling of vehicles, and keeping the vehicles informed of their surroundings can effectively reduce the pressure on the road and the signal system.

The mathematical model also allows for scheduling optimization of traffic flows during peak traffic periods. From the collected data hierarchy strategy, it is clear that the parameters to be iterated are the peak traffic period, peak traffic section, and announcement traffic distribution. Therefore, the existing registered vehicles are first processed in the model according to the splitting strategy to aggregate them. Then, using the feature that the number of vehicles passing the target road section in one day and night must be nonconsecutive positive integers, the interval time of vehicles is used as a reference to achieve loss-free iteration using the mathematical model. Taking the smooth operation of public transportation as the starting target, the target value is gradually optimized through layer-by-layer drawing, and finally, the regional road section passing capacity is effectively converged. Based on the improved mathematical model, to calculate the road throughput capacity of the iterative data map is shown in Figure 7.

After using the improved mathematical model to optimize the traffic flow of a road section, the throughput capacity of the road section for vehicles is significantly improved. And thanks to the enhanced information exchange between vehicles, between vehicles and pedestrians or cyclists, and between vehicles and the core network by the mathematical model in this study, the congestion during the peak commuting period is also greatly reduced.

The mathematical model conducted in this section next quantifies the optimization of complex wireless systems and intelligent transportation networks in the assessment. The use of radar plots enables a more detailed demonstration of the computational performance of the mathematical model established in this study in multiple dimensions. In this paper, the vehicle delay times at each intersection are selected as the raw data, and the resultant plots obtained after processing are shown in Figure 8.

In Figure 8, a total of six main roads correspond to six intersections with signalized groups in the target road network. They are arranged in a clockwise manner, and the average delay time of intersections without coordinated control optimization is enclosed by a blue straight line, while the average delay time of intersections after coordinated optimization is enclosed by a yellow straight line. The area enclosed by the blue straight line in Figure 8, i.e., the result of the data without optimization, has sharper edges, with the data at

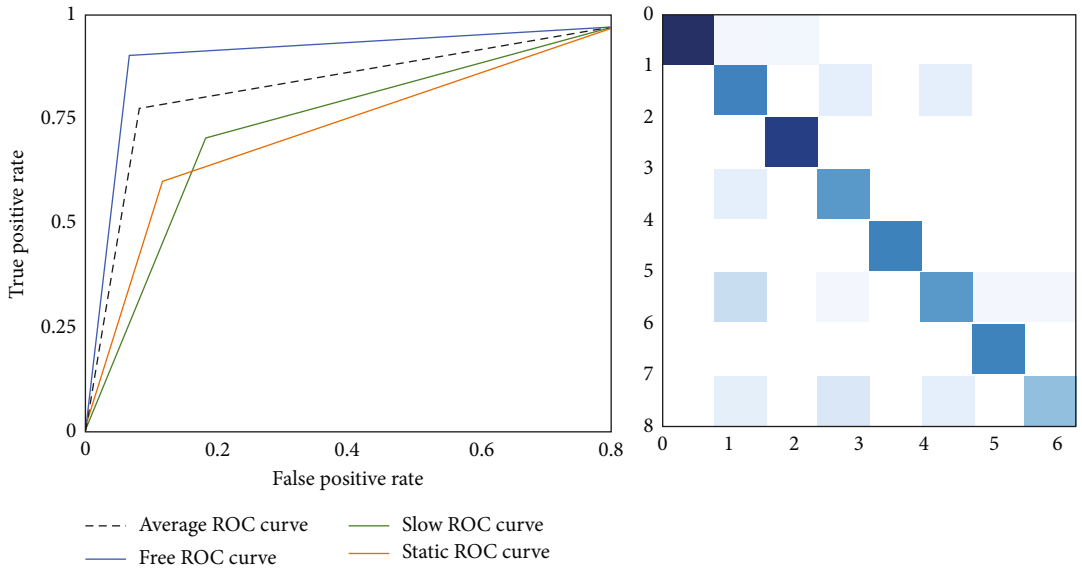

Figure 6: ROC curves and confusion matrix plots for three vehicle modes.

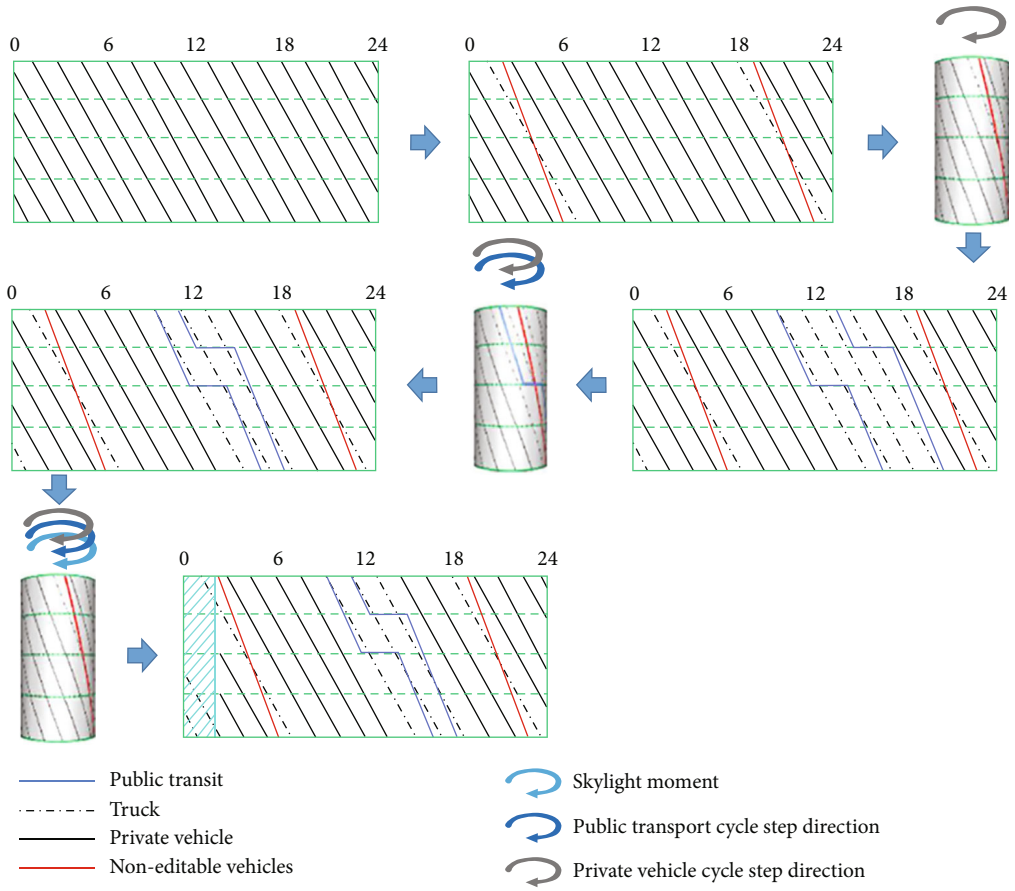

Figure 7: Calculation of vehicle passing ability data map of regional road sections based on improved mathematical model.

dimensions I18 and T16 being the most distant from the center point and the data at I3 being the closest to the origin. The graph formed by the area enclosed by the yellow lines is relatively rounded, mainly thanks to the data at I3 being enlarged, while the data at dimensions I9, T16, and I18 are significantly reduced. It is also obvious that the area enclosed by the yellow area is smaller than the area enclosed by the blue line, which means that the coordinated control

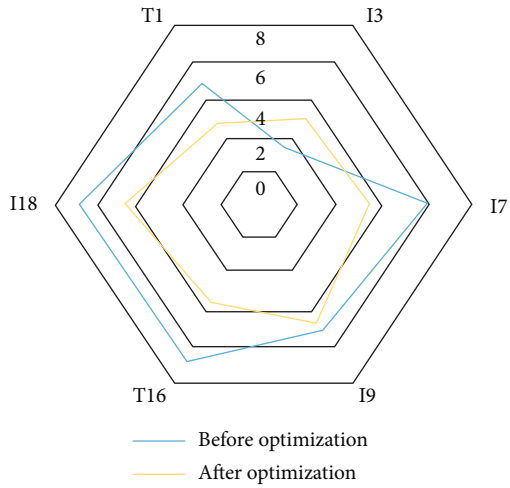

Figure 8: Mathematical model for congested road traffic optimization before and after the extension time radar map.

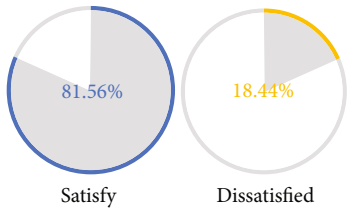

Figure 9: Satisfaction survey results of tested smart car drivers.

optimized timing scheme achieves the desired effect in coordinating the delay control and also reduces the average delay of all intersections in the network.

This mathematical model was added to the traffic network system for a three-month trial run. Then, a satisfaction questionnaire was distributed to 80 smart car drivers using the traffic complex wireless signal network, and the results are tallied in Figure 9.

The questionnaire results show that 81.56% of the smart car drivers are satisfied with this mathematical model, which again indicates that the results of this study and the mathematical model are scientifically valid in complex wireless signal systems. And still, 18.44% of smart car users made an unsatisfactory evaluation of this mathematical model. Collecting the details of the questionnaire revealed that the main points of their dissatisfaction were mainly insufficient signal strength in urban suburbs, the signal received during traffic congestion would be noisy, and sometimes, there would be no timely feedback about the presence of pedestrians next to the vehicle. To address these issues, this study will follow up and target to improve and optimize the mathematical model.

This chapter examines the full range of the established mathematical model, from the accuracy of signal transmission to the variation of the number of different signal leaves. The traffic of the three main modes of vehicle operation is also computed, and based on this, the target value is gradually optimized by laying out layer by layer with the starting objective that public transportation can operate smoothly. These relevant and necessary experimental groups have led to valid conclusions, and the results show that the mathematical model developed in this study is scientific and valid in complex wireless signal systems. The combination of the above experiments and their results is the only way to obtain excellent results with more than 80% satisfaction from the users.

5. Conclusion

In this study, a mathematical model is established based on the Doppler effect caused by signal propagation during vehicle operation. In order to verify the signal transmission accuracy of the developed mathematical model, it is compared with the three mathematical models commonly used in today's transportation system. The test results under the same conditions show that the mathematical model developed in this study has better transmission accuracy in all segments when processing complex signal systems. The mathematical model developed in this study also shows good accuracy in the interval 0 to 10 where the number of signal leaf nodes is small. This shows that the model maintains sparsity without reducing its signal transmission accuracy and has good performance. In the selected intelligent vehicle communication system, among the three signal modes with different random signals, the accuracy of the mathematical model changes with the number of signals. With the increase in the number of signal seeds in the system, the signal accuracy of the mathematical model is generally improved, which indicates that the more the number of tree layers generated for the actual transmission of signals, the higher the propagation accuracy. However, the phenomenon of a slight decrease after reaching the critical value may be due to the overflow of tree nodes caused by the excessive depth of the generated tree, resulting in the reduction of signal propagation accuracy. Select multiple vehicles in different states of the transportation system, collect relevant data, and draw ROC curves using mathematical models. Select three main modes of vehicles on the road: waiting state, free driving state, and slow driving state. It can be concluded that the more free and complex the motion behavior of the vehicle, the greater the load it exerts on the road and the system. The results show that the timing scheme optimized by coordination control achieves the expected effect on coordinating delay time control and reduces the average delay time of all intersections in the road network. However, the mathematical model of signal propagation has defects and needs further improvement. There is also the risk of data leakage. Smart car drivers and relevant practitioners should use the results obtained from the analysis wisely.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Evaluation Method of Innovative Education Model of E-Commerce Video Live Broadcast Based on Big Data Analysis Technology

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In the environment of education big data, how colleges and universities make good use of these data not only affects the orderly operation of the whole education and teaching system of colleges and universities. It will also become an inexhaustible driving force to help colleges and universities promote the reform and innovation of the education and teaching system. This paper takes student evaluation data and student online learning data as research objects. Focusing on the teaching operation and students' autonomous learning, this paper uses the improved k-mode algorithm to cluster analyze the classroom teaching operation. This paper uses neural network algorithm based on machine learning to predict and compare students' online course learning. It is hoped that it can provide meaningful reference for the construction of teaching management system and the reform and innovation of teaching management system in colleges and universities. Two research works are mainly carried out through the preliminary analysis and transformation of the data of student evaluation of teaching in a certain university. The improved cosine dissimilarity algorithm is used to eliminate the abnormal teaching evaluation data. The normalization method was used to standardize the teaching evaluation data. The traditional k-mode algorithm is used to cluster the teaching evaluation data. Some problems of k-mode algorithm are pointed out, and the traditional k-mode algorithm is improved. Experimental results show that the improved algorithm is more reasonable and effective.

1. Introduction

Internet technology will be employed in my country, and various social networks and mobile Internet have begun to be popularized in our country, which also gradually broadens the application scope of Internet technology in my country. In recent years, my country's Internet data has also continued to grow, and the era of big data has arrived. The application is in my country, such as market economy, education, and cultural life, and has promoted the development and progress of all aspects of the country. In the era of big data, data processing has three major changes compared with traditional data mining: full volume rather than sampling, efficiency rather than precision, and correlation rather than causality [1]. The real meaning of big data lies not only in the huge data information but also in the professional modeling and analysis of these data to mine its potential value [2]. Large data volume, low data value density, storage, analysis, and processing [3] are the contained potential values, and it will become the core content of big data research [4].

Two groups on such basis of the minimum error functions. In the scheduled K category, the main idea is to randomly select K cluster center points as the class center of the current cluster (not the final class center point) given the K value of the number of classification categories, and calculate the distance between each point and the class center point, divide it into the clusters with the closest distance until the division of all point clusters is completed, then, recalculate the center point of each cluster (average distance), recalculate ones, and assign each cluster [5], the cluster to which the point belongs, and this cycle iterates until

the center point of the cluster is less than the threshold or reaches the specified number of iterations [6].

The e-commerce video live broadcast course is one of the new contents of the e-commerce major. Because the course content is relatively new, students have more practice in live broadcast, so there are some differences with other majors in the students' live broadcast e-commerce learning process and the teachers' teaching process with disciplinary questions [7].

As an emerging online shopping method, live video streaming has enriched the online sales method of goods and has a strong sense of participation and experience, enabling consumers to have a better consumption experience. Many companies are still optimistic about the development trend of live broadcast e-commerce in the next few years. "Live broadcast with goods" has been a new transformation as well as upgrading of traditional firms [8]. However, live broadcast talents and live broadcast team building are the shortest way for enterprises to expand online sales.

Such positions and division of labor formed around live broadcast are becoming more and more specific, and live broadcast delivery may become the main means of corporate marketing [9]. The new occupations that have emerged so it will indeed put pressure on the training of it and such teaching implementation of new courses represented by live e-commerce courses will put a certain degree of pressure on teachers in lesson preparation, teaching, and tutoring. How to be competent in the teaching work of new courses, perform their duties as teachers, and be responsible as professional teachers of live e-commerce courses. There is a general lack of professional self-confidence and competence [10].

With the popularity of live streaming, the theoretical learning content of live streaming on the Internet is iterating rapidly, from the development history of internet live streaming, introduction of mainstream live streaming e-commerce platforms, to the prerequisites and preparations for live streaming, introduction to live streaming, live streaming review, data analysis, etc. Relying on textbooks alone is far from enough, and some textbooks are outdated when they are written. Live delivery of goods is a new content and method [9]. At present, such construction of relevant teaching materials and the design of practical links have not completely kept up, and the combination of schools and the live broadcast industry is relatively shallow, which is also a common practice of e-commerce teaching in the mobile Internet era [11].

Course ideology and politics can form a collaborative education mechanism with professional course teaching. First of all, due to the limited ideological and political level of teachers themselves, the excavation of ideological and political elements is not deep enough, so that the ideological and political elements of live broadcast e-commerce have not been naturally and properly integrated into the school's classroom education process [12]. The radiation-driven role of construction needs to be exerted. Secondly, in terms of teaching ability, there is a lack of targeted and demonstrative "course ideological and political" teaching guidance for teachers of live e-commerce professional courses, and an effective teaching incentive system cannot be formed. Its influence is limited, and it lacks the attractiveness and appeal of effective teaching. Sometimes, too much attention is paid to the professional teaching of live e-commerce courses, and it is neglected to enhance the education of students' "road confidence", "personality confidence", "professional confidence", and "occupational confidence".

2. Literature Review

2.1. Status Quo of Big Data Analysis Technology Education Research. During the "Thirteenth Five-Year Plan" period, Guizhou Province fully implemented the province's big data strategic action, took the development of big data as a new strategic engine for the overall development of the province, established the big data concept that data is a resource, and promoted big data as a government It is a new means of governance capacity, a new way to serve the society and people's livelihood, a new driving force to lead industrial transformation and upgrading, and a new engine to promote mass entrepreneurship and innovation [13]. More than 20 big data scientific research institutions such as Guiyang Big Data Strategic Key Laboratory and Inspur Laboratory have been built successively. The layout of the big data industry has begun to take shape [14]. With the "Cloud Guizhou" system platform as the carrier, intelligent transportation cloud, food safety cloud, and the 7 cloud projects are the first to be applied, and the construction of "N cloud" such as Beidou location cloud and smart education cloud has achieved initial results, and the field of cloud application has been continuously expanded [15].

Foreign countries started earlier in big data research than in China, and foreign research on big data pays more attention to technology and application research, which to a certain extent benefits from the strong support of the government. For example, the U.S. government has established six departments for big data research, and most of its research projects are researching big data analysis algorithms, big data storage technologies, and big data security technologies [16].

Nagoya University in Japan, Columbia University, or Technology Sydney in Australia have all established data science research institutions; a large number of universities such as the University of Dundee and the Chinese University of Hong Kong have newly established data science institutions, Research Orientation Courses [17].

"A Brief Problem Statement", hoping to use educational big data to analyze students' learning behavior, so as to realize students' adaptive learning and improve the target of learning. At the same time, the U.S. Department of Education has carried out a lot of work on the collection of educational data and has collected a large amount of educational data. Its data portal Data.gov has gathered more than 300 large-scale data related to demographics, academic performance, loan status, campus security, etc. In the data set, the data range is very comprehensive. Data.gov also provides data analysts with different formats of data as well as online data analysis and online data visualization capabilities [18]. At the same time, Data.gov also provides an API interface

to facilitate users to obtain data and facilitate external calls and analysis.

2.2. K-Modes Algorithm. In the ancient traditional taxonomy, the classification problem mainly comes from people's cognition of things. People mainly rely on experience and domain knowledge. The classification of things is mainly in the qualitative sense, and it is difficult to achieve the quantitative sense. However, various industries in various fields have put out problems, and the ancient traditional taxonomy based only on experience and domain knowledge is powerless, so people put mathematics introduced into taxonomy as a tool; a numerical taxonomy with quantitative taxonomic significance was formed [19]. After that, with the further increase of the difficulty of classification problems, people began to gradually introduce the related techniques of multivariate analysis into numerical taxonomy, forming the widely used cluster analysis technology today.

Since there is a certain overlap in their respective characteristics between various clustering analysis algorithms, it is difficult to find a clear classification plan to give a concise classification of clustering analysis methods. Currently, the commonly used classification methods are mainly divided based on the idea of clustering, as follows:

(i) Partitioning Methods: for a data set containing N samples, the event element specifies the number of classification families K ($K < N$), first randomly gives the initial K cluster centers and records according to the same class The closer the distance between different records, the farther the distance between heterogeneous records is. Clustering is performed based on the K centers, and the K cluster centers are relocated and repeated iteratively to continuously improve the clustering effect until the optimal clustering is finally obtained

(ii) Method (Hierarchical Methods): for a given sample data set, the decomposition conditions are continuously decomposed according to the hierarchical nature of the sample data until the termination conditions are met. This method can be further subdivided into "bottom-up" hierarchical method and "top-down" hierarchical method according to different situations of the problem. The basic idea of the hierarchical method: when the method is hierarchically divided, it can be divided according to distance, density, and connectivity, or it can be extended to subspace for hierarchical division. That is, a bottom-up or top-down strategy is selected for a given data set, and iteratively divides by distance or density or connectivity until the decomposition satisfies a given condition

(iii) Ways: this method divides according to the density of data points according to a preset threshold. It will be divided into the same in close clusters

(iv) Grid-based Methods: it adopts such idea of space-driven, also known as fuzzy minimum and the several (finite) cell grids; all processing is carried out on the unit grid as the object. Such processing time has nothing to do with the number of data objects to be processed, and its processing time is only related to the number of unit grids in the quantization space

(v) Methods: the basic idea of this method is to assume a mathematical model for a certain cluster, and find the sample data that matches the mathematical model, so that the sample data and the mathematical model form an optimal fit combine. The usual practice is to determine sometimes based on statistical results. The idea of change is to achieve optimal clustering by optimizing the adaptability between a given data object and a mathematical model. The representative algorithms based on this idea are: PARTICLE FILTERS algorithm, MRKD-TREES algorithm, SOON algorithm, and hybrid algorithm

2.3. Neural Network Algorithm. Since the neural network and mathematical has gone through decades. Although its development has experienced several ups and downs, some researchers with unique insights are still working on neural networks The research of network will undergo the research, laid such solid foundation for the wide application and rapid development of today's neural network in various fields.

Since the simulating of the biological nervous system, after decades of research, the work units have such characteristics of linearity, nonlimitation, very qualitative, nonconvexity, etc. It has the advantages of them.

At present, such simulation of the human brain, the method will lead to the processing problem into several processing units. Through the distributed parallel processing mechanism, the processing of unstructured information and some perceptual information is realized. Compared with the past, there has been a qualitative change, opening up a new space for the application of neural networks in many fields.

The course practice of e-commerce video live broadcast, in addition to the preparatory work and later maintenance, is mainly the live broadcast business. To develop a professional live broadcast business, you need to prepare a lot of professional props, such as sound cards, independent microphones, multitasking and multithreaded computers, cameras, background walls, arranged and designed scenes, etc. Most of these props can be simplified by various methods, such as computers and cameras can be directly replaced by mobile phones, and the background wall can be a solid color and simple wall. However, to achieve smooth live broadcast practice, a fast network environment is inseparable, and this is a hardware support that cannot be replaced by any method. This has also become a major problem for many teachers when implementing tasks in traditional classrooms.

To sum up, they incorporated the live video major into their talent training programs, and have carried out various forms of e-commerce live video education model innovation to varying degrees. However, the innovative education model of most colleges and universities e-commerce video live broadcast is not perfect, which restricts the realization of teaching objectives and the development of students'

comprehensive quality. Colleges and universities need such a complete evaluation system to evaluate the professional education mode of e-commerce video live broadcast to be perfected. Therefore, the analysis evaluates education innovation mode of e-commerce video live broadcast to enhance the innovation for video live broadcast education model in colleges and universities, cultivate more high-quality video broadcast talents, and promote economic development.

3. Methodology

3.1. Application of the Improved K-Modes Algorithm in the Evaluation of Teaching Conditions of College Teachers. As a regular part of higher education, the evaluation of teachers' teaching quality plays a guiding role in promoting the reform of higher education mode and realizing the high-quality development of education. At present, there are some problems in the evaluation of teaching quality of college teachers, such as the separation of evaluation from reality, excessive procedural justice, and so on. It does not reflect the humanistic concept and growth value of teachers' teaching quality evaluation, which leads to problems such as low effectiveness of evaluation results and low validity of evaluation indicators. The current classroom teaching quality evaluation system in colleges and universities in China mainly evaluates students' learning effect and teachers' teaching effect. Based on qualitative analysis and k means clustering analysis, this paper evaluates students' learning effects from a quantitative perspective. And according to the different types of students and the characteristics of the curriculum, improve teaching strategies, select scientific teaching methods, enhance the teaching effect of teachers, and improve the teaching quality of teachers, the classic one of the partition method. Its algorithm implementation is basically the same. From the introduction above, it can be seen that it is a simple and practical clustering method, but it cannot handle data sets containing categorical variables. Therefore, Huang et al. improved the one which can solve the problem of categorical data. The algorithm uses the common SMD (Simple Matching Distance) method to process categorical variables. The mode replaces the mean, the Hamming between the sample data points, and their corresponding cluster centers.

Through the analysis, processing and mining of teaching evaluation data, exploring a scientific, reasonable and effective evaluation strategy has far-reaching significance for the improvement of teachers' teaching ability, the improvement of student training quality, the improvement of teaching management, and the sustainable and healthy development of schools.

The multidimensional classification problem, due to the difference between categorical and numerical data, the degree of difference between the data is difficult to measure by grading. At the same time, for the convenience of expression, without changing its interpretation, this paper makes corresponding transformations for each evaluation value of students' evaluation of teaching, namely, assign each distinct type of data.

$f(x)$ is the transformation function of the evaluation value;

x is the original evaluation value of PJ; $x \in$ (excellent, good, moderate, failed), and $i = 1, 2, 3, 4$.

$$f(x) = \begin{cases} 5, x = \text{excellent}, \\ 4, x = \text{good}, \\ 3, x = \text{medium}, \\ 2, x = \text{pass}, \\ 1, x = \text{failed}. \end{cases} \tag{1}$$

Some abnormal data will inevitably exist. It will remove them from the sample set, which singular data to ensure the validity and authenticity for such evaluation.

To make an objective and fair evaluation when evaluating a course taught by a teacher, but made an evaluation with a strong personal color, which caused their evaluation to be different from other students. There is a large deviation in the evaluation of the students. Therefore, these abnormal data need to be removed from the evaluation data.

The improvement of the calculation formula of cosine distance similarity, directly using the cosine distance method to remove abnormal data for each classification file obtained above will cause the problem that the elimination result does not match the actual situation. Example 1: if there are two sample data x and y, their evaluation values are (1, 1, 1, and 1) and (5, 5, 5, and 5), respectively, and the cosine distance similarity is calculated as follows:

$$\cos(x, y) = \frac{1 \times 5 + 1 \times 5 + 1 \times 5 + 1 \times 5}{\sqrt{1^2 + 1^2 + 1^2 + 1^2} \times \sqrt{5^2 + 5^2 + 5^2 + 5^2}} = 1. \tag{2}$$

From the calculation results of the above formula, it can be seen that x and y are very similar, which is obviously contrary to the actual situation. There is a big problem in directly adopting this method. Therefore, this method needs to be improved. The improvement strategy specifically includes the following three aspects (still take Example 1 as an example):

The improved dissimilarity calculation formula is shown in Formula (3).

$$\begin{aligned} Sim(X, Y) &= \cos(X, Y) \\ &= \frac{\sum_{i=1}^{m} \left((x_i - p_x) \times \left(y_i - p_y \right) \right)}{\sqrt{\sum_{i=1}^{m} (x_i - p_x)^2} \times \sqrt{\sum_{i=1}^{m} \left(y_i - p_y \right)^2}} \\ &= \frac{X - Y}{\|X\| \times \|Y\|}. \end{aligned} \tag{3}$$

Recalculate the cosine distance similarity of the two sample data with the postreplacement evaluation value. The example is shown as follows:

$$\cos(x, y) = \frac{(-1\times 2)+(-1\times 2)+(-1\times 2)+(-1\times 2)}{\sqrt{(-1)^2+(-1)^2+(-1)^2+(-1)^2}\times\sqrt{2^2+2^2+2^2+2^2}} = -1. \tag{4}$$

It can be seen that after the improvement, the cosine distance similarity model has a good consistency with the real situation.

The improved dissimilarity calculation formula is shown in Formula (5).

$$Sim(X, Y) = \cos(X, Y) = \frac{\sum_{i=1}^{m}\left((x_i - p_x)\times\left(y_i - p_y\right)\right)}{\sqrt{0.0001^2}\times\sqrt{\sum_{i=1}^{m}\left(y_i - p_y\right)^2}} = \frac{X - Y}{\|X\|\times\|Y\|}. \tag{5}$$

Solve the problem of who to compare the similarity with. The cosine distance similarity comparison is for the comparison of two multidimensional sample data, so it is necessary to construct a target sample for comparison (hereinafter referred to as the target sample). For the partial center distance, the study takes such sample one corresponding to the average data as the target sample, denoted as T, namely,

$$T = \left(\frac{1}{N}\sum_{i=1}^{N} x_{i1} - p_1, \frac{1}{N}\sum_{i=1}^{N} x_{i2} - p_2, \cdots, \frac{1}{N}\sum_{i=1}^{N} x_{im} - p_m\right). \tag{6}$$

M will be dimensions, xij is the evaluation value of the jth column of the ith sample data, and pj is the average value of the value range of the jth dimension of the sample data.

Abnormal student evaluation results and analysis. Applying the above method, 237,924 student evaluation records in R College's 1,326 classified sample data files were eliminated:

The data is scaled and uniformly mapped to the [0, 1] interval, so that all evaluation data on the same attribute column are standardized to the same equivalent, so that the evaluations are comparable. Its mapping method is as follows:

$$x'_{ij} = \frac{x_{ij} - \min_{i\le j\le m} x_{ij}}{\max_{i\le j\le m} x_{ij} - \min_{i\le j\le m} x_{ij}}. \tag{7}$$

The standardized flow chart is obtained according to Formula (7), as shown in Figure 1.

After eliminating it, based on the teaching evaluation situation for teachers in a certain term of R College, through the discussion on the K-modes algorithm in Chapter 2, it can be seen that each attribute value will be the one, wide range of applications. But the algorithm also has three serious deficiencies when it solves them. The first or the second is the determination of the initial K cluster centers; the third is the measurement and the following is the evaluation of

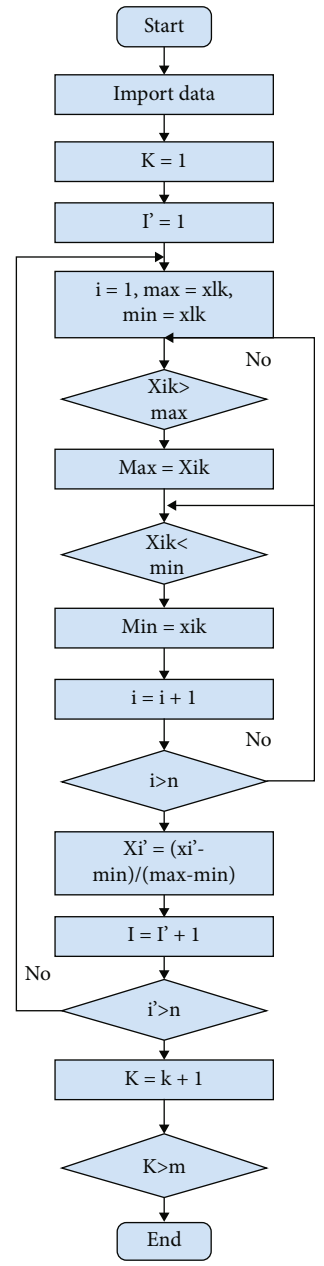

Figure 1: Standardization flow chart of teaching evaluation data files.

teachers' teaching ability by improving one in these three aspects.

It is based on the known clustering number K in advance. In many practical applications, K is not known. Even if K is known, the effect of clustering according to K may be very poor. No valuable information can be mined, and the effect of clustering cannot be achieved. Therefore, there are many software packages currently used to determine K, such as the Mclust package; the user can input the upper limit of the desired clustering family; the system performs a large number of calculations by distance, density, and other methods, and finally determines an optimal clustering. The number of classes, but for some problems cannot be calculated, and the efficiency is very low. Another

example is the Nbclust package. Its idea is similar to the Mclust package. By defining multiple evaluation indicators, various traversals are performed, and finally the cluster with the largest number of indicators supported is selected. Definition of error sum of squares is shown as follow:

$$SSE = \sum_{i=1}^{k} \sum_{x \in L_I} Dist(x, Z_l)^2. \tag{8}$$

The form is as follows:

$$f(x) = \begin{cases} C_1, x_{ij} = 5, \\ C_2, x_{ij} = 4, \\ C_3, x_{ij} = 3, \\ C_4, x_{ij} = 2, \\ C_5, x_{ij} = 1. \end{cases} \tag{9}$$

The frequency calculation formula for calculating the similarity of sample data based on frequency (AVF) is as follows:

$$AVF(x_i) = \frac{1}{m} \sum_{j=1}^{m} f\left(x_{ij}\right). \tag{10}$$

Calculate the value of SSE when each sample data point is the cluster center, and select the one when $l = 1$; in each sample except the data point that has been used as the assumed +1st initial cluster center, the SSE with l + 1 cluster centers is shown as follows:

$$\begin{cases} Z = \{Z_l | Z_l \in X, \text{and } Z_l \text{ and } Z_l, Z_2, \cdots, Z_{l-1} \text{ different}, l \le k\}, \\ Z_l = \max_{x \in X} DXJSSE(x), \\ DXJSSE(x) = \left(\sum_{j=1, x \in L_j}^{l-1} Dist\left(x, x_j\right)^2 + \min_{x \in X} \sum_{i=1}^{n} Dist(x, x_i)^2 \right). \end{cases} \tag{11}$$

The calculation formula of the improved K-modes will in line with definition of the distance metric between two different values of the two sample data under a certain attribute and another attribute given above. The definition of the distance metric between the two sample data is as follows:

$$d(x, y) = \sum_{i=1}^{m} \sum_{j=1, \cdots m, j \ne i} d_{ij}(x_{Ai}, y_{Ai}). \tag{12}$$

3.2. Application Research of Neural Network Model in College Students' Learning Prediction. This paper combs, cleans, transforms, analyzes, and mines the data of students' teaching evaluation in a university. The improved K-Modes clustering algorithm is used to model and analyze the operation of teaching. The evaluation model of teachers' teaching status is established. On the basis of improving the similarity calculation model in three aspects, the improved model is applied to deal with the abnormal teaching evaluation data. The results were normalized by normalization method. As the main channel of personnel training, the positive and negative excitation of neurons > 5859. We take the Kth neuron as an example to design, as shown in Figure 2.

We discussed a general artificial neural network structure, at the same time, we can also construct a neural network with another structure (the structure here refers to the connection of two neurons), that is, a neural network with multiple hidden layers. For example, there is a neural network with nl layers; then, the first layer is the input layer; the nth layer is the output layer, and each layer l in the middle is closely connected with the H + 1 layer. In this configuration, it is easy to calculate the output value of the neural network, we can follow the formula derived earlier, step by step forward propagation, calculate each activation value of the L2 layer cell by cell, and so on, then is the activation value of the L3th layer until the last Lnth layer. This connection graph has no loops or closed loops, so this kind of neural network is called a feed forward network.

The mathematical expression of Figure 2 is as follows:

$$\begin{cases} u_k = \sum_{i=1}^{n} w_{kj} x_{ij}, \\ v_k = u_k + b_k, \\ y_k = \phi(v_k). \end{cases} \tag{13}$$

The input item xij in Formula (13) is the jth feature of the ith training sample. In this problem, $i = 1, 2, 3, \cdots, n$, where $n = 150$, $j = 1, 2, 3, .., d$, and $d = 6$; wkj is the weight of the kth neuron on the jth feature of the sample; uk is the linear combination of each input item and the corresponding weight; bk is the kth neuron. The threshold (vk) of the unit is the excitation function of the kth neuron; yk is the output item of the kth neuron. The topology diagram of the neural network for this problem is shown in Figure 3.

For the feedforward neural network, there are only two types of neurons, one is the output unit, and the other is the computing unit. For the computing unit, it can accept multiple different inputs, but since there is no feedback information, there can only be one output. But this only one output can be coupled to any other unit as input, so the input of other layers except the input house is only related to the previous layer; the input layer and the output layer are connected to the peripheral, and the other layers in the middle both are hidden layers.

4. Result Analysis and Discussio.

4.1. Result Analysis of Improved K-Modes Algorithm. In the collected e-commerce live video course data, there will be outliers in the students' teaching evaluation data. The k-modes algorithm can automatically correct the outliers, estimate the fitting value according to the similar distance, and automatically store the samples into the abnormal value. In the sample data file library, after correction, the abnormal

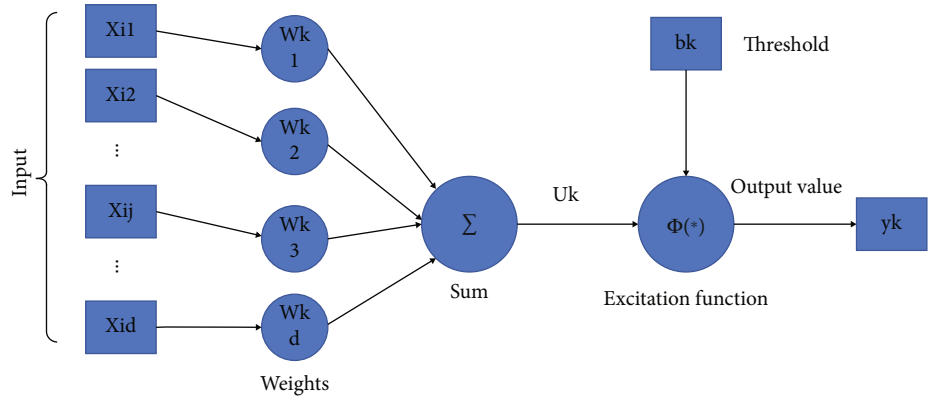

Figure 2: Structure diagram of the kth neuron.

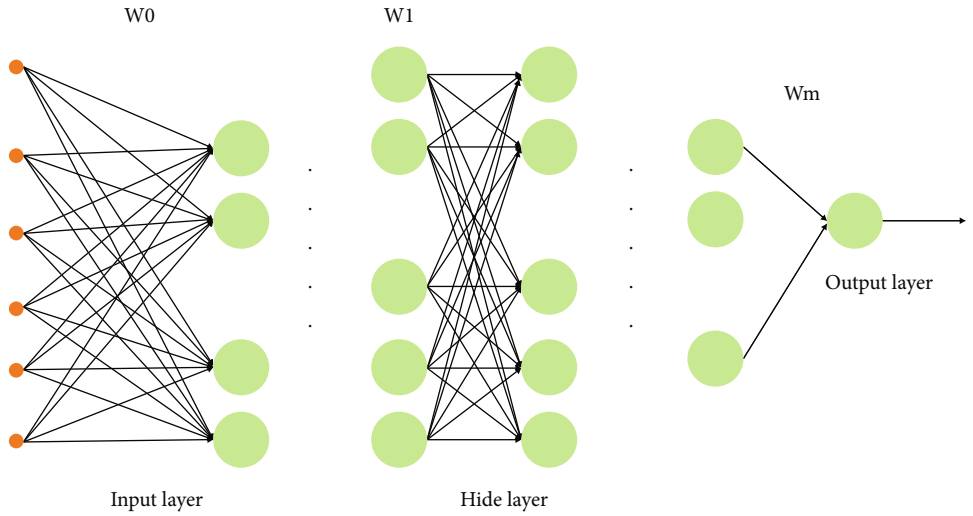

Figure 3: Topological structure diagram of m-layer of neural network.

sample is deleted from the classification file. As shown in Figure 4.

In the cluster analysis, the most important thing will be the one with K-Modes, and obtain the wrong ones in Figure 5. Diagram of the relationship of K.

However, it should be noted that the ones are carried out by the same method as above. The preclustering result found that it was increased when it is doubled; the preclustering results find that the inflection point of the image appears.

After removing outliers and determining the optimal clustering K value, the best fitting evaluation value is obtained, which can be used for comprehensive evaluation of the course teaching in the innovative education model of e-commerce video live broadcast. The effect of the modes algorithm on the clustering of a certain semester of Y school is shown in Figure 6.

It will be in poor clustering effect. Cooccurrence is used as a distance measure to improve the traditional ways. According to the clustering results, ones in the whole school and the teaching situation are analyzed by semester. In this way, it provides a scientific basis for correct decision-making and targeted policy implementation; on the other hand, it enables teachers to understand their own and other teachers' teaching conditions in a timely manner, and take targeted measures to enhance the internal driving force for continuous improvement of teaching.

How the teaching situation can better academic year semester as the time period, the teaching situation of the school has been clustered in three houses, including the teachers of the whole school in the past five years. The analysis is as follows, although it is slightly different in each one, the evaluation results are relatively stable. Figure 7 shows the statistical results of student teaching evaluation in a semester of school Y.

Figure 8 shows the change chart of the cluster center, the distribution of various types of people, the proportion of various types, and the proportion of teachers in the three categories.

The proportion is basically within the range of (43% and 45%); The second category (basically, 2-3 of the 4 indicators are rated as "good", and at least one of them is rated as "moderate"), and the proportion is basically the category (the evaluation of the four indicators is below "moderate"), and the proportion is basically as a whole.

About 55% are rated as "excellent" and "good", and about 45% are rated as "moderate" and below. Although

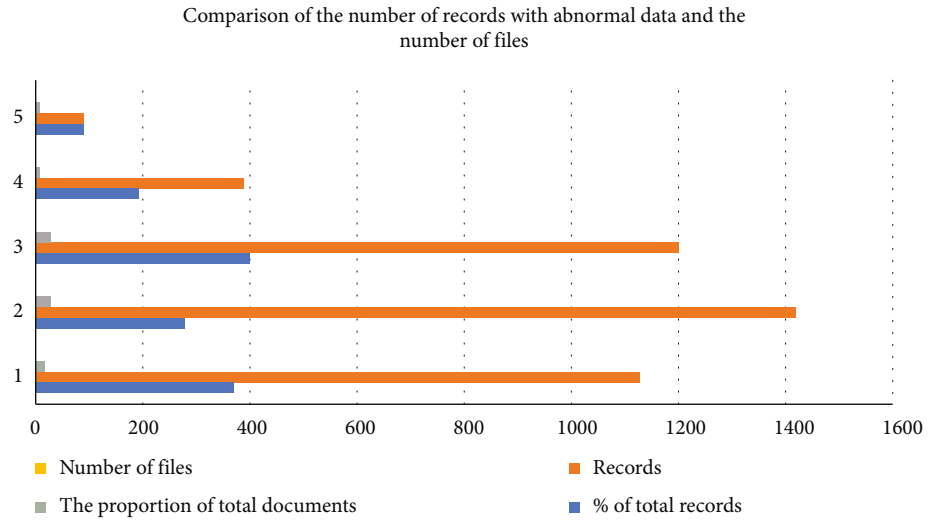

Figure 4: Comparison of the number of records containing abnormal data, the number of files, and the number of records.

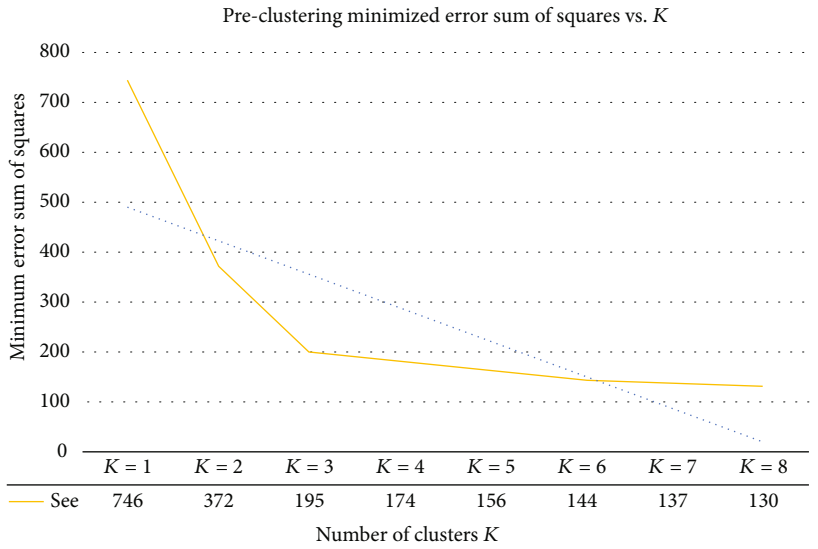

Figure 5: Minimum squared error, the relationship between the sum and the number of clusters K.

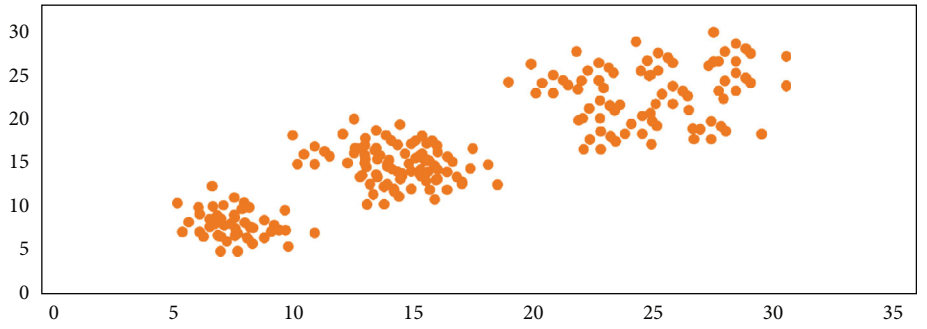

Figure 6: Clustering results of teachers' teaching status after removing outliers in a semester in Y school.

there have been slight fluctuations in each semester in the past five years, the first category and the second category show a downward trend from semester to semester, while the third category shows an obvious upward trend from semester to semester, which indicates that the overall teaching situation of the whole school presents a clear downward trend, and the teaching management department should do it.

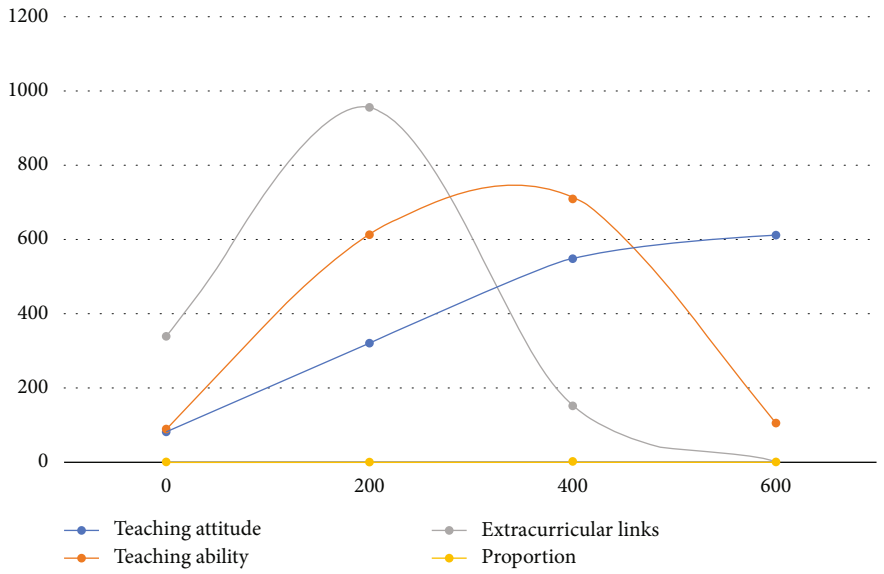

Figure 7: Statistical table of students' teaching evaluation in a certain semester of Y school.

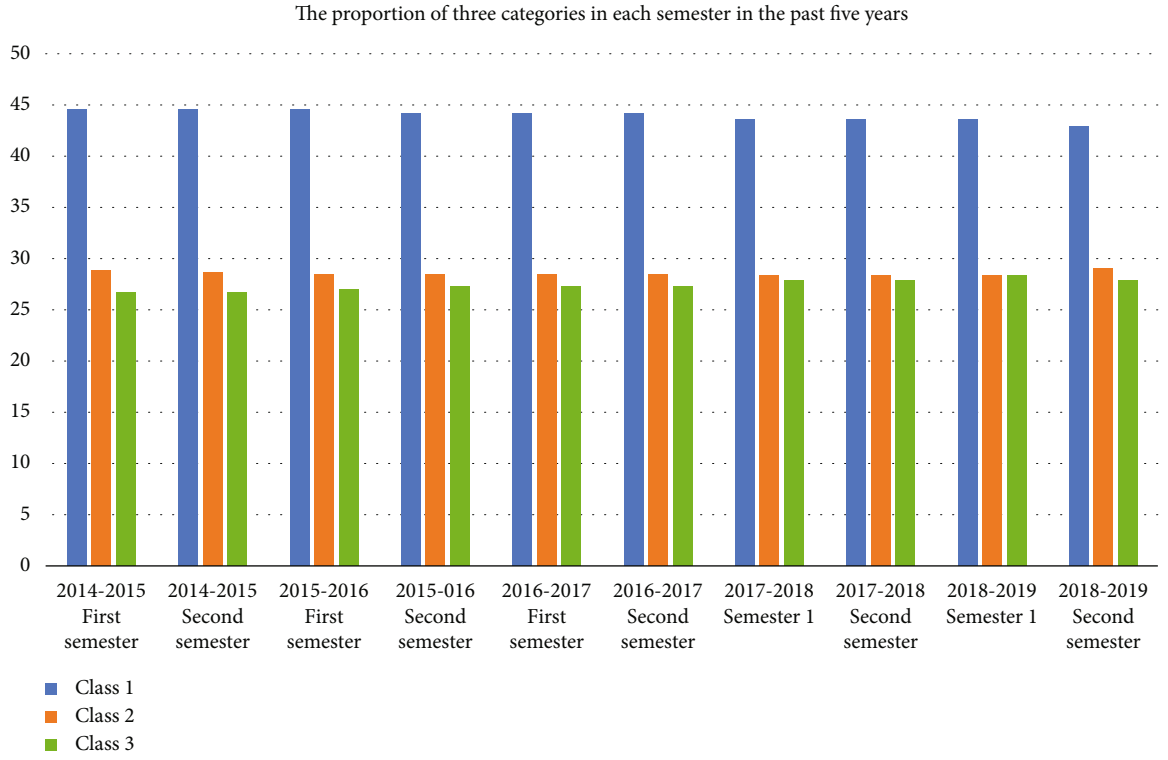

Figure 8: Histogram of the proportion of teachers in three categories in each semester of Y school in the past five years.

In the evaluation of the "extracurricular link" evaluation indicators, less than 0.7% were rated as "excellent", less than 10% were rated as "good", and less than 10% rated as "average" The ratio is about 64%; about 20% is rated as "pass", and about 5% is rated as "fail". It can be seen that students' evaluation of this indicator is the lowest. It also reflects that students are very dissatisfied with this part. The problem may be in two aspects, one is that students have higher requirements for teachers to participate in extracurricular guidance; the other is that there is a problem in the management of this teaching link; therefore, the teaching management department urgently needs to make great efforts in this link.

With the increase of the number of users, the difference between users is gradually expanding. In this paper, we select the classical user behavior impact indicators, and then use k-means analysis method to cluster the existing historical data. Applying K-means clustering analysis one by one, on the

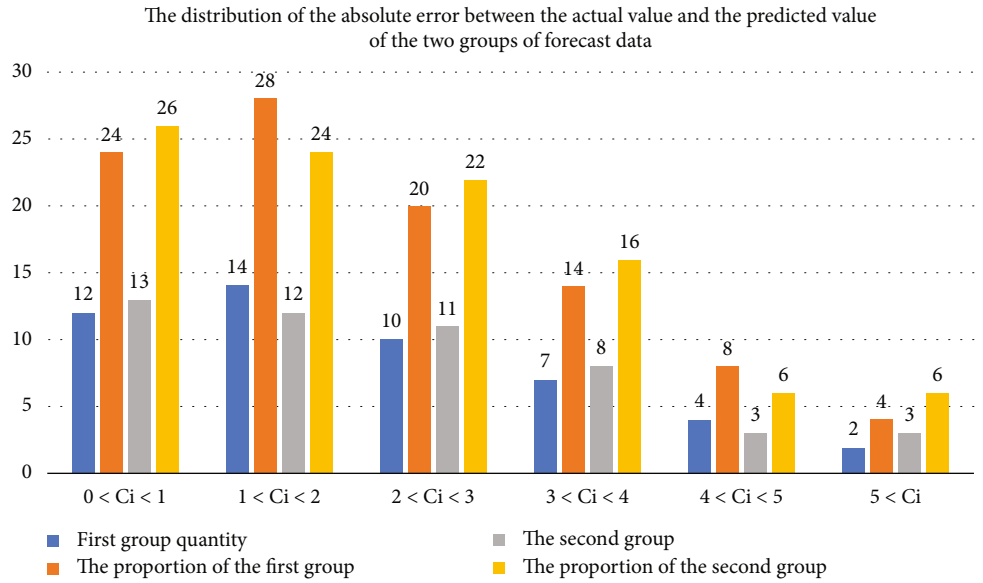

Figure 9: Distribution of the absolute error between the actual value and the predicted value of the two groups of forecast data.

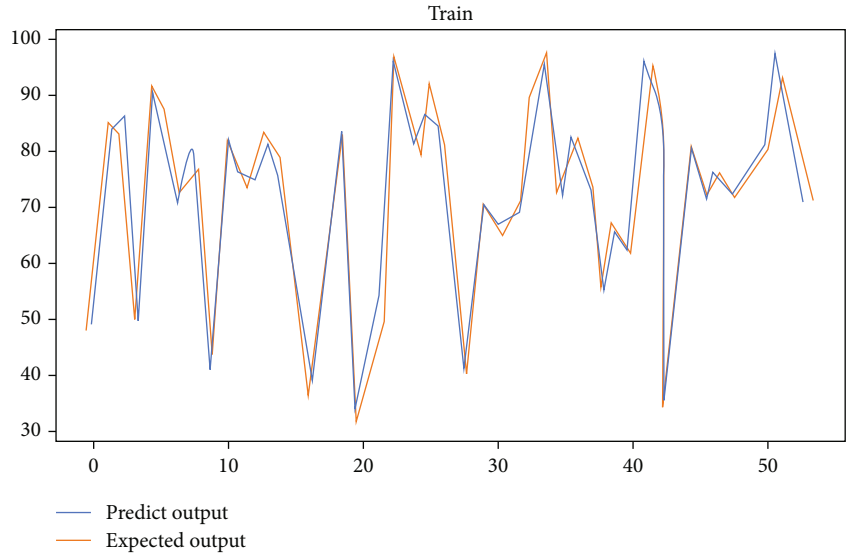

Figure 10: Comparison of training results with the ground truth.

one hand, we can identify singular points in the data, but in fact, we attach great importance to users. On the other hand, it makes the degree of user classification controllable and the level of user classification clear. The attributes and behaviors of users of the same kind are relatively consistent. It is convenient for enterprises to reasonably classify users, so as to provide accurate services for users, so as to achieve a win-win situation for enterprises and users.

4.2. Application Research of Neural Network Model in College Students' Learning Prediction. Classroom teaching is the main channel for talent training for the quality of talent training. E-commerce live video courses are a new education model. In this section, I will discuss the behaviors of donkey students during online learning through this model. Data, using neural network model to predict the learning effect, so as to provide support for students to adjust their learning behavior in a timely manner and teachers to provide targeted teaching.

Based on the above neural network model, by training 150 training samples for 15,000 times, the output of the training result is shown in Figure 9. The training output value basically coincides with the real image, indicating that the model is effective. Figure 10 shows the comparison between the training results and the ground situation.

It can be seen that the average error is within 1.73; about two-thirds of the output value is smaller than the actual value and about one-third of the output value.

For the students' course learning, this section analyzes the model's response to the training data "same class with the same teacher" and "different class with different teachers" in two groups of 50 students each. Based on the

prediction of learning effect, the comparison of the prediction data with the model established by traditional regression analysis further shows that the model is more powerful in predicting the learning effect of students. Its histogram is shown in Figure 9.

5. Conclusion

This paper studies the evaluation method of e-commerce video live innovation education mode and draws the following conclusions: according to the k-mode clustering results, for the whole school, the overall teaching situation of unit teachers can provide policy implementation. Teachers can timely learn about their own and other teachers' teaching conditions and classroom teaching for talent training. Based on the behavior data generated for students, the neural network model predicts the online learning effect of students, and provides targeted basis for adjusting their learning behavior and teachers. Today, with the rapid development of online education, online learning is an indispensable part of talent training in the new era, especially for the training of various professionals in the new engineering field. Guide teaching by improving the construction of the evaluation system and formulate corresponding teaching strategies according to the reality of each student. Truly create a diversified, multilevel and multiangle teaching evaluation model based on big data. Truly let the teaching evaluation objectively show the actual situation of students, and really let the teaching evaluation promotes the all-round development of students.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Intelligent Image Analysis and Recognition Method for Art Design Majors

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Art design major is a relatively important course in college teaching. It involves a wide range of directions. Advertising art, landscape art, interior design, etc. are closely related to people's lives. Art design has appeared in all aspects of people's lives. However, a new art design program is time-consuming and human resources for art design. Different art designs will contain relatively similar characteristics, which can alleviate many difficulties for art designers. However, it is also a relatively difficult task to discover the relationship between the characteristics of the art and design only by artificial means. Image recognition technology can assist designers to discover and find the relationship between artworks, and these related features can assist designers to design. In this study, an intelligent image recognition method for intelligent art design is designed using the VB-CNN-GRU method. It can identify patterns, shapes, color matching, and text features of artistic design products. The research results show that the VB-CNN-GRU method can accurately complete the intelligent image recognition task of art design major. The VB-CNN-GRU method has specifically higher accuracy in art design image recognition than the single VB-CNN method. The maximum prediction error of VB-CNN-GRU in art design image recognition is only 2.37%. For the four characteristics of art design, it can better assist designers to complete related designs.

1. Introduction

Art design is a relatively broad profession, and its scope is also relatively wide. It mainly includes advertising design, interior design, clothing design, and product modeling design. With the improvement of people's living standards and the improvement of people's aesthetic ability, people's pursuit of products does not only focus on the quality of the products themselves [1, 2]. An excellent advertising design or product design is often an important factor for people to choose products. In today's society, it can be found that art- and design-related products have spread all aspects of life. For advertising design, designers often need to use the patterns, colors, and words contained in advertising products to attract consumers' attention. In this materially abundant society, people have a lot of choices for the necessities of life. People are often attracted to advertising art design, which reflects the importance of advertising art design. The success of advertising art is that it can immediately attract people's attention, which puts forward more requirements for advertising designers. Advertising design needs to meet the preferences of most people for aesthetic ability [3, 4]. For the art of landscape gardens, more and more local governments and developers focus on the artistic design of landscape gardens. The layout, shape, and color matching of landscape gardens are important factors that affect people's pursuit and preferences. Interior design is also the research object that art design majors have more contact with, and interior design is also an art design that people need to contact every moment. The interior is not only a place for people to rest and live but also a place to reflect aesthetics. Effective interior design can keep people happy, which can make people more actively pursue the beauty of life and the feeling brought by art design. From the above analysis, it can be seen that the scope of art design is relatively wide, and it also involves people's daily life. This further illustrates the importance of art and design majors for social development. The factors of artistic design are mainly reflected in the pattern, shape, color, and character characteristics of the artwork. However, the process of artistic design is

relatively long and complicated, which brings a great challenge to the designer. Similarly, there are many common features between art and design. If designers can find commonalities between art and design, they can then be improved and enhanced by using relevant art design templates [5, 6]. This art design method will not only improve the efficiency of design but also be more targeted for art design products [7, 8].

Since there are many commonalities in the artistic design of different objects, it is necessary to find many commonalities in the artistic design. The traditional way of artificial appreciation is that it is difficult to find the common relationship between artistic design and products. This is the factor art appreciation is a perceptual thing, and different people have different appreciation abilities. However, if the relationship between artistic design elements and products is processed into data, it is possible to quantitatively analyze the correlation between artistic design features and products from a data perspective [9, 10]. Image recognition is an important method to identify products. Image recognition technology has also been demonstrated in many areas of life, such as transportation, education, and medical care. The principle of the image recognition method is to process the color and pattern of the research object into data, which can use the intelligent algorithm to find the relationship between the relevant features of the image [11, 12]. For art design majors, it can also use image recognition technology to identify patterns, colors, and other characteristics of artworks. After the relevant features of these artworks are converted into data, intelligent image recognition methods can find the relationship between the artistic design elements and the product. This also provides more reference for the designer's artistic design. At the same time, the image recognition technology of art design needs to use big data technology to identify and predict the characteristics of artworks.

At the current stage, intelligent image recognition methods are relatively mature. For different research objects, it needs to be continuously adjusted according to the data characteristics and data forms of the research objects, which is a convenient way [13, 14]. The most common applications of intelligent image recognition algorithms are convolutional neural networks (CNN) and variants of CNN. With the advancement of computer performance and the needs of researchers for algorithms, the speed of CNN variants update is relatively fast, which provides more convenience for the application of different research objects [15, 16]. CNN is also a kind of big data technology, and its commonality with big data technology is to deal with cumbersome data and complex relationships between data. The speed and ability of humans to process data is often limited. The emergence of big data has changed people's life and production activities. In actual work and life, the data characteristics of most research objects often contain temporal characteristics at the same time, and big data methods also contain methods for dealing with temporal characteristics. Most researchers will use the long short-term memory (LSTM) algorithm to process the temporal characteristics of the data, which has the ability to memorize the data. It can also fuse data at different times according to the contribution of the data to the feature. There are also many variants of the LSTM method, which are also based on the needs of researchers for feature extraction capabilities or computing time. In a word, the emergence of big data technology has provided more convenience for the research of art design [17, 18]. Researchers only need to adjust the relevant layers and related structures of big data algorithms, and it no longer needs to deal with complex underlying codes. Continuing advances in computer performance have also dispelled researchers' concerns about the amount of data.

This research discusses and designs an image intelligence recognition and analysis method related to art and design, which mainly applies variational Bayesian convolutional neural network and GRU method. At the same time, it analyzes the four characteristics of pattern, color, shape, and text of art design related majors. This study will introduce image recognition methods for art and design professionals from 5 different chapters. Section 1 mainly studies the importance of the art and design profession and the background of intelligent algorithms for image recognition. Section 2 describes the current research status of art design related elements and research objects. Section 3 studies the process and working principle of the intelligent image recognition method applied in the art and design profession. Section 4, as the focus of this study, analyzes the accuracy of the VB-CNN as well as the VB-CNN-GRU method in predicting four characteristics of artistic design. Section 5 illustrates the practical application value of image intelligence algorithms for art and design professionals.

2. Related Work

Art design will involve advertising design, product design, and landscape garden design and other fields, and it has been involved in many aspects of people's daily life and production activities. Art design will have a certain impact on people's appreciation level and purchasing ability. The characteristic elements involved in artistic design are also more complex. Many researchers have presented research and discussion on the related theory of art and design and the application of art and design. Wang and Zhu [19] mainly studies the relationship between art design management and enterprise management. The scope of art design is relatively broad. It applies wireless communication technology and Internet technology to the research of enterprise management and art design. This research aims to realize an intelligent art design system using wireless communication technology and internet method. The research results show that the creative ability of art design based on this Internet management model has been greatly improved. Compared with the traditional management mode of art design, the management ability has increased by 10.61%. This method can better guide the artistic design of enterprise management and the artistic design of products. Yang [20] analyzes and studies the teaching system of art design, which is why the traditional education system of art design has relatively big defects, which is a method that lags behind high-tech technology. It uses the method of 3D virtual simulation to establish an online art teaching management system. At

the same time, it uses support vector machine and simulated annealing algorithm to design an efficient art design teaching system. The research results show that this system has relatively high accuracy and relatively low error. At the same time, this intelligent art design system also has specific practical application value in engineering. For the actual online teaching of art design, this intelligent system is also worth promoting. Dong [21] already believes that the advancement of high technology is conducive to improving the progress in the field of art and design. It has also found that sensor systems can assist art designers in efficient art product design. In this study, an art design system is designed, which can integrate various sensor systems, signal acquisition and processing systems, and extraction functions of art design features. It verifies this art design method is based on artificial intelligence method using the actual data value of parent-child restaurant. The research results show that the multisensor system can accurately and quickly acquire and process the relevant features and patterns of artworks. This intelligent art design system can improve the work efficiency of designers, and it can also assist designers to design more valuable artworks. Dong [21] realizes that virtual reality technology has been widely used in many fields, and it has also achieved great success in different research objects. It considers the application of virtual reality technology in art design and the teaching work of art design majors in colleges and universities. It takes the bamboo forest as the research object to carry out the simulation modeling of this characteristic and realizes the virtual reality technology of the bamboo forest. In this system, lighting and scene rendering can assist the artistic design of the bamboo forest. The research results show that this kind of art design technology based on virtual reality can not only improve the realism of artworks but also play a great role in art teaching in colleges and universities. Feng [22] mainly studies animation art in the field of art design. It uses new technology and new media technology to study the animation theory, dimension, and cognitive experience of animation in the process of animation art. And it uses the edge computing method to study the design theory and related properties of animation art. This research method can improve the management and sharing techniques of animation art design. This research mainly uses the deep neural network method to extract four characteristics such as patterns of art design majors. This is an intelligent method, which can provide designers with a relatively fast and accurate reference.

3. Image Recognition and Analysis Scheme and Research Principles for Art Design Majors

3.1. The Importance of Big Data Technology for Image Recognition in Art Design. The research goal of this research is to realize the recognition and analysis of images related to art design using intelligent algorithms. Art and design majors occupy an important position in today's life and production. This study mainly analyzes the four characteristics of pattern, color, shape, and text involved in the process of artistic design. Patterns and colors are relatively intuitive features. The four characteristics of pattern, color, text, and model selected in this study are the four most important characteristics in the art design profession; and they are more important for the design of art design works. For artistic design, text and modeling features can reflect the artistic value and emotional information reflected by the artwork. For works of art, it reflects more artistic value and people's appreciation for works of art. However, the patterns and combinations of colors and shapes of artworks are ever-changing, which leads to the specific and nonfixed characteristics of artworks. This research will use the method of image recognition to study and appreciate the four characteristics of artworks. Image recognition is a kind of intelligent engineering that is common in modern life. It can use data to identify relevant features. Most image recognition tasks rely on algorithms in the field of artificial intelligence. Big data technology can convert the image of artwork into data form, and it can use the form of distance and correlation to identify relevant artwork features. It is difficult to discover the artistic value and related characteristics of artwork images by relying solely on artificial vision. Big data technology can find relevant features very well. Therefore, big data technology is a crucial algorithm for image recognition and analysis of artworks, and it can also quantitatively analyze the image features of artworks, which is a way that cannot be achieved by manual means.

3.2. Application and Design of Big Data Technology in the Field of Art Design Image Recognition. Through the above analysis, this research needs to use big data technology to realize the image feature recognition of artworks. This research analyzes and recognizes four related characteristics of pattern, shape, color, and text of artistic design. Since it is difficult to collect artwork related images in real life, this study chooses a variational Bayesian convolutional neural network algorithm to identify these four characteristics of art design. CNN is an algorithm widely used in the field of image recognition, and the VB-CNN algorithm is mainly used in the research object of small data sets. At the same time, the text and modeling characteristics of artworks have a great relationship with the changes of time. This is because artworks also have an inevitable connection with the political economy of the times, and they also have many temporal characteristics. This study also considers art designing temporal features for image recognition. Figure 1 analyzes and illustrates the flow and scheme of the application of big data theory in art design theory. The scope of artistic design is relatively wide. This study selects the design of automobiles and furniture as examples, which are two common works of art in reality. In this intelligent recognition scheme, it needs to collect four characteristics of artwork, pattern, shape, text, and color as the basis of neural network algorithm. The related data of these four features are processed and input to the input layer of VB-CNN for convolution operation. Then, when the data is feature extracted, it needs to be input into the GRU neural network for temporal feature extraction. Finally, it will send the relevant results to the art researcher in the form of a computer or mobile phone APP.

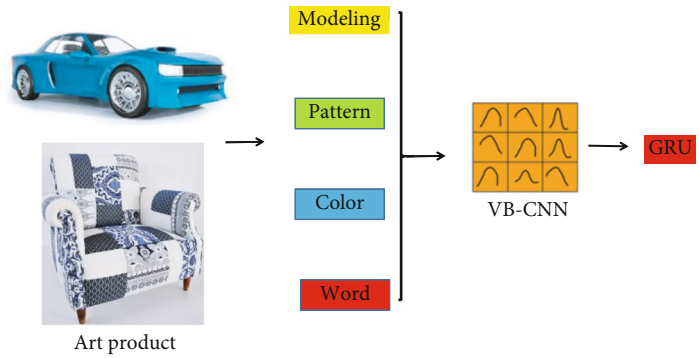

Figure 1: Design scheme of VB-CNN and GRU method in the field of artwork image recognition.

3.3. Principle and Introduction of VB-CNN Algorithm and GRU Algorithm. The biggest difference between VB-CNN and CNN methods is that the weights and biases of VB-CNN are different. The VB-CNN method can fully consider the influence of historical information of artwork features, which is the so-called prior knowledge, which can improve the prediction accuracy of the research object. Considering the difficulty of collecting artwork image recognition datasets, this means that artwork image features will exist in smaller datasets, and the VB-CNN method can exert its own advantages in small datasets. Figure 2 shows the distribution of weights and biases for the differences between VB-CNN and CNN methods. The weights of the VB-CNN method exist in the form of a probability distribution, which will be processed using approximation and variational methods. The VB-CNN method is more favorable for processing small datasets compared to the CNN method.

Through the above research and analysis, it can be found that the changes in the characters and patterns of artworks are also closely related to the changes of the times, and the patterns and styles of words are related to contemporary economic and political factors. This shows that artwork image recognition and analysis also take into account the temporal characteristics of features. Both GRU and LSTM methods are better algorithms for dealing with temporal features. However, the GRU method has a relatively small number of parameters when calculating the parameters. The LSTM method is different from the CNN method. There is no weight sharing mechanism in the LSTM algorithm. Therefore, this study considers the application of the GRU method. Figure 3 shows a schematic diagram of the division of the four features of the artwork image, which will be divided according to the distance relationship between the data.

3.4. The Derivation Process of Variational Bayesian Method and the Description of GRU. There is a big difference in principle between the VB-CNN method and the CNN method. There is also a gap between the VB-CNN and the CNN method in the content of the convolution operation. The derivation process of the VB-CNN method is described below.

There is a differential pressure between convolution operations and fully connected neural networks and LSTM methods. The convolution operation will involve parameters such as filters and sliding steps, and these parameters will also satisfy certain mathematical relationships. Equation (1) shows the relation satisfied by the convolution parameters.

$$w' = \frac{(w + 2p - k)}{s} + 1. \tag{1}$$

Variational Bayesian convolutional neural networks also involve more convolution operations. Equation (2) shows the guidelines for the convolution operation. VB-CNN also contains network layers such as convolutional layers and pooling layers.

$$\delta^{l-1} = \text{conv2}\left(\text{rot180}\left(W^l\right), \delta^l, 'full'\right)\phi'\left(v^{l-1}\right). \tag{2}$$

For the characteristics of pictures, Chinese characters, and shapes in the recognition of artistic design patterns, this research will convert them into the form of data. Since VB-CNN requires input as well as label data, Equation (3) and (4) show the representations of relevant features for artistic design image recognition.

$$x = \{x_1, x_2, x_3, \cdots \cdots x_N\}, \tag{3}$$

$$y = \{y_1, y_2, y_3, \cdots \cdots y_N\}. \tag{4}$$

VB-CNN is a kind of convolutional neural network that calculates after the basis of prior knowledge, and Equation (5) shows the correlation between prior knowledge and posterior knowledge of VB-CNN.

$$P(y^*|x^*, X, Y) = \int p(y^*|f^*)p(f^*|x*, X, Y)df^*. \tag{5}$$

Since the integral operation of Equation (5) has certain difficulties, it requires certain approximation and variational operations for the computational performance of the computer. Equation (6) shows the procedure for

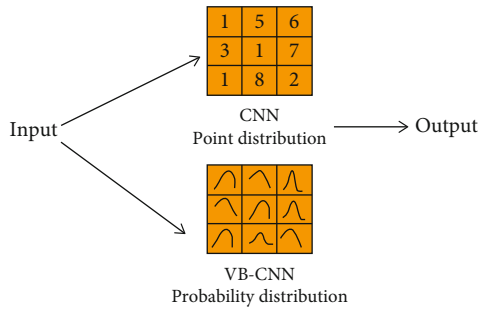

Figure 2: Schematic diagram of the difference in weight distribution between VB-CNN and CNN.

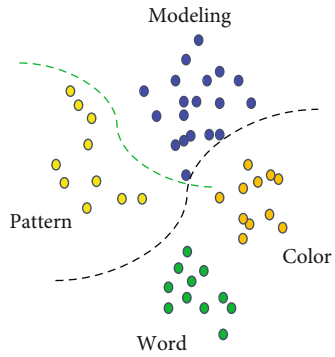

Figure 3: Schematic diagram of artwork data division.

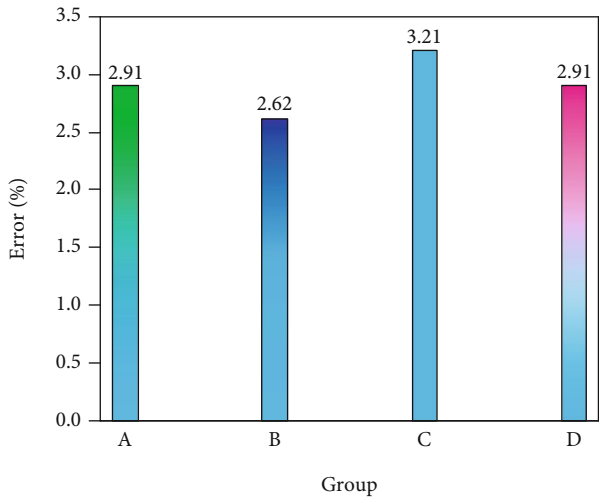

Figure 4: Four feature prediction errors for art design image recognition using a single VB-CNN approach.

approximate computation of variational Bayes.

$$P(y^*|x^*, X, Y) = \int p(y^*|f^*)p(f^*|x*, \omega)p(\omega|X, Y)df^*d\omega. \tag{6}$$

Equation (7) shows the calculation of the KL divergence introduced by the variational Bayesian method, which is also an approximate calculation criterion for a posteriori knowledge.

$$\ell_V = \int q(\omega)p(F|X, \omega)\log p(Y|F)dFd\omega - KL(q(\omega)\|p(\omega). \tag{7}$$

Equation (8) shows a variational and approximation form of the VB-CNN method, which facilitates the calculation of the distribution and parameters of prior knowledge and posterior knowledge.

$$L \approx \frac{1}{2\sigma(f)^2}\left\|y' - \hat{y}'\right\|^2 + \frac{1}{2}\log\sigma(f)^2 + \frac{1}{2D}\sum_{i=1}^{D}\left(p_d\|M_d\|_2^2 + \|b\|_2^2\right). \tag{8}$$

GRU is a variant of LSTM method, which also mainly consists of different gate structures. Equations (9) and (10) show a calculation method of the GRU's update gate, which needs to update the historical state information and the current state information.

$$g_r = \sigma(W_r[h_{t-1}, x_t] + b_r), \tag{9}$$

$$\tilde{h}_t = \tanh\left(W_h[g_r h_{t-1}, x_t] + b_h\right). \tag{10}$$

Equations (11) and (12) illustrate the calculation criteria for the reset gate of the GRU.

$$g_z = \sigma(W_z[h_{t-1}, x_t] + b_z), \tag{11}$$

$$h_t = (1 - g_z)h_{t-1} + g_z\tilde{h}_t. \tag{12}$$

4. Result Analysis and Discussion

Art design is closely related to people's life and production. People's pursuit of products is also constantly pursuing products with beautiful artistic design. The goal of this research is to use big data technology to complete the task of intelligent image recognition and analysis of features related to art design. It mainly adopts the VB-CNN-GRU method in big data technology according to the data characteristics of artistic design. Combining the actual characteristics of art design, this study selects four characteristics of art design: pattern, color, shape, and text as the characteristic objects of this study. The driving force of big data technology learning is a huge amount of data. Only if enough data is provided to big data theory, it can learn the correlation between artistic features. The selection of the data set comes from the data of multiple artistic features in Yiwu Mall, Zhejiang Province. The selection of the dataset needs to include as many artistic features as possible, so as to ensure that the distribution of weights and biases conforms to the characteristics of most artistic products. Therefore, it needs to fully consider the source of the dataset. It performs preprocessing and data cleaning process on the collected data sets of different artworks, and these data will be further processed into

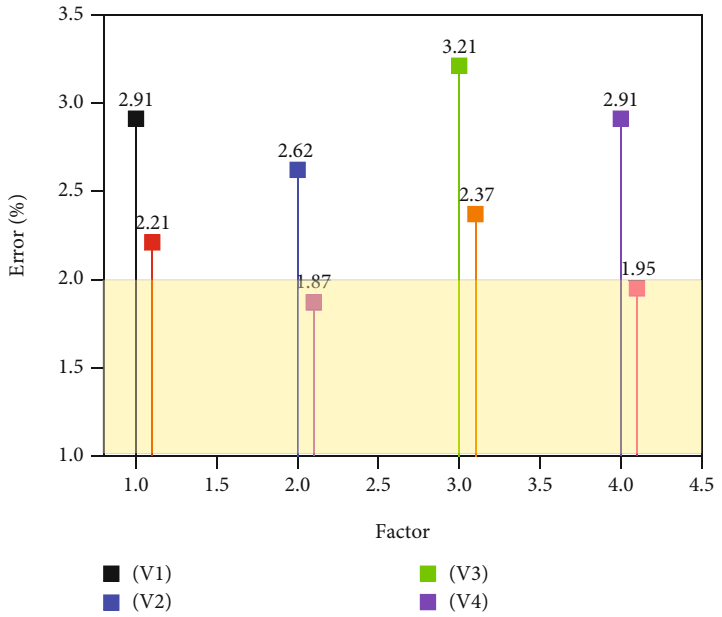

Figure 5: Four feature prediction errors for art design image recognition using VB-CNN-GRU method.

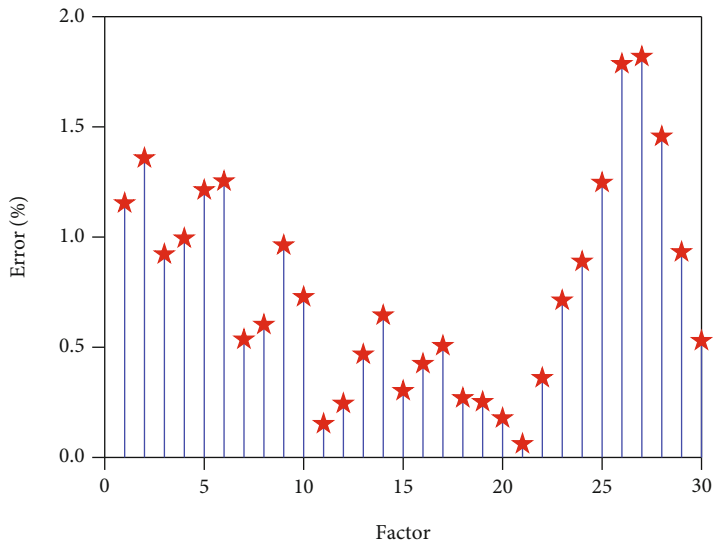

Figure 6: Prediction error distribution of modeling features for art design image recognition.

data of the same distribution and the same interval, which is beneficial to the training of the VB-CNN-GRU method.

In order to analyze the characteristics of products related to art design, this study first uses a single VB-CNN method to analyze the accuracy of the application of big data technology in the field of image recognition of art design products. This method of analysis is also to illustrate that the four characteristics in art design are also closely related to time. Figure 4 illustrates the prediction error distributions for four features of artistic design images using a single VB-CNN method. In general, most engineering studies consider 5% as an acceptable margin of error. If the error exceeds 5%, it means that the model cannot meet the requirements of art and design majors. Although the VB-CNN method has relatively high accuracy on small datasets, it also cannot extract the temporal features of the research objects. This also results in lower prediction errors if the study subjects have high temporal correlations. It can be seen from Figure 4 that the VB-CNN method has certain feasibility in predicting the four image features of art design, and it can meet the image recognition task in the field of art design. However, it can also be seen from Figure 4 that the values of the four features related to art design are also maintained at a relatively high level, which is unfavorable for the recognition of actual art design images.

In order to further compare the accuracy of the VB-CNN method and the VB-CNN-GRU method in the field of art design image recognition, this study also analyzes the

prediction errors of the GRU method in predicting four characteristics of art design images. Figure 5 shows the prediction error distributions for four features of artistic design images using the VB-CNN-GRU method. From Figure 5, it can be intuitively seen that the prediction errors of the four features of art design image recognition have been significantly reduced after using the GRU method. This can illustrate two points. There is a strong temporal correlation between the words, patterns, and colors of artistic designs. GRU method can improve the accuracy of art design image recognition. For practical engineering applications, the VB-CNN-GRU method is more conducive to completing the image recognition task of art and design majors. The prediction error of text features is reduced from 3.21% to 2.37%. The prediction error of pattern features is also reduced from 2.91% to 2.21%. The prediction errors of the four kinds of artistic design image recognition have been reduced to different degrees.

Through the above analysis, it can be found that VB-CNN-GRU is more suitable for the prediction and extraction tasks of art design image recognition-related features. In the following research and analysis, this study selected the VB-CNN-GRU method to analyze the relative accuracy and reliability. During the VB-CNN-GRU training process, the four features of artistic design are trained and tested separately. In this study, 30 sets of different art design-related data were selected to analyze the accuracy separately. Figure 6 shows the prediction error of the VB-CNN-GRU method in predicting the modeling features for artistic design image recognition. There is a large fluctuation in the error distribution of the model features, which indicates that the 30 sets of test sets are widely sourced and contain different types of artwork, which leads to relatively large fluctuations for the model features. From Figure 6, it can be seen that most of the prediction errors of modeling features are distributed within 1.5%, which can fully illustrate the reliability of the VB-CNN-GRU method in predicting the modeling features of artistic design. For the actual art design field, this margin of error is also acceptable. Only a small part of the error will be between 1.5% and 2%. There are also a small number of modeling features whose prediction error is less than 1%. Overall, the modeling features of artistic designs can be identified and analyzed by the intelligent algorithms provided in this study.

For the four characteristics of artistic design, the pattern characteristic is a relatively intuitive one. When people choose art products, they pay more attention to the patterns and color matching of artworks. Therefore, the prediction and recognition of the pattern features of artistic design is a more important task for the image recognition task of artistic design. Figure 7 illustrates the linear correlation coefficients of the predicted values of the pattern features of the artistic design. To more accurately illustrate the performance of the method proposed in this study, it uses the blue curve to illustrate the distribution of data points. The blue line represents the distribution of 95% confidence intervals for pattern features. The pattern feature distribution of the art design major is on both sides of the linear function, indicating that the predicted value of the pattern feature has a point

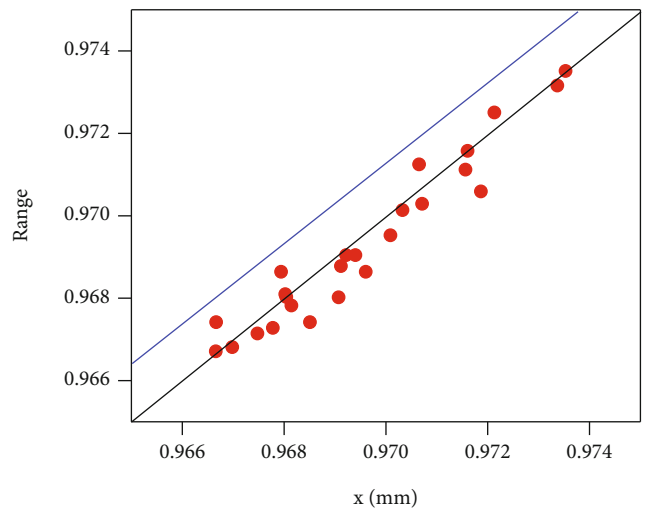

Figure 7: Linear correlation coefficients of predicted values of pattern features for artistic design image recognition.

larger than the actual value, and it also has a point smaller than the actual value data. If the predicted value of the pattern feature of the artistic design is in good agreement with the actual value, the data points will be distributed on both sides of the $y - x$ linear function, and the closer the data point is to the $y - x$ function, it will indicate the pattern feature of the artistic feature. It is better captured by the VB-CNN-GRU method. It can also be seen from Figure 7 that the 30 data points of the pattern feature of artistic design are well distributed on both sides of the $y - x$ function, which meets the requirements of the linear correlation coefficient. The linear correlation coefficient of the pattern features of artistic design even reached 0.98, which is enough to illustrate the practicability of the VB-CNN-GRU method in the recognition and analysis of pattern features of artistic design.

Text features are an expression of recording artistic design products. Art products of different periods will contain different forms of written expressions. Text is also a relatively easy-to-understand art compared to patterns, colors, and shapes. However, the text features of artistic design will contain relatively strong temporal correlation. Figure 8 is the analysis and explanation of the distribution curves of the predicted and actual values of the text features of artistic design. In Figure 8, the area in the middle of the two curves represents the prediction error of the text features of the art design profession, which can reflect the effectiveness of the VB-CNN-GRU method. If the area of this part is relatively small, this means that the accuracy of this method is relatively high. In general, the predicted value of the text features of artistic design is in good agreement with the trend of the actual value, although there are more peaks and valleys for the text features of artistic design for 30 different sets of data. The reason for the relatively large fluctuations in the text features of art design majors may be that these text features are derived from the feature data of different artworks, which is to verify the generalization ability of the VB-CNN-GRU method. The predicted value of the character feature of

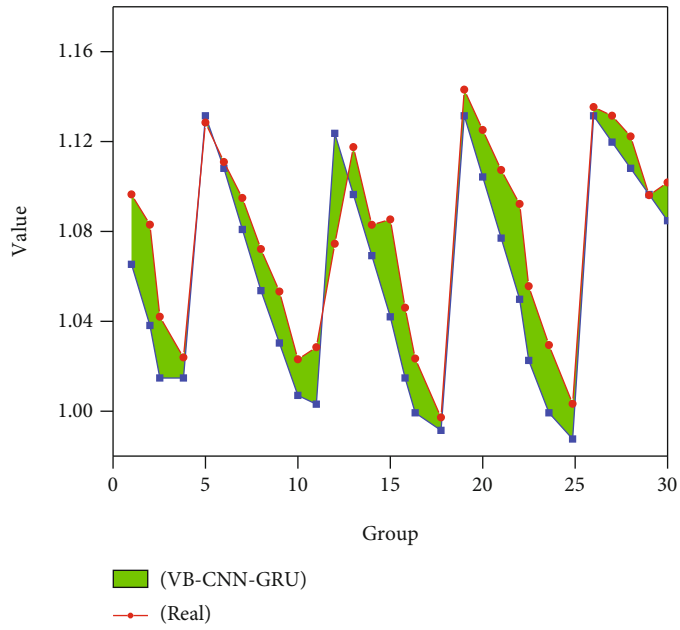

Figure 8: Distribution of predicted and actual values of text features for art design image recognition.

artistic design is also in good agreement with the actual value. This shows that the VB-CNN-GRU method predicts and recognizes the temporal correlation and nonlinear relationship of text features very well. For the recognition and analysis of the actual art design text features, the VB-CNN-GRU method also has enough information to complete the image recognition task of art design.

5. Conclusions

The field of art design is relatively wide, which probably includes many life-related fields such as advertising design, landscape garden design, and interior design. With the improvement of people's living standards and the improvement of aesthetic ability, when people buy products, they often take the product's artistic design characteristics as an important criterion. It can be seen that art design has penetrated deep into people's lives, which further illustrates the importance of art design. Art design involves features such as pattern, color, text, and shape. The relationship between these features is relatively complex, and it is difficult to discover the relationship between the features of art and design in the way of human experience. This brings a certain degree of difficulty to the design ideas of art designers. The design between different art designs also has a certain reference, which requires finding an efficient art design mining method. The VB-CNN-GRU method can extract image-related spatial and temporal features of art and design professionals, which can assist designers to find art and design-related features that cannot be extracted by artificial methods.

This research fully studies the application of image recognition technology in the art and design profession. At the same time, considering the advantages of VB-CNN and GRU methods in extracting image features, this study also designs a variational Bayesian convolutional neural network method to study the image recognition method of artistic design. It mainly analyzes the four characteristics of pattern, text, shape, and color in the field of art design. First, it uses a single VB-CNN method to analyze the prediction errors of four features in the field of art and design. Although the prediction errors of the four characteristics related to art and design are within the acceptable range in the art and design field, the four largest values still reach 3.21%. Then, this study analyzes the VB-CNN-GRU method in predicting the art and design The reliability of four features such as pattern and shape, the prediction errors of these four features have been significantly reduced, and the largest error is only 2.37%. This can illustrate the specific reliability of the VB-CNN-GRU method in the image recognition of artistic design. In the actual art design task, it only requires the designer to provide the artwork to the dog official, and it can predict the relevant features according to the intelligent art image recognition method designed in this study, which is an efficient and accurate method.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Research Article

Construction and Application of Video Big Data Analysis Platform for Smart City Development

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With the progress of society and the rapid development of science and technology, daily data volume also shows an exponential upward trend. From the research report of the Internet data center, we can see that the growth rate of data will change from the original slow growth to a sharp rise within 10 years. This shows that the era of big data has arrived, and video data plays an important role in it. Video comes from all aspects of life. As a typical unstructured data, video has the characteristics of large memory, and with the leap of society, this characteristic is becoming increasingly obvious. Taking video data analysis as the starting point, this paper proposes a long-term and short-term memory neural network integrating attention mechanism and verifies it in the experimental data set. The experiment shows that this method has superior performance in model accuracy and work efficiency. Therefore, the application of this method to the construction and application of video big data analysis platform is an important step to promote the development of smart cities.

1. Introduction

In the field of urban public security, the development of cities is progressing day by day, and a large number of population collectives appear, which puts forward higher requirements for public security management level and urban governance ability. However, in the traditional management system, although a large number of cameras and other infrastructure are arranged in the urban area, due to the limitation of technical level, the method of manual real-time observation, playback, and viewing of video data is generally adopted, which only effectively controls the onsite situation in some key areas such as densely populated areas, checkpoints, and urban trunk roads, and it is difficult to find all public safety problems and emergencies at the first time [1]. At the same time, in the video monitoring system, the application of big data technology will replace manual processing of huge data streams, screen out useless data, extract high-value data for visual presentation, help managers quickly find emergencies and security incidents, and reserve sufficient time for subsequent work. During the operation of video monitoring big data system, currently, we are mainly faced with the problems of independent operation of monitoring systems at all levels, which form an information island. A single video monitoring system is difficult to extract enough high-value information from limited video data, and the powerful data processing and logical computing capabilities of big data system have not been brought into full play, resulting in performance redundancy [2]. In view of this, video surveillance systems at all levels and supporting databases need to be integrated. On the one hand, a unified data processing platform is established. Video monitoring systems at all levels submit tasks such as data processing and operation analysis to the data processing platform, as well as upload the captured image data to the data platform. Personnel of all departments directly access the data processing platform to view multidimensional information such as people, places, and objects within the scope of authority, so as to effectively meet the application needs of video monitoring big data. For example, the public security department inquires the image and video of a specific time period in the data processing platform to find

the details of the suspect's facial feature information and wearing feature information. The rail transit operation department grasps the real-time road conditions by consulting the image and video and data reports and checks whether there are problems such as line congestion [3]. On the other hand, considering that the data collected by the video monitoring system is composed of multisource heterogeneous data, taking intelligent transportation and intelligent behavior as examples, and collecting relational data such as the number of violations and individual driving age, as well as time series data such as individual geographical location; there are obvious differences in the characteristics, distribution, and production of different types of data. If a unified processing method is adopted, the processing capacity of the video monitoring big data system will be weakened and reduced the actual utilization of data [4]. Based on this kind of problem, it is necessary to classify videos, which can be classified through AI+ video monitoring technology.

Video analysis technology based on artificial intelligence has been deeply integrated into various industry fields. Video objects include people, vehicles, environment, and objects; relevant management departments need to make corresponding technology choices in combination with industry characteristics and video characteristics, so as to achieve efficient analysis and utilization of video. This behavior plays an important role in urban public safety, network security, emergency disposal, and other fields [5]. The smart city analysis platform needs to include the storage, analysis, classification, sharing, data mining, data early warning, and other functions of video data. The system platform needs to show the panorama of the city, reflect the key characteristics of the city, and have the functions of emergency early warning and intelligent scheduling [6]. On this basis, this paper studies the LSTM video analysis model based on the integrated attention mechanism, aiming to create a video big data analysis platform for smart cities and promote the construction of smart cities.

The innovation contribution of this research is to propose an LSTM neural network model combining attention mechanism. This model inherits the advantages of recurrent neural network and has good advantages in sequence task processing. The LSTM model based on the fusion attention mechanism is tested on the data set. The results show that this method has obvious advantages in model accuracy and work efficiency and has strong advantages in video feature extraction and video classification. Therefore, applying this method to intelligent city construction will greatly promote the development of cities. Video big data technology focuses on helping all kinds of customers to quickly find high-value information from the increasingly massive unstructured video data. Assist customers to improve the efficiency and accuracy of their decisions.

2. The Related Works

The video monitoring equipment that can be seen everywhere in China is the basic hardware equipment of the video big data analysis platform, but the monitoring equipment in most parts of China has the functions of video acquisition, storage and output, and cannot realize intelligent video analysis. At present, the function of monitoring system is too single, and it can only support viewing, which requires manual video classification, feature retrieval, and other tasks. Video monitoring equipment and stored management equipment lack intelligent video analysis function, or the function is very single, and only supports event classification and location classification; complex tasks such as finding and searching video features need to be carried out manually, which not only consumes a lot of human and material resources, but also easily leads to feature leakage; task completion is not up to standard. Therefore, there are great loopholes in video data mining. It is easy to waste data resources [7]. The use of video resources in various places only stays on tasks such as data collection, vehicle search, and person tracking, which are mainly used in public security management and personal security. At present, video analysis is still in the stage of low technology analysis. Only simple intelligent technology or no intelligent method is used for video analysis and classification. Therefore, it is easy to find videos that cannot be found or are too slow to find. It is also easy to find videos with low reliability and too much workload in the search process. More importantly, it is easy to ignore the features we need to find in videos in this work. These problems all point to the low-end of video analysis means and low intelligence [8].

At this stage, in the smart city, the application of video surveillance big data technology effectively solves the problem of low efficiency of data processing and can complete the analysis and processing of huge data streams in a short time. However, due to the complex environment, camera resolution and other factors, some video images taken are ambiguous, and it is difficult for the big data platform to extract sufficient and real data information. As a result, data processing results and decision-making suggestions to users lack practical reference value. For example, in simple and pure scenes, the big data platform can extract real feature information and obtain accurate detection results. In scenes with large traffic and a large number of facilities and obstacles, the detection accuracy of the algorithm will be affected by factors such as light and color, so it is difficult to obtain accurate detection results, and it is impossible to correctly distinguish the behavior of all people and effectively predict potential problems [9]. To solve these problems, we should start from the technical level and take three measures: image enhancement, image restoration, and image super-resolution reconstruction to provide high-quality, high-resolution, and complete detailed video image data for the big data platform. First of all, image enhancement is to use new algorithms such as image defogging, image denoising, and image dark detail enhancement to replace the original image filtering algorithms, so as to improve the image quality and clarity. Secondly, image restoration relies on image degradation knowledge to build a degradation model, and uses Wiener filtering algorithm, wavelet algorithm, and other methods to carry out inverse process processing in the model, gradually restore the image, eliminate the image blur caused by motion and other factors, and obtain a clear

image. Finally, the technical principle of image super-resolution reconstruction technology comes from the signal processing method, using high-frequency components to improve the resolution, and generating a large number of restored images on the basis of low-resolution images, and then screening [10].

There are extensive achievements in the analysis and research of video big data. Mohammadi et al. proposed an image analysis method based on Hadop method. In this method, there is an HDFS module, which can ensure the storage of images. In addition, he also used a distributed framework for image analysis. This method has the advantages of good analysis effect and fast speed, but it is not suitable for dynamic image data processing [11]. Some scholars also studied the storage and search of massive data. Nelson et al. developed a massive image retrieval system based on Hadop technology. He also applied HDFS module for storage, but he added Lucene module to the former to provide retrieval [12]. At present, the mainstream technology of video storage is to compress video frames and pictures, and this technology is also relatively mature. Therefore, the research focus of the above scholars is not on how to compress video, but on how to quickly store and retrieve video images. One solution is to clip the video and store it in the HDFS module in a complete and appropriate size. When video is needed, download it, and use third-party technology for processing [13]. Another method uses the segmentation attribute of HDFS to store the video distributed, and then uses the decoding technology of the module to decode the video, but the subsequent operations need to be considered to splice the cut video [14]. Hadop technology also has strong applications in other video processing and analysis fields. There is still no good way to solve the problem of obtaining the main information of video, but this application is the most needed function in the era of big data. Analyzing video according to video content is an important progress in the field of video analysis. This method can enable people to quickly read a large amount of video data and obtain useful information from it, but it still has the disadvantages of insufficient applicability and low efficiency. On the basis of previous studies, this paper proposes an LSTM video big data analysis method based on attention fusion mechanism. Experiments show that this method has good adaptability in video feature extraction and video classification tasks.

3. Video Big Data Processing Method Based on the Fusion of LSTM and Attention Mechanism

This paper investigates the recognition of video big data analysis platform in promoting the construction of smart city. The subjects of the survey are relevant participants in the construction of smart city, relevant government departments of smart city, citizens, and university research institutions. The questionnaire was distributed online, and the results showed that only 2% of the people said they did not agree. Most people believe that the construction of video big data analysis platform can promote the construction of smart cities. The results are shown in Figure 1.

Figure 2 shows the video big data analysis platform for smart city development. This paper mainly studies how to carry out tasks such as feature extraction and video classification for video big data, and carry out preoperations such as video information acquisition, storage, download, and acquisition based on this goal Figure 2. At the same time, it also solves the difficulties of improving video processing efficiency and storage efficiency. In distributed storage technology, the most important algorithm is load balancing algorithm. The principle of this method is actually a reasonable allocation algorithm of computer resources. Its work is to allocate resources between computer groups and internal hardware of computers and finally maximize the utilization of resources. The algorithm can ensure the reasonable allocation of tasks, improve work efficiency, and balance the load of each hardware of the computer, so as to protect equipment resources. In the task of video classification, the traditional time series model has some shortcomings, such as low efficiency and poor accuracy. Therefore, on the basis of video storage, this paper studies the time series video prediction task and video classification task based on long-term and short-term memory neural network (LSTM) and adds the attention mechanism as the core algorithm in the smart city data analysis platform. After experimental verification, the algorithm shows high correctness and wide applicability. Each time step of the test data set will be executed one at a time. A model will be used to predict the time step, and then, the actual expected value of the next month will be obtained from the test set and provided to the model for the prediction of the next time step. This simulates a real scenario in which new data can be obtained every month and used for the next prediction. This will be simulated by testing the structure of the data set. All predictions on the test data set will be collected and error scores calculated to summarize the model's skills for each prediction time step. The root mean square error (RMSE) is used to punish the larger error, and the score obtained is the same as the unit of the prediction data.

The earliest sequence task is to process text, and video is composed of frames. Therefore, the study of text processing methods has a great inspiration for video frame sequence processing. Language is not only a means to distinguish between others and animals, but also an important way to distinguish different ethnic groups. The first object used in text processing is Latin language, which has a high degree of independence and is easier to be encoded in matrix form. The encoded text can be processed simply by calculating the distance between different units. The research in this field has a long history. Compared with text processing, speech processing is more complex. Speech information not only contains the text information we need, but also contains a lot of noise information we do not need. Therefore, when processing voice text, we must first carry out noise reduction to filter out the impurities in the voice signal and then compare the voice data before and after processing to ensure the integrity of information features. In addition, the most

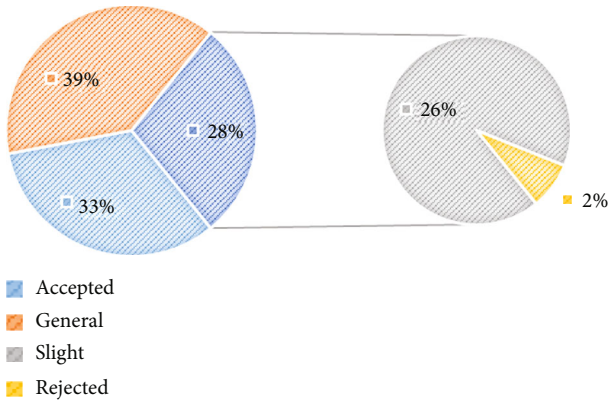

Figure 1: People's recognition of video big data analysis platform.

important link in the process of speech information processing is to distinguish language types, which is a priori condition to ensure the smooth progress of the follow-up work. The core idea of speech data processing lies in logical judgment. The correct logical connection is the key to speech analysis. The core of video data processing is also logical judgment. This paper uses the LSTM network model integrating attention mechanism to classify video events, so as to solve the practical problems encountered during the construction and management of smart cities and promote the healthy development of smart cities.

3.1. Basis of Recurrent Neural Network. The basic idea of recurrent neural network (RNN) is to process the data with logical relationship. Its structure has high repeatability. Its processing object is to analyze the logical relationship between adjacent units in the data. The weight of this model has the advantages of popularity and collinearity. RNN will have a multilayer network structure in the sequence tasks at multiple time points. The number of sequences is consistent with the number of layers of the network structure, with a high degree of correspondence. Its structure is shown in Figure 3. In Figure 3, the structure correspondence and sequence characteristics in RNN are introduced in detail. S represents the hidden layer, which has the function of data storage and memory; U represents the weight to be added during the transmission of input data to the hidden layer; O is the output value but not the final output; V is the weight matrix through which the data is transmitted from the hidden layer to the output layer; L is the loss function of the model; and Y is the final result of the model output [15]. Figure 3 shows the structure of the recurrent neural network.

By analyzing the above figure, the input at time t in the expanded structure diagram can be expressed as x_t, and the hidden layer is s_t at this time. It can be seen from the figure that the data of the hidden layer should not only be combined with the input at this time, but also consider the value of the hidden layer at the previous time. The above structure diagram clearly shows the forward propagation theory of RNN, according to which tasks such as prediction at a certain time can be carried out.

$$\widehat{y}_t = \sigma(o_t), \tag{1}$$

$$o_t = g(V \cdot s_t + c), \tag{2}$$

$$s_t = f(U \cdot X_t + W \cdot s_{t-1} + b), \tag{3}$$

where σ and f in the above formula are activation functions. The two common activation functions are $soft$ max activation function and tanh activation function, respectively. B in the formula means the offset of the function, and $\widehat{y}_t$ represents the final output of the model, that is, the predicted value. In addition, the RNN model parameters are mainly determined by back propagation. The gradient descent method is used to iterate the model, and finally, the parameters with the highest accuracy and the best model performance are calculated. The direction of gradient descent is controlled by the loss function, and its formula is as follows:

$$L = \sum_{t=1}^{T} L_t. \tag{4}$$

The determination of model performance is to determine the weight matrix of each stage in the model and other parameters in the formula. The gradient calculation formula is as follows:

$$\frac{\partial L}{\partial c} = \sum_{t=1}^{T} \frac{\partial L_t}{\partial c} = \sum_{t=1}^{T} \frac{\partial L_t}{\partial o_t} \cdot \frac{\partial o_t}{\partial c} = \sum_{t=1}^{T} \widehat{y}_t - y_t, \tag{5}$$

$$\frac{\partial L}{\partial V} = \sum_{t=1}^{T} \frac{\partial L_t}{\partial V} = \sum_{t=1}^{T} \frac{\partial L_t}{\partial o_t} \cdot \frac{\partial o_t}{\partial V} = \sum_{t=1}^{T} \left(\widehat{y}_t - y_t\right)^T. \tag{6}$$

The determination of the above parameters basically determines the network structure of RNN.

3.2. Basis of Long and Short-Term Memory. RNN network model is mainly born to understand the task of time series prediction, but this model has a well-known drawback. When the network structure of the model gradually increases, the gradient will disappear. The gradient vanishing problem is mainly due to the high learning ability of the hidden layer, which leads to excessive learning, resulting in the smooth function curve, and finally leads to the failure of the prediction and classification task. RNN model has many variants. LSTM (long- and short-term memory) is one of them. It can process the data of time series and effectively avoid the problem of gradient disappearance. This model mainly includes forgetting gate and input-output gate. In RNN, the hidden layer is the main structure that exists at any time. Its state depends on the input information at that time and the hidden information at the previous time, and the hidden information at this time affects the hidden information at the next moment [16]. Compared with the simple iterative problem of RNN, LSTM designs a more complex structure called forgetting gate, so it can avoid the gradient disappearance problem.

In Figure 4 above, the input at time t and the hidden information at the previous time enter the activation

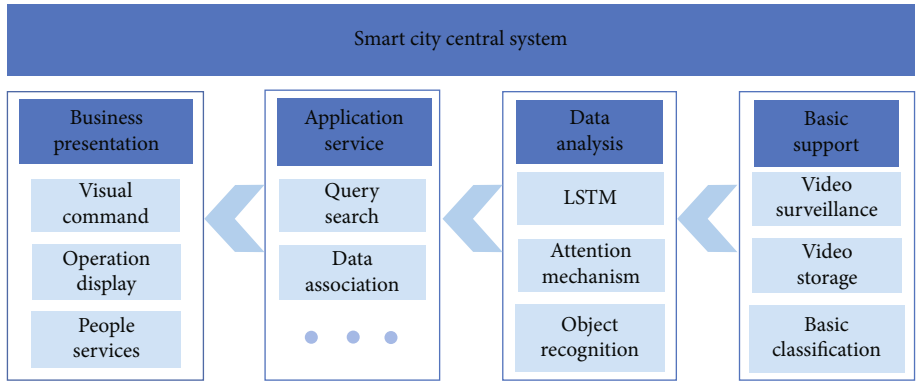

Figure 2: Video big data analysis platform for smart city development.

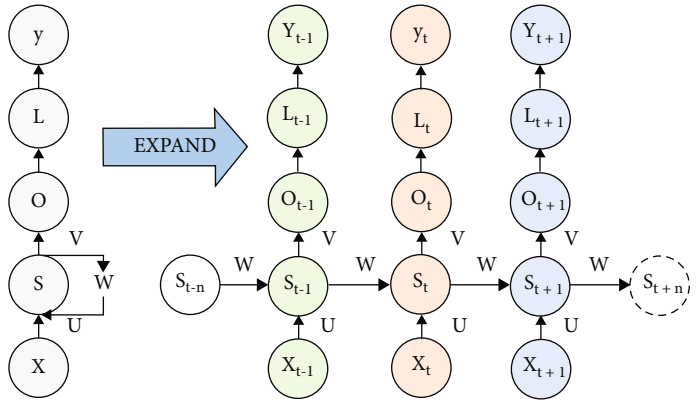

Figure 3: Structure of recurrent neural network.

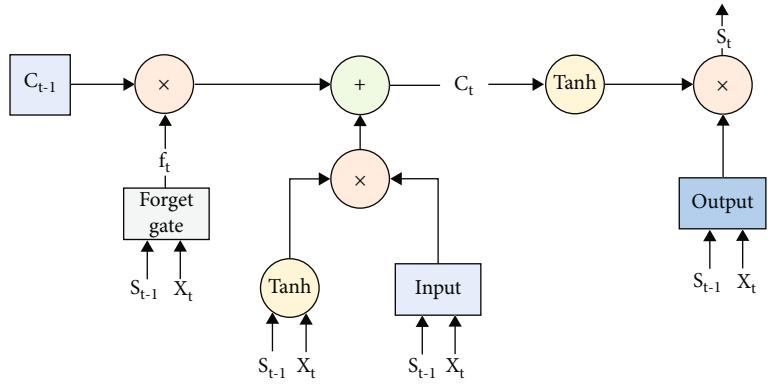

Figure 4: Structure diagram of LSTM model.

function at the same time and then get the output for the next step. This process is the work of the forgetting gate. The meaning of the output value f_t represents the probability that the information at the previous time is deleted, and its formula is as follows:

$$f_t = \sigma\left(W_f s_{t-1} + U_f x_t + b_f\right). \tag{7}$$

Input the T, time information, and the last time hidden state information into the tanh activation function, and then, multiply its output with the t, time information, and the last time hidden state information to obtain this part of the output at

$$a_t = \tanh\left(W_a s_{t-1} + U_a x_t + b_a\right). \tag{8}$$

Then, input the a_t and computed CT into the tanh activation function, and multiply it by the output to obtain the hidden information at that time:

$$o_t = \tanh\left(W_o s_{t-1} + U_o x_t + b_o\right), \tag{9}$$

$$h_t = o_t \odot \tanh c_t. \tag{10}$$

The forward calculation formula of LSTM model can be obtained by accumulating the above formulas:

$$\widehat{y}_t = \sigma(\mathrm{V}\mathrm{h}_t + c). \tag{11}$$

Compared with RNN, LSTM has the characteristics of complex structure, but the structure is clear and easy to understand, has strong adaptability, and can also solve the problem of RNN gradient disappearance. The load balancing algorithm introduced earlier in this paper also uses this model, which predicts the load of nodes, so as to make dynamic adjustment, form a closed-loop control system to automatically allocate tasks, and improve the efficiency and stability of tasks [17].

3.3. Attention Mechanism. In the actual monitoring system, there are generally 20 cameras working in a cluster. The frame rate is calculated according to 25 seconds per second, and the resolution is calculated according to a single 2 million. Based on this data, the monitoring system needs to process such huge data per second, which is obviously a task that a single device cannot complete. Similarly, the amount of video and picture data stored in a day is also massive, which is also a great test for the storage and analysis system. Therefore, a distributed system is needed for data storage and analysis. Based on the above distributed data storage design, the video classification steps can realize multidirectional parallel operation. On this basis, in order to improve the accuracy of video classification, this paper integrates attention mechanism on the basis of LSTM to improve the accuracy of video classification. The introduction of attention mechanism can reduce the computational burden of processing multidimensional data input, select the data with a high degree of coincidence with the target information through structured means for detailed processing, and only pay attention to the part of the target concerned. This method can enable the algorithm system to focus on processing data objects that overlap with the target features and can greatly improve work efficiency and task quality.

The attention mechanism is essentially an automatic weighting scheme. In the traditional model, the decoder can only obtain the fixed hidden vectors of a certain layer of the encoder (generally using the last layer) as input each time it predicts. From the perspective of weighting, it is actually a simple global average of the hidden vectors of all layers of the encoder [18]. With the introduction of attention mechanism, each time step model will be weighted sum all the hidden vectors of the encoder according to the automatically calculated weight probability and get a new context vector. Because the weight of the hidden layer of each time step is different, the input context received by each time step decoder is no longer fixed. So that each time step decoder can focus on processing the most relevant information in the original module and the current output [19].

After the introduction of attention mechanism, the original encoding and decoding work has become relatively complex, in which the interval has also changed from a single value to a group of vectors. The output of the encoder also becomes a multidimensional vector, from which the decoder obtains a vector with high reliability for calculation. The calculation formula is as follows:

The weight a_t^i of the attention mechanism is calculated by the hidden unit of the encoder and decoder. Note that the mechanism adopts a quantitative calculation of the improvement effect. Let us first define that in the example above, the query item is the hidden state of the decoder, and the key item and the value item are both the hidden state of the encoder. In the sense, note that the input of the mechanism includes the query item and the key item and value item corresponding to the query item, wherein the value item is a group item that needs to be weighted average. In the weighted average, the weight of the value item is used to calculate the query item and the key item corresponding to the value item.

$$a_t^i = \frac{\exp\left(\mathrm{score}(s_t, h_i)\right)}{\sum_{j=1}^{n} \exp\left(\mathrm{score}\left(s_t, h_j\right)\right)}. \tag{12}$$

In the above formula, the expression of the fractional function score is variable, and there are two common ones below.

$$\mathrm{score\_addition}\left(s_t, h_j\right) = V^T \tanh\left(W_a[s_t ; h_i]\right), \tag{13}$$

$$\mathrm{score\_multiplication}(s_t, h_i) = s_t^T W_a h_i. \tag{14}$$

Combined with the attention weight, the front and rear semantic vector c_t is calculated according to the front and rear sequence vectors.

$$c_t = \sum a_i^t * h_i. \tag{15}$$

The hidden value h_t and semantic vector of the decoder can get the final weight through tanh activation function.

$$a_t = f(c_t, h_t) = \tanh\left(W_a[c_t ; h_t]\right). \tag{16}$$

Input the attention weight to the next unit through the following formula.

$$y_t = f(h_t, y_t, c_t), \tag{17}$$

where W and V mean the weight matrix, a represents the attention weight value, f is the activation function, and c_t is the semantic vector. The essence of attention mechanism is to add the target elements to the network, so that the model will pay attention to the sequence related to the target elements in the operation process, so as to control the resource allocation and finally improve the work efficiency [20].

It is difficult to distinguish the correlation between input and target only relying on the encoding and decoding module of LSTM. Therefore, this model introduces a temporal attention mechanism between the encoder and decoder corresponding to each video feature, automatically learns the

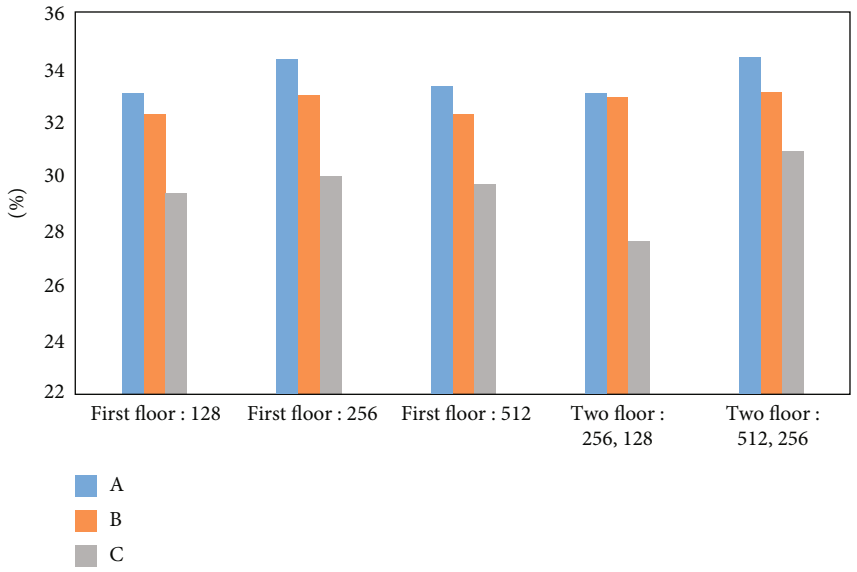

Figure 5: Experimental results of LSTM under different parameter states.

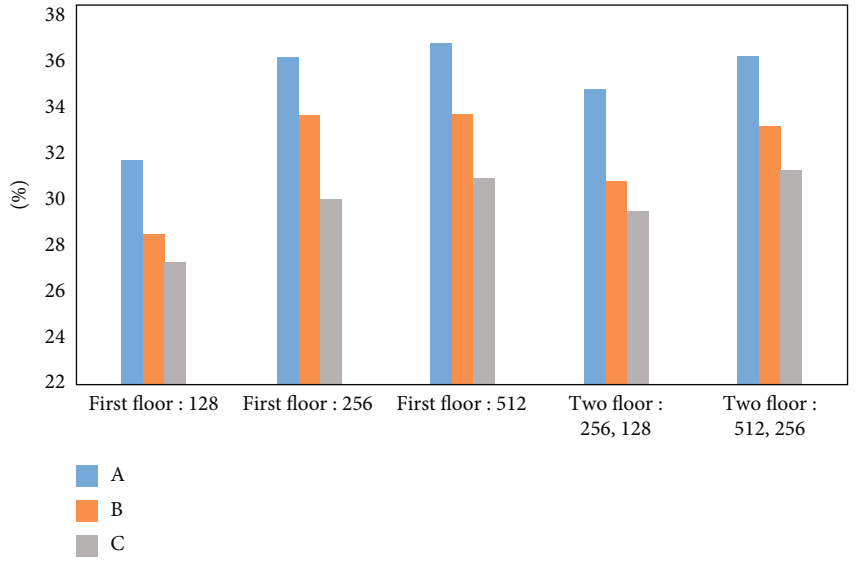

Figure 6: Experimental results of GRU under different parameter states.

correlation between the decoder's predicted output and the encoder's hidden vector, and is used to simulate the attention allocation of different video features.

4. Analysis of Simulation Results

The data processed by RNN series models are time series data containing time information, so increasing the width of the network has a better effect on improving the performance of the network model. Considering that different data have different characteristic dimensions, this paper uses comparative experiments to illustrate the specific situation. Both LSTM and Gru networks are variants of RNN, but LSTM has one more gate unit than Gru, which can control the direction of information flow, so it has structural and functional advantages. At the same time, in order to verify the difference in accuracy between the two variants of the network, this paper sets up a comparative experiment: In the experiment, each video is set to take 50 frames for calculation, and the time interval is automatically selected according to the time length of the video. In this paper, the LSTM and Gru networks in the cyclic neural network are compared, and three experiments are carried out with different structural parameters. The accuracy results are shown in Figure 5.

As can be seen from Figures 5 and 6, LSTM and Gru networks have high similarity in model accuracy, but LSTM has obvious advantages in structure and function. It can be seen from the figure that the accuracy of the LSTM model still needs to be improved. In order to improve the accuracy of the model, this paper adds an attention mechanism. In order to more objectively verify the performance of the LSTM

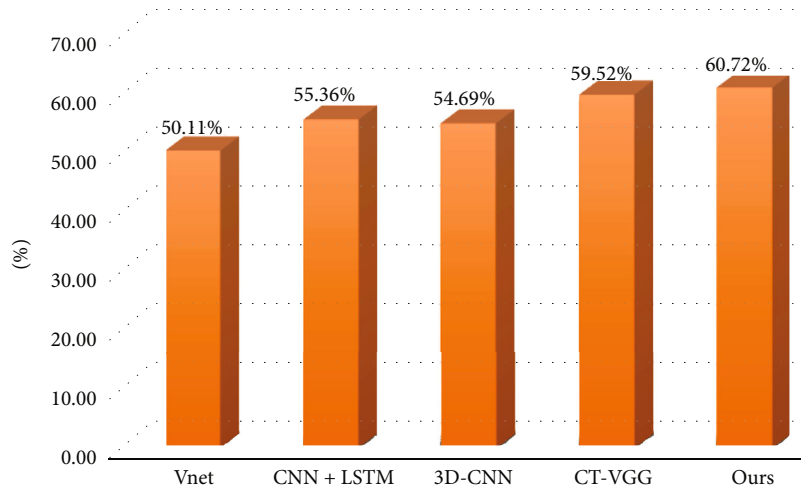

Figure 7: Comparison of recognition results of different network models applied to BAUM-1s dataset.

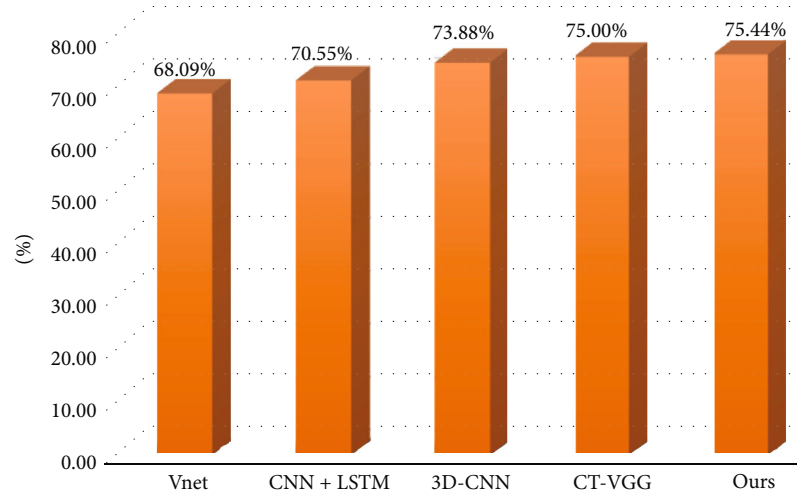

Figure 8: Comparison of recognition results of different network models applied to RML dataset.

network model after adding an attention mechanism, this paper uses baum-1s and RML data sets to verify the performance of the model.

In order to verify the effectiveness of the LSTM network integrating attention mechanism in video feature extraction, a comparative experiment is set up in this paper. Figures 7 and 8 show the comparison between this method and other methods. By analyzing the figure, the LSTM model with attention mechanism in this paper achieved an average accuracy of 60.72% and 75.44%, respectively, in the comparative experiment. This paper sets up four groups of comparative experiments. The first group uses deep CNN (VNET) to extract video dynamic features. The second group adopts CNN+LSTM method to extract video dynamic features. The third group uses 3d-cnn to extract video features. The fourth group used CT-VGG for dynamic video feature extraction. Through the experimental data, we can see that the LSTM model with attention mechanism has the highest accuracy, so it shows that this model can effectively carry out the task of video dynamic feature extraction.

In the process of determining the network model, the performance accuracy of the model will change with the length of the time step. It is verified by experiments that there is a positive correlation between the increase of the time step and the performance of the model. The application of multiple time steps can improve the generalization ability of the model, because in the operation of multiple time steps, the model can automatically eliminate the influence of contingency and maintain the reliable stability of the model. In this paper, several groups of multitime step comparative experiments are set up, and the false alarm rate is used as the model evaluation parameter. The lower the false alarm rate is, the more reliable the stability of the model is. The results are shown in Figure 9. With the increase of time step, the false alarm rate gradually decreases, and the LSTM model integrating attention mechanism proposed in this paper always has the lowest false alarm rate.

In order to verify the effect of the method proposed in this paper from multiple dimensions, this paper also makes a statistical comparison of the running time of the model. The results show that the running time of the

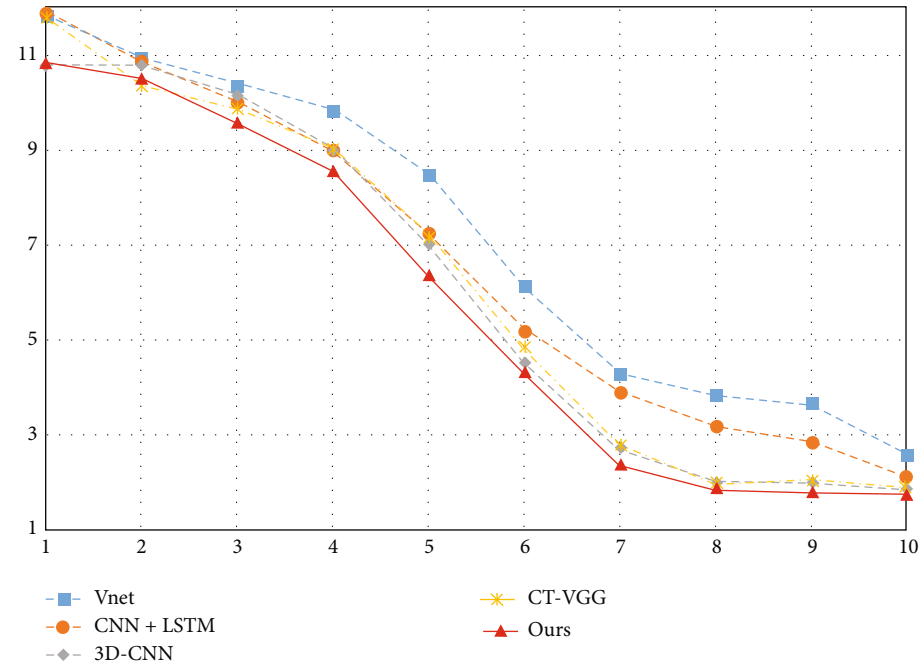

Figure 9: Comparison of false alarm rates of various models with different time step lengths.

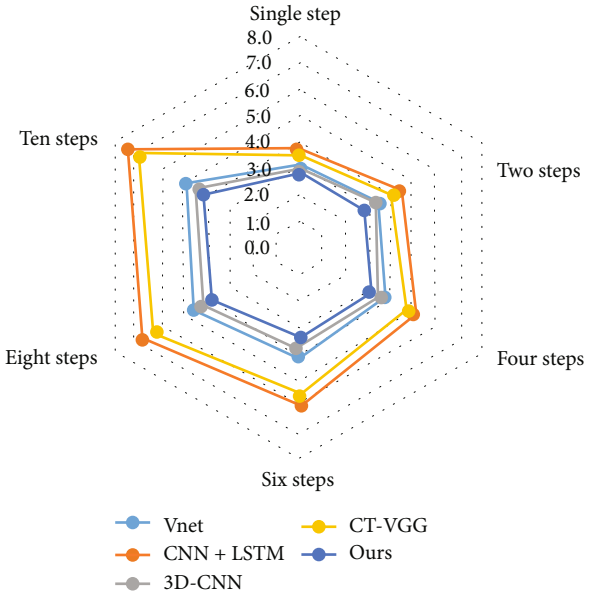

Figure 10: Comparison of running time of different models.

LSTM model integrating attention mechanism proposed in this paper is significantly lower than that of other models, because the LSTM model starts from two ends, and the computational efficiency is higher than that of other models. Moreover, it can be seen from Figure 10 that with the increase of time step, the time comparison between several models becomes more obvious, and the gap also gradually increases.

Through three groups of comparative experiments, this paper studies the performance of the model from three levels: model accuracy, false alarm rate, and running time. Finally, it shows that the LSTM model with attention mechanism has strong performance and is suitable for video big data analysis.

5. Summary and Outlook

In this paper, an LSTM neural network model combined with attention mechanism is proposed. This model inherits the advantages of recurrent neural network and has good advantages in sequence task processing. At the same time, the model can well solve the gradient disappearance problem in the recurrent neural network. The LSTM model proposed in this paper is tested on the data set. Compared with other RNN variants, LSTM has a more flexible model structure. Finally, the attention mechanism is integrated into the LSTM network to form the core method of this paper. The model with attention mechanism can carry out adaptive attention classification according to different types of videos, which greatly improves the efficiency of the model. The results show that this method has obvious advantages in model accuracy and work efficiency and has strong advantages in video feature extraction and video classification. Applying this method to the construction of intelligent city will greatly promote the development of the city. However, the study still has some limitations. Video analysis and feature extraction models have room for improvement in both structure and performance and are difficult to meet the work requirements in the big data environment. Therefore, further analysis is needed in future research and development.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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