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Research Article

Smart Building Skin Design with Dynamic Climate Adaptability of Smart Cities Based on Artificial Intelligence

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As the separation and carrier of indoor and outdoor energy and climate conditions, building skin plays an important role in indoor environment regulation and effective utilization of outdoor environmental resources. The traditional fixed skin of residential buildings in cold regions lacks the ability to respond to the external climate, so it is difficult to meet the dual requirements of building energy efficiency and indoor comfort. In the long river of architectural development, the most important thing of architectural design is how to meet the climate adaptability. Traditional architectural forms have long been unable to meet the current social development, climate conditions, and user needs. Based on the basic theory, this paper establishes a systematic understanding of inlay, studies the design method of complex skin with geometric algorithm as the operating tool, discusses the application of this method in architectural design in combination with practice, more systematically and comprehensively studies the building skin with dynamic climate adaptability, and makes a physical model of building skin with dynamic climate adaptability. The contrast experiments under different control modes were carried out using the climate chamber experimental system. This research focuses on taking geometric principles as the prototype, trying to break the common design idea of generating skin by overlapping cells, and providing a systematic skin design method with strong operability and modular structure, hoping to help expand creative thinking.

1. Introduction

The most important reason for the emergence of architecture in human social life is that at the moment when human beings have the need to settle down, in the book "On Architecture" written by M. A. Lauger, Barbarians, in the shelter made of leaves, do not know how to protect themselves in a humid environment [1]. The reason is that the climate environment has advantages and disadvantages. Different global climates have produced different forms of buildings. As G. Brodepont said, "This early house has many inspirations: the basic reason for building a house is to change the climate given by nature and to carry out some human activities conveniently and comfortably" [2]. China has a wide area and different architectural forms. For example, traditional dwellings in China, in the northeast of China, because of the small sun elevation angle, tend to have larger courtyards and thicker walls to resist the cold. In northwest China, however, cave dwellings are the main ones. Because of the land characteristics of the Loess Plateau, people dig caves on the mountain, and the caves are warm in winter and cool in summer, which is suitable for the local climate. In order to adapt to the hot weather, people in the south of China build dry-column buildings, and this kind of steep roof and overhead ground floor can provide good ventilation and shade for the buildings [3].

Commonly used building envelope structures include walls, roofs, and curtain walls of doors and windows, which are generally fixed envelope structures, while dynamic building skin, as a kind of intelligent variable building envelope structure, can respond to environmental changes in a dynamic way. Architects and engineers need to weigh many factors when considering the design of the enclosure structure, including environmental issues, aesthetics, and indoor comfort. [4]. These factors make the building envelope a multifunctional component, so the integration

method is the best way to solve the design of building envelope. In the design of building energy consumption and building climate adaptability, the building skin has sufficient regulation and control capability is an important factor affecting both [5]. As the separation interface between indoor and outdoor, the building skin ensures a comfortable and stable indoor environment in terms of sound, light, heat, wind, and other aspects by selectively filtering various outdoor climate factors and selectively using favorable outdoor energy such as solar energy and reduces the use frequency of energy consumption equipment [6]. Therefore, building skin energy-saving design plays an important role in energy-saving building design. Some of the environmental factors have a favorable impact on the indoor environment, while others will have an adverse impact, and the two factors transform into each other with different times and different environments. From the early civilization of human beings to modern times, the practice and exploration of building to resist uncertain climate change to create a suitable indoor environment have never stopped [7]. From the 1960s to the present, the intelligent evolution of building skin has gone through many stages, gradually expanding into a multidisciplinary cross research field facing the requirements of multigreen performance optimization of buildings, evolving the theories and methods of intelligent skin design of buildings such as dynamic buildings and climate adaptive skin and emerging intelligent skin design works such as the Arab World Research Center and Al Bahar Building. Under the joint action of the demand of contemporary construction industry and the thrust of artificial intelligence technology, there is a diversified development trend.

Dynamic building skin is completely controlled automatically by control software. The control software is connected with three main sensors located at the top of the tower, including wind sensor, light sensor, and rain sensor. By collecting the environmental values fed back by sensors, the sun movement is simulated in the control software, and the opening and closing degree of each dynamic skin unit is controlled [8]. This period of time is often nonworking time, so it is unnecessary to set up a dynamic sun shading unit in the north area. In order to determine the curtain wall area where shading units need to be set, the solar heat gain on the curtain wall surface is simulated and analyzed first, and 400 Wh/m^2 is taken as the extreme value. Dynamic shading units are set in front of the curtain wall area that exceeds this extreme value. Building skin is a multifunctional "interaction and filtering system" of indoor environment and outdoor climate, which needs to solve the contradiction between "utilization" and "protection" caused by the changing climate [9]. With the development of science and technology, there are more choices of materials and technologies in the design of building skin, which provides conditions for solving the abovementioned contradictions. With the deepening of the integration of computer and artificial intelligence, the powerful data processing ability of computer provides efficient technical support for studying and solving complex problems, which drives and catalyzes the process of subject integration. According to statistics, from 1901 to 2008, the proportion of interdisciplinary research achievements awarded in the Nobel Natural Science Prize was 52% of the total, which has risen to 66.7% in recent years, and has been on the rise. Among them, as a series of logical judgments and operations organized in sequence, the algorithm makes the design process more controllable, rational, and efficient than traditional methods [10]. The introduction and development of intelligent skin systems can use limited materials and technologies to cope with more changing conditions, generate more green building skin systems, and make intelligent buildings develop in a more sustainable direction. Therefore, intelligent skin has become a major trend and inevitable choice of intelligent buildings.

With the disintegration of this far-reaching mathematical theory, non-Euclidean geometry is gradually accepted by people, and it is performing a new type of aesthetics characterized by fuzziness and deformation. Topological geometry, as one of non-Euclidean geometry, has gradually become the main theoretical basis of architectural skin, and with the independence of skin, it has gradually become one of the main means for architects to express architectural form. Up to now, scholars have made a certain scale of research on the skin of intelligent buildings with dynamic climate adaptability, but there is still little research on the application of artificial intelligence methods to the skin design of intelligent buildings with dynamic climate adaptability. This research is supported by the National Natural Science Foundation's general project "Research on the Design of Climate-Adaptable Building Skin Based on Thermal Ambient Intelligence Regulation." It aims at classifying, analyzing, and summarizing the existing research and builds cases of dynamic climate-adaptive building skin, classifying it according to its environmental factors, trying to sort out its design strategy, sorting out the design realization forms, and summarizing the common design realization forms. For the analysis of the control mode, we try to divide the control mode into four levels and analyze its control principle. We also carried out model experiments to get rid of the dilemma of talking on paper, explore new ideas on how to build models and carry out experimental tests, illustrate the feasibility of dynamic climate adaptive building skin by building solid models, establish a technical basis for further experiments, and compare the advantages and disadvantages of different control modes under the experimental environment conditions through the collation, analysis, and comparison of experimental data. Its innovation lies in the following points: (1) The coverage of research on dynamic climate adaptive building skin is more comprehensive. In many research studies, the concept of dynamic climate adaptive building skin is often limited to intelligent mechanical design, but in fact, the dynamic climate adaptive building skin also includes other forms of design, so the research on dynamic climate adaptive building skin in this paper will be more systematic and comprehensive. (2) The Arduino platform is used as the control system, and the physical model of the building skin with dynamic climate adaptability is made, and the comparative experiments under different control modes are carried out by using the climate cabin experimental system, which

provides a new idea for studying the adjustment ability of the building skin with dynamic climate adaptability and the influence of different control modes on the adjustment ability of the building skin with dynamic climate adaptability.

2. Related Work

In the movement of modern architecture, due to the development of architectural technology, architectural skin expresses itself as an independent identity, and the innovation of skin that follows attracts the attention of many architects. The unitary pattern of modern architecture began to be greatly challenged in the second half of the century, and the architectural skin began to appear in the world with a pluralistic tendency.

Kuru A takes many architectural forms of Shanghai World Expo as the basic breakthrough point and studies the topological evolution process of architectural form of Shanghai World Expo by the topological analysis method, so as to understand the modern architectural form and explore the topological framework system of architectural form, so as to promote the development of architectural form [11]. Perino and Serra proposed an equivalent thermal analysis model based on frequency response and numerical simulation on the heat transfer process of building envelope under natural climate conditions in heating areas [12]. Baduge et al. verified the energy-saving effect by adopting the research method of theoretical analysis, numerical simulation, and experimental test on the new dynamic composite envelope of 000PK building, which provided valuable basic data and conclusions for theoretical calculation and application of dynamic skin [13]. EVIR and others applied the parametric design method to optimize the layout of the hexagonal skin module, so that it can reasonably adjust the building light environment in different seasons [14]. Alqiaa summarized the related research of intelligent building and found that most of the research focused on the development of new intelligent control technology and its application in HVAC system, lighting system, fire protection, elevator, security, and communication system. In addition, there are some comparative studies on dynamic climate adaptive building skin [15]. Zhai et al. analyzed the influence of different control logic of the intelligent control system of a building in Denmark on its building energy consumption and indoor thermal comfort, got a relatively optimized control strategy, and put forward a simple algorithm of building energy consumption and thermal environment [16]. Ilbeigi gives full play to the potential of "frame," a modern architectural load-bearing system. It replaces the wall with cross-shaped steel columns. With the characteristics of free flow in the plane, the load-bearing and enclosure functions of the skin are weakened or even disappeared, and great freedom is obtained. With the vigorous development of industrial technology and modern architectural theory, skin has not only become an independent subject in the objective world but also has a series of formal rules and design theories for itself, creating another "real" world outside the objective world [17]. Shaikh et al., starting from solving the adverse impact of China's specific continental climate on buildings, put forward the concept of strain architecture, that is, buildings should adapt to China's changing continental climate, adapt to the dramatic changes in climate, and take coping measures, and the architectural form should change according to the changes in climate [18]. Barozzi et al. believe that the development of information technology makes intelligent and dynamic building facades an inevitable requirement for sustainable building development. While giving the concept, functions, and characteristics of intelligent and dynamic facades, dynamic building facades are divided into four categories according to design strategies, namely, integrated dynamic sunshade system, integrated dynamic solar reflection system, integrated dynamic natural ventilation system, and integrated dynamic energy production system [19]. Khalil and Abu-Nasser studied the evolution and development of building dynamic system. The evolution of building dynamic system is divided into three stages. In the preindustrial revolution period, traditional doors, windows, vertical ladders, and other components with manual or mechanical braking were the representatives of building dynamic components. During the industrial revolution, the components such as steam engine and vertical ladder braked by motor were regarded as representatives of dynamic components of buildings in this period [20, 21].

3. Methodology

3.1. Summary of Research on Dynamic Climate Adaptive Building Skin Design. As the manifestation of human evolution, architecture has always been branded with the times. In this chapter, the theoretical research on climate adaptive movable building skin is divided into two aspects, namely, climate adaptive skin and movable building skin. Through the analysis of the relevant theories of these two aspects, the relationship between architecture, people, and environment is examined. With the development of the construction industry, more and more movable building skins are concerned by architects for their adjustable and adaptable features, which has triggered a lot of theoretical research. Through these studies, movable building skins are no longer just the imagination of architects but have become an important form of building skins for the development of the times. Among them, the most famous are the "skeleton support theory," "symbiosis theory," and "philosophy of change." Climate factors have a particularly prominent impact on architectural design and construction. In 1994, the Ministry of Construction issued the Standard for the Division of Building Climatic Zones, which divides the building climate zoning system of China into two levels, namely, first level zone and second level zone. The purpose is to distinguish the differences in the impact of climatic conditions on buildings in different regions of China in terms of design and construction, define the basic requirements for buildings in each climate zone, provide building climate parameters, and make rational use of climate resources in general, preventing adverse impacts of climate environment on buildings. When the building skin is

not able to adjust this difference to meet people's comfort needs, it needs the assistance of equipment that can adjust the indoor environment, which leads to more energy consumption and more serious environmental pollution. The relationship between outdoor climate conditions, skin adjustment capacity, and equipment energy consumption can be expressed as shown in Figure 1.

Building users have certain standard values for indoor temperature and humidity, ambient radiation temperature, ventilation rate, indoor air quality, indoor illumination, and sound. Compared with the traditional building skin, the dynamic adaptive skin has stronger adjustment ability, which can selectively control the amount of outdoor temperature and humidity, solar radiation, wind, and noise entering the room, adjust the indoor environment to meet people's comfort requirements, and reduce the building's energy consumption in heating, cooling, and lighting. The indoor air environment is related to the indoor air quality. The indoor air quality can be improved from the perspective of control approaches through natural ventilation of the skin and structural design related to mechanical ventilation. The indoor acoustic environment is related to the sound pressure level of the indoor environment and the characteristics of the sound. The skin is related to the acoustic design of the skin material and structure to control the noise entering the room. The indoor light environment is related to the indoor illuminance. According to the room's function, users have different light environment requirements, and the skin is related to the lighting design including the form, size, structure, materials, and other lighting openings. In summer, too high relative humidity makes people feel "sultry," while too low relative humidity makes people feel "dry heat." In winter, too high relative humidity can make people feel wet and cold, while too low relative humidity can make people have sore throat and dry and itchy skin. The average radiation temperature refers to the average temperature of the radiation effect of the surrounding surfaces on the human body, and the amount of radiant heat exchange only depends on the temperature of each surface and the relative position between people and the surface. According to the Technical Specification for Healthy Housing Construction formulated by China Engineering Construction Standardization Association in 2009 [22], the design reference target values of relevant factors are shown in Table 1.

Among the abovementioned factors affecting thermal comfort, people pay more attention to air temperature, humidity, and airflow velocity. Building heating, cooling, and ventilation equipment also focuses on these three factors to change the indoor environment but pays less attention to the average radiation temperature. In winter, people pay more attention to the indoor air temperature and ignore whether the internal surface temperature of walls or windows is too low. Similarly, in summer, the internal surface temperature of the building skin with poor thermal performance is too high, and people still feel hot. The inner surface temperature of the building skin is comfortable only when it is 34°C lower than the human surface temperature. The thermal conductivity of the skin is reduced, the gap between the radiation temperature of the inner surface of the building skin and the indoor design temperature is narrowed, and the indoor air flow rate and indoor humidity within the appropriate range are maintained by enhancing the natural ventilation effect of the skin, so as to reduce the compensation of energy consumption equipment for indoor environmental comfort and achieve the purpose of reducing energy consumption.

3.2. Artificial Intelligence Combined with Climate Adaptive Optimal Design of Building Skin. In a broad sense, epidermis includes biological level and material level. The epidermis is interpreted as follows: first, the most superficial layer of plants and animals; second, the outer layer of human and animal skin. The inner skin refers to maintaining the surface of the internal functional space or having independent functions. The outer skin refers to the outermost interface directly contacting with the outer space. In the single skin of some buildings, the inner and outer skins are integrated. In addition, the epidermis can be divided into differential homeomorphism epidermis, namely, topological homeomorphism epidermis and nonhomeomorphism epidermis according to the degree of topological transformation. Homeomorphic epidermis can be divided into differential homeomorphic epidermis and topological homeomorphic epidermis. Differential homeomorphism skin refers to the skin formed in the process of differential homeomorphism extrusion, stretching, bending, and torsion. Topological homeomorphism skin refers to the skin formed in the process of topological homeomorphism transformation of buildings. Nonembryo skin refers to the skin formed by the nonembryo changes of buildings. Then, after more than 30 years of development, fruitful application results and theoretical research progress have been made. Especially in recent years, the upsurge of evolutionary computation has been formed in the century, computational intelligence has become an important direction of artificial intelligence research, and later the rise of artificial life research has made the genetic algorithm receive extensive attention. The basic idea of the algorithm is that referring to the basic principle of Darwin's theory of biological evolution, the problem to be solved is simulated as biological evolution, and chromosomes are selected and reserved according to the principle of survival of the fittest, so that new individuals are constantly generated in iterative evolution, and individuals are constantly optimized. The architecture of AI application is shown in Figure 2.

The multiobjective genetic algorithm puts forward niche theory for the first time, which can effectively keep the diversity of the population in the operation of the algorithm, and introduces the concept of Pareto rank to classify individuals, which has an important influence on the development of the later multiobjective optimization. When selecting individuals, individuals with small Pareto rank and large fitness value are preferred. When encountering individuals with the same Pareto rank, the niche theory is introduced to maintain the diversity of the population, and the individuals with smaller niche numbers are selected as

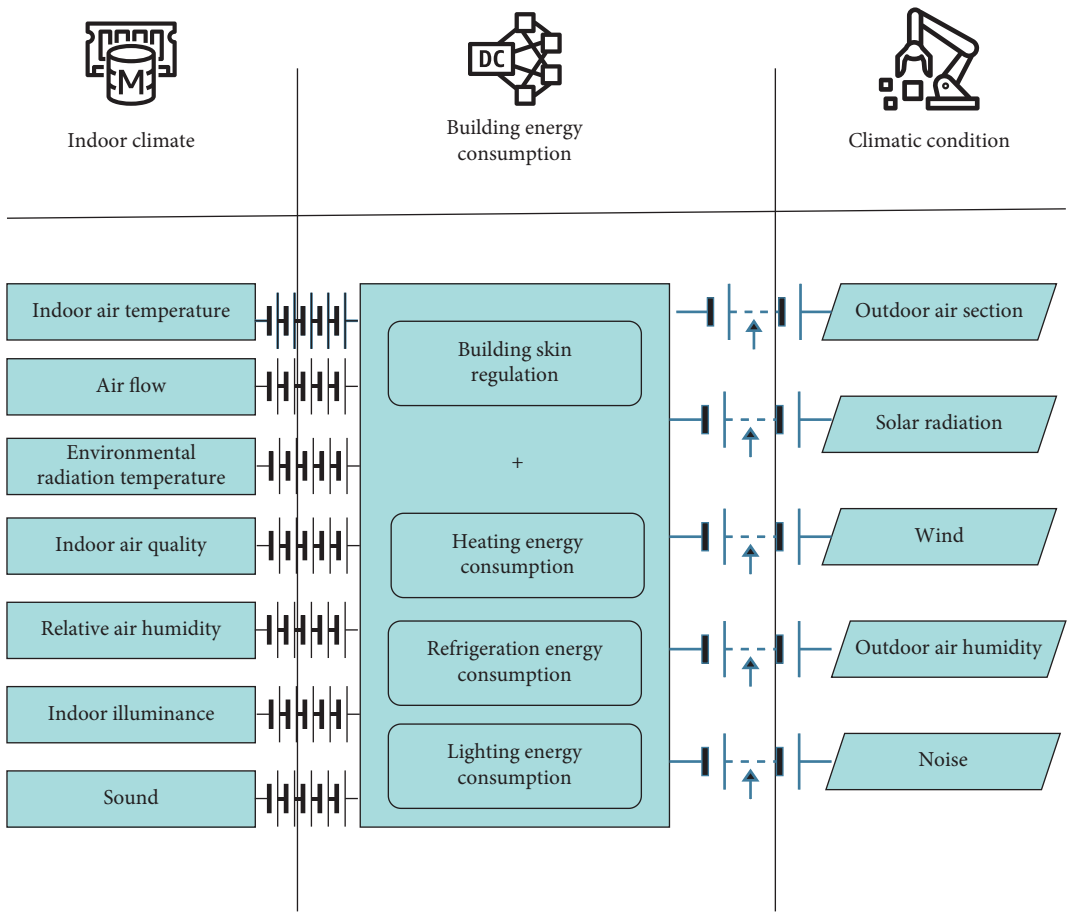

Figure 1: Relationship among indoor environment, building energy consumption, and climatic conditions.

Table 1: Reference index of indoor thermal environment.

Parameter	Standard value	Remarks
Temperature (°C)	24~28 18~22	Refrigeration in summer Heating in winter
Air velocity (m/s)	≤0.3 ≤0.2	Refrigeration in summer Heating in winter
Air tightness ventilation rate	1 0.5	Hot summer and warm winter, hot summer and cold winter area And cold and severe cold areas
PMV index	0.5~0.5	—
Relative humidity (%)	40~65 30~60	Refrigeration in summer Heating in winter

excellent individuals to be reserved for the next generation. However, MOGA is too simple in the distribution of fitness value, sensitive to the density of niche search space and the shape of Pareto optimal solution, and easy to rely too much on the convergence radius of niche.

The basic operation of noninferior hierarchical sorting is as follows: in the current population, first, we construct a noninferior solution set F_k (noninferior solution refers to individuals who are not dominated by any individual in the population, and the set composed of noninferior solutions is called a noninferior solution set), set the highest dominance level of $k = 1$, and assign a larger virtual fitness value of f_d^k to individuals in the solution set. We ignore the individuals in the noninferior solution set F_k, let $k = k+1$, and construct the noninferior solution set F_k again in the current population. Similarly, the dominance level of the solution set is k, and we assign a virtual fitness value to the individuals in the solution set, which is smaller than the fitness value assigned by the previous dominance level. We repeat the abovementioned process until the stratification of individuals in the population ends.

The algorithm uses the shared niche technology to calculate the new fitness value according to the assigned virtual fitness value for each individual within the

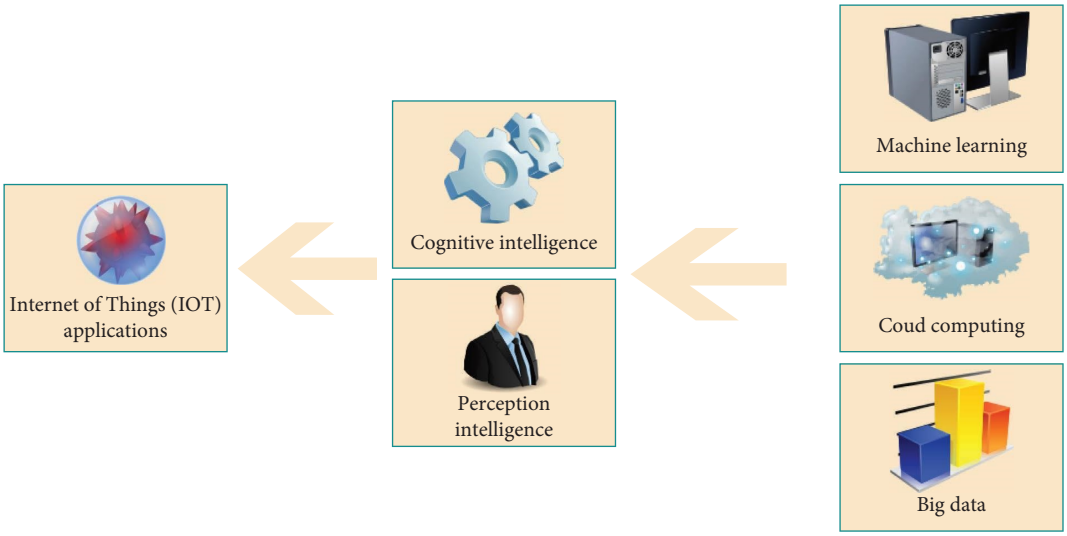

Figure 2: Structure diagram of artificial intelligence.

dominance level as the basis for the selection operation. The specific steps are as follows:

$$d(j-i) = \sqrt{\sum_{n-1}^{N}\left(\frac{M_{n-M_n^j}^{i}}{M_n^{\max}-M_n^{\min}}\right)^2}, \quad (1)$$

where N is the number of objective functions and $M_n^{\max}$ and $M_n^{\min}$ are the maximum and minimum values of the n objective function, respectively.

We use formula (1) to calculate the sharing function of individual j and individual i:

$$\mathrm{Sha}\left(d_{j-i}\right) = \left\{\begin{array}{c} 1-\left[\dfrac{d_{j-i}}{\sigma_{\mathrm{share}}}\right]^2, d_{j-i} < \sigma_{\mathrm{share}} \\ \\ 0 \end{array}\right\}, \quad (2)$$

where σ_{share} is a predetermined niche parameter, also known as the shared radius.

We calculate the niche number of individual j.

$$M_j = \sum_{i}^{N_k}\mathrm{Sha}\left(d_{j-i}\right), \quad (3)$$

where N_k refers to the number of individuals in the noninferior solution set k corresponding to the F_k dominance level.

We calculate the new fitness value of individuals as

$$f_{sha}^{k}(j) = \frac{f_d^k}{M_j}. \quad (4)$$

The nondominated sorting genetic algorithm (NSGA) is a genetic algorithm based on Pareto optimal solution. Among many multiobjective optimization genetic algorithms, NSGA more directly and comprehensively reflects Goldberg's non dominated sorting idea. Its theory is mature and has been applied to many fields. However, NSGA also has some shortcomings. For example, when the population size is large, the adoption of the noninferior stratification method will lead to the extension of the running time of the program. The algorithm lacks elite retention strategy. Although niche theory ensures the diversity of the population, it cannot retain outstanding individuals. In addition, NSGA is also sensitive to the sharing radius, which has certain limitations in application.

Artificial intelligence is a branch of computer science. Its fundamental goal is to enable machines to think like human beings, which includes many technologies that are currently being developed and is still far from reaching the true meaning of "artificial intelligence." In the application of dynamic climate adaptive building skin, because it is difficult to grasp the law of changes in outdoor climate environment, the quantitative relationship between changes in skin components and the ability to adjust environmental factors is also difficult to determine, and whether based on preset automatic control or intelligent control based on feedback mechanism, its controller follows a fixed control logic. It cannot be perfectly adapted to the outdoor climate and environmental changes with low regularity. The inspiration of big data to dynamic climate adaptive building skin can be divided into two following aspects: one is that a large number of similar skin usage data supports the machine learning of this skin and the support of big data speeds up the learning progress of machine learning of dynamic climate adaptive building skin. Secondly, it will be the future trend to connect the dynamic climate adaptive building skin with other intelligent building equipment, share information, become a system, coordinate with each other, and jointly adjust the indoor environment.

3.3. Improved Multi-Pareto Evolutionary Algorithm. The solar thermal gain coefficient is one of the physical quantities used to evaluate the performance of a window, which

represents the ratio of the amount of solar radiation passing through the window interface to the total amount of sunlight incident. Dynamic skin is different from traditional window components, and its form is complex. At present, there is no software that can directly calculate the SHGC value of dynamic skin. In the process of photon propagation, there are three forms of interaction with the medium surface, namely, light reflection, light absorption, and light transmission through the medium. The geometric arrangement state between the molecular chains in the medium determines its properties. For materials with an isotropic aggregate structure, light can pass through rather than be fully reflected or absorbed. For materials with an anisotropic aggregate structure, light cannot pass through but can only be reflected and absorbed. With the rapid development of architectural technology, the skin represents itself independently, and the form of architectural skin is becoming more and more rich. Building skin can be divided into two basic types from the perspective of space enclosure and volume form, namely, exterior skin and interior skin. Generally speaking, the topological structures such as square, round, or sheet are usually formed by the tight combination of the outer skin. However, there is no direct connection between the inner epidermis, which is mainly connected by the internal space.

Minimal surface is favored by designers because of its unique aesthetic feeling and mathematical connotation, and popular three-dimensional software on the market has gradually built it in. For example, the implicit equation of spiral minimal surface Gyroid adopted by Taichung Opera House is $\cos(x)\sin(y) + \cos(y)\sin(z) + \cos(z)\sin(x) = 0$, which can generate lattice in Grasshopper and make the coordinate values of each point meet this equation, and then it can be shaped with the help of ISO surface arithmetic unit in millipede plug-in. In the paper "Weierstrass representation of minimal surface and architectural modeling," the general solution of minimal surface in three-dimensional space is analyzed as

$$\left\{\begin{array}{c} x = 2\mathrm{Re}\int \varnothing_1 d_z = \mathrm{Re}\int f\left(1-g^2\right)d_z \\ y = 2\mathrm{Re}\int \varnothing_2 d_z = \mathrm{Re}\int if\left(1+g^2\right)d_z \\ z = 2\mathrm{Re}\int \varnothing_3 d_z = \mathrm{Re}\int \mathrm{fgd}_z \end{array}\right\}. \tag{5}$$

Before the Pareto selection, the meaning of Pareto optimal solution theory and the specific process of Pareto selection should be clarified. Pareto optimal solution theory clarifies the idea of domination, assuming that multiobjective optimization is a minimum problem, set m objective functions to constitute vector $f(x) = (f_1(x), f_2(x), \ldots, f_m(x))$, and take any of the two variables $x_1, x_2 \subset U$. When $\forall i \in \{1, 2, \ldots, m\}$ makes $f_i(x_1) < f_i(x_2)$, x_1 governs x_2. When $\exists i \in \{1, 2, \ldots, m\}$ makes $f_i(x_1) < f_i(x_2)$ and $\exists i \in \{1, 2, \ldots, m\}$ makes $f_i(x_1) > f_i(x_2)$, it is said that x_1 and x_2 do not dominate each other.

We use formula (6) to calculate the distance between candidate j and other individuals in the population:

$$\mathrm{dji} = \sqrt{\sum_{k=1}^{N}\left[\frac{M_k^i - M_k^j}{M_k^{\max} - M_k^{\min}}\right]^2}. \tag{6}$$

In the genetic algorithm, the crossover process and mutation process may cause the individual to mutate into a better individual, which plays an important role in increasing the diversity of the population but may cause certain damage to the excellent individual. To reduce this damage, after each crossover process and mutation process, the offspring and the parent are compared using Pareto optimal solution theory. If the fitness value of the offspring is indeed better than that of the parent, the offspring will be retained; if the fitness value of the offspring is lower than that of the parent, the parent will be retained.

The construction unit expects to complete the project with the lowest cost and the shortest time limit. Formula (7) can make the processes in the scheme meet the logical relationship, and formula (8) ensures that the daily resource usage does not exceed the upper limit of resource supply. Then, formulas (9) and (10) are used to determine the project time limit and cost. Finally, Powertrain control module (PCM) multiobjective selection theory is used to compare and choose multiple schemes.

$$t_j - t_i - d_i \geq 0,\ j \in S_i, \tag{7}$$

$$\sum_{t_{j\in A_{t_j}}} r_{\mathrm{dik}} \leq b_k\ (k = 1, 2, \ldots, p), \tag{8}$$

$$\min T = \max\{t_i + d_i \mid i = 1, 2, \ldots, n\}, \tag{9}$$

$$\min M = \sum_{i=1}^{n} m_{ig}\ (g = 1, 2, \ldots, q). \tag{10}$$

For PCM-driven dynamic skin, light first enters the skin from the outside through the glass, and part of the light will be emitted from the cavity inside the skin to the outside or indoors through the glass. Therefore, in the incident phase, the external medium is outdoor air, and the adjacent medium is glass. In the emergent stage, the external medium is air in the cavity, and the adjacent medium is glass. It can be seen that for the dynamic skin prototype, the incident light entering the skin and the outgoing light passing through the skin are both air medium incident to the glass surface and then transmitted to indoor or outdoor. For the above-mentioned problems, the following solutions are adopted. First of all, the reflection, absorption, and transmission coefficients of the glass material are based on the data provided by the manufacturer in LBNLWindow. The heat absorption effect is considered, and multiple Fresnel reflections between the inner and outer surfaces of the glass are also included in the data provided by the manufacturer. At the same time, according to the reflection law, computer tools are used to simulate the propagation of light waves in the dynamic skin unit to avoid manual calculation, and energy transfer calculation is carried out in the process of ray tracing. The computer solves a problem by using all the

possibilities collected in the database to analyze and deal with one thing. The speed of solving problems varies with different computing power of computers. The answers are very scientific and reasonable but not humanized. Because human beings have leaping thinking ability and emotional factors, solving problems is often unexpected. It is a solution that greatly protects human interests or their own interests. Finally, the reflected energy, transmitted energy, and absorbed energy of the dynamic skin as a whole are obtained, and the overall reflection coefficient, transmission coefficient, and absorption coefficient of the skin are calculated. Similarly, for the light ray reflecting the interior side glass surface, the next time it will not reflect and refract the interior side glass surface. For the light reflected from the sunshade or the edge structure, the next time and the four types of materials may reflect or refract.

4. Result Analysis and Discussion

The building skin not only has the function of limiting space, enclosing the main body of the building and expressing form but also should effectively use the favorable factors in the environment to resist the unfavorable factors from entering the room. In the last chapter, many shortcomings of the existing building skin in adjustability and utilization of outdoor environmental factors are analyzed. Although the traditional fixed skin has excellent thermal insulation performance, it "shuts out" the outdoor environment, and its environmental adaptability and application range are greatly limited. In order to cope with the changing climate conditions, we should give full play to the dual functions of building skin as "use" and "prevention." At the beginning of the design, the dynamic skin should consider various solutions to the complex climate in the life cycle of the building and increase its adjustability to solve the comprehensive adaptability of the building skin. The World Health Organization has found that the long-term stability of indoor thermal environment will lead to "sick building syndrome." Because of the popularity of air-conditioned environment, people who stay in air-conditioned environment for a long time will have a decline in human adaptability, physiological resistance, and immunity. For another example, the air interlayer can collect the solar radiation heat and heat the indoor temperature, which is a part of the heat storage system. If some openings are designed on the outer glass, hot air pressure can be used to make the air in the glass interlayer flow and help indoor air ventilation, which is part of the ventilation system.

The purpose of skin integration is to improve its performance, that is, more "use" of favorable climatic conditions and "protect" unfavorable climatic conditions from entering the room. In the skin energy-saving design, the basic strategies of each technical key point have been analyzed one by one in the previous section and are summarized as shown in Table 2.

It can be seen from Table 2 that due to the immutability of traditional building skin, different energy-saving performance improvement strategies may contradict each other and different energy-saving performance improvement strategies may be combined with each other. In winter, the building skin mainly plays the role of lighting, heat preservation, and solar energy utilization, while in summer, it mainly plays the role of shading, ventilation, and heat insulation.

Octopus provides a variety of machine learning tools, including support vector machine, artificial neural network, and composition pattern generation network. This paper uses support vector machine as a supervised learning tool. Support vector machine is actually a kind of classifier that classifies data according to the supervised learning method. For linear separable data, basic linear separable data, and linear nonseparable data, support vector machine can segment the data through two-dimensional linear functions, planes, or hyperplanes to find the existence range of input instances. The value of c specifies the acceptable error range of SVM. The larger the value of c, the smaller the allowable error range and the more accurate the classification. On the contrary, the smaller the value of c, the larger the allowable error range and the lower the classification accuracy. The SHGC, U, and VT values corresponding to the dynamic skin with different diameters of shading balls are obtained above, and these initial parameters are used as training data to be learned by support vector machines. Figures 3–8 show the original data of some parameters and the functional relationship obtained after training.

The energy consumption simulation module adopts Ldybug and Honeybee based on Grasshopper platform, and its kernel is software such as Energy Plus, Radiance, and Daysim, LBNLThermal. By calling this software, the building energy consumption simulation, lighting simulation, and window heat transfer calculation are completed. As can be seen from the previous part, the evaluation index is the typical daily load in winter and summer. Therefore, according to the four design working states of dynamic skin, the cold and heat loads of experimental buildings with dynamic skin in typical summer days and typical winter days are simulated. In summer, the dynamic skin is in shading state, radiating state at night, gaining heat during typical winter days, and keeping warm at night, and finally the typical daily load in winter and summer is obtained.

The temperature field and velocity field in the whole area after the dynamic adaptive skin cover the insulation board. As shown in Figure 8, the natural convection intensity of air is further weakened compared with that in the figure. Similar to the daytime rule, the weakening of convection heat transfer makes the temperature change of the inner wall relatively small, and the temperature is increased by 0.1°C compared with the 1500 mm buffer layer. Thanks to the influence of convective heat transfer changes, the thermal insulation performance of 1200 mm buffer layer is better than that of 1500 mm buffer layer.

At the same time, in combination with the construction costs and operating energy costs of the experimental and benchmark test pieces, the economic analysis of the dynamic skin can be conducted through the investment recovery period to verify the economic feasibility of the application of the dynamic skin in the project. Two comparison test pieces, including dynamic skin model test piece and benchmark test

Table 2: Basic strategies for key technical points.

Lighting	Increase sunlight into the room
Heat preservation	Enhance the tightness of the skin and reduce the heat transfer coefficient of the skin
Solar energy/power	Increase solar radiation into the room, and more solar energy is converted into thermal energy
Hide from sunlight	Reduce the sun's rays into the room
Ventilate	Reduce the airtightness of skin
Insulate against heat	Reduce skin heat transfer coefficient, increase heat storage, and reduce indoor and outdoor energy exchange

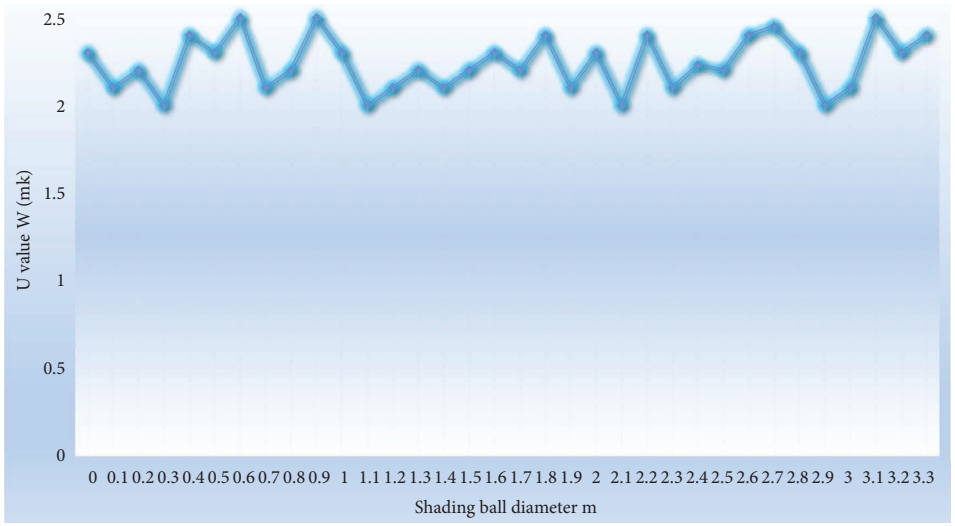

Figure 3: Simulation U value of dynamic skin driven by PCM of various sizes in summer shading state.

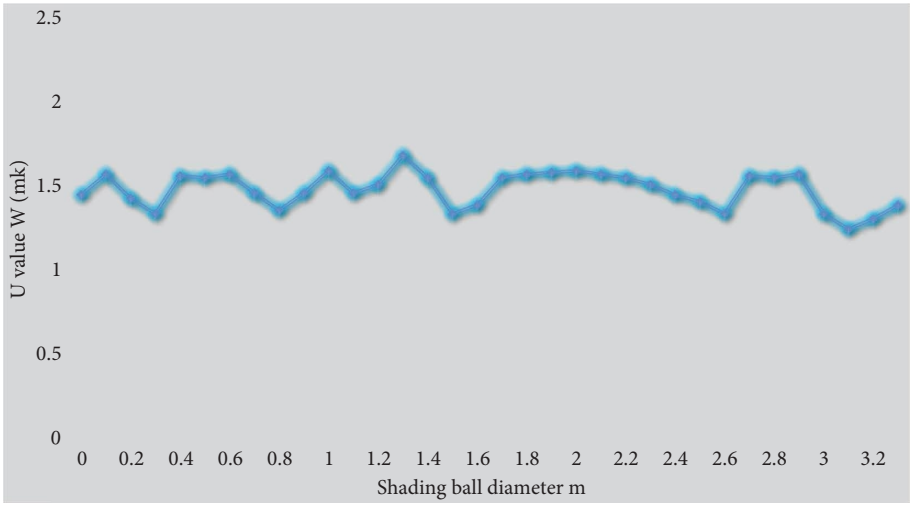

Figure 4: Relationship function between shading ball diameter and skin U value obtained by machine learning.

piece, are set up for the hot box comparison experiment, which are installed on two identical hot boxes, respectively. During the experiment, they are placed in the same outdoor environment. The internal temperature of the hot box, the internal and external surface temperature of the test piece, and the change of heat flow are monitored and recorded to evaluate the relative thermal insulation performance of different test pieces and their impact on the internal thermal environment of the hot box. At the same time, the dynamic skin driven by PCM can also become an economical and reasonable low-energy building curtain wall scheme as long as the reasonable price of sunshade spherical film material is selected. Compared with ordinary glass windows, PCM-driven dynamic skin has obvious energy-saving

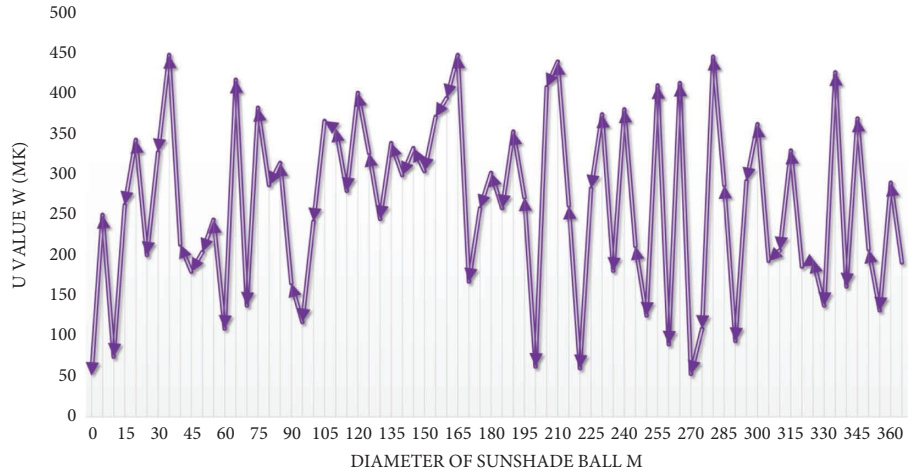

Figure 5: *U* value of dynamic skin simulation driven by PCM of all sizes in summer heat dissipation state.

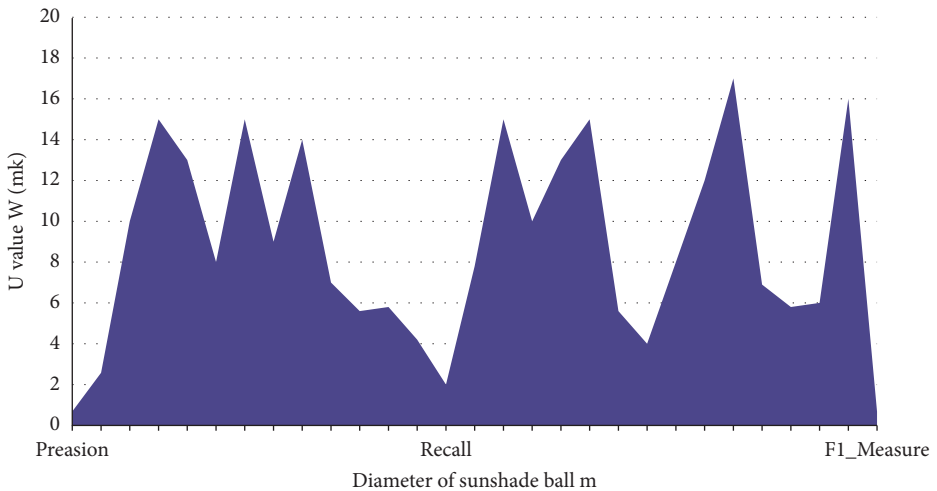

Figure 6: Relation function between sunshade ball diameter and skin *U* value obtained after machine learning.

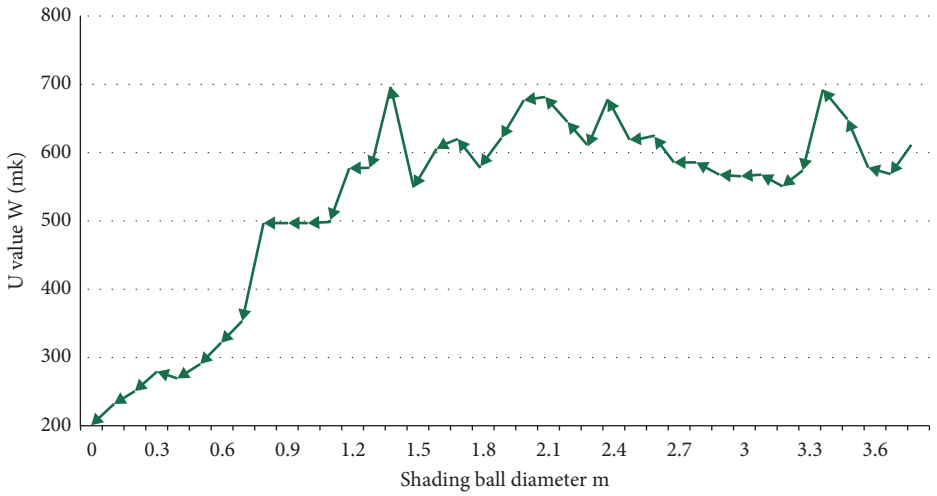

Figure 7: Dynamic skin simulation *U* values of PCM drivers of all sizes in winter insulation state.

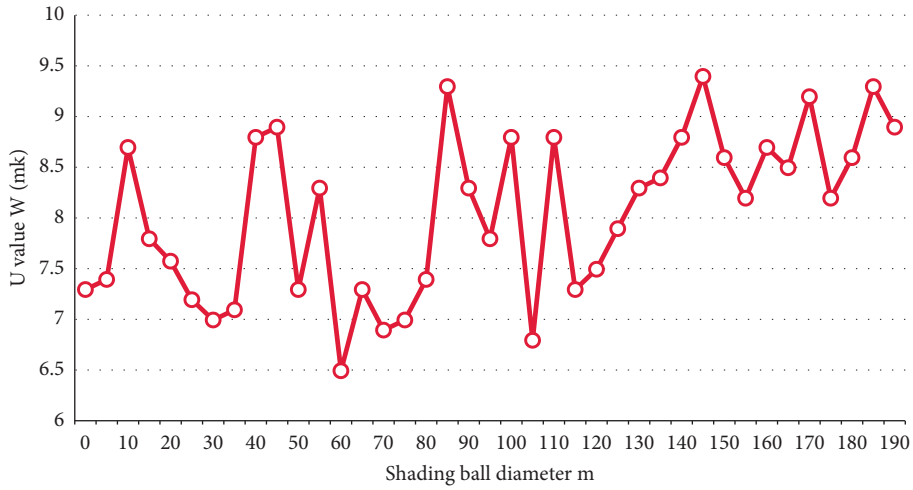

Figure 8: Relation function between sunshade ball diameter and skin U value obtained after machine learning.

advantages in summer climate, which can effectively block indoor heat gain during the day, and its effect is more obvious in sunny weather compared with cloudy weather with little direct sunlight.

5. Conclusions

Building skin is an important part of the intelligent building perception system. It has gone through three stages of development, namely, variable devices, information feedback, and intelligent interaction. Now, it can undertake more and more functions by combining machine learning, big data, and Internet of things technology. The maturity of modern industrial technology and information technology has been very high, and now it has ushered in the era of artificial intelligence. Parametric design, modular design, and other design-related technologies are also becoming mature. Because of its intelligent, organic, and sustainable characteristics, the dynamic climate-adaptive building skin can adapt to the development trend of the times, and it is bound to be accepted by the times. How to maximize the function of technology while bringing aesthetic characteristics different from those of previous times is a question that needs to be considered in the future development of dynamic climate-adaptive building skin. Based on the abovementioned reasons, this paper mainly studies several key methods in the design process of climate responsive dynamic building skin in hot summer and cold winter regions and puts forward corresponding solutions around three main work contents in the design process, namely, design response to climate, selection and application, performance evaluation and optimization. The heat transfer and fluid flow in the dynamic skin are simulated. Through comparing and analyzing the temperature field and flow field distribution under different working conditions, it is proved that the dynamic adaptive skin model has good thermal performance. Even if all possible parameters are considered, the model proposed in this paper is still relatively simple compared with the variables of the natural model. A more accurate model is the future research work.

Data Availability

The figures and tables used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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Research Article

Design and Application of Multimedia Technology-Based Curriculum for Visual Communication Majors

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The rapid change of technology has driven the information industry to advance and develop, and the computer network technology has been greatly improved, which also promotes the artistic expression of visual communication to develop in the direction of diversification and enrichment, providing designers with more sufficient performance carriers in visual communication design. As an essential communication method and medium in modern art and design, multimedia technology assumes the role of information transmission and communication in the teaching process of visual communication design and is an important communication platform. At the same time, in order to meet the market demand for talents, visual communication professional teaching is also faced with the contemporary task of cultivating innovative talents. And multimedia technology is gradually being applied in the field of education and teaching, becoming one of the driving forces to promote the evolution of teaching methods and teaching modes. Multimedia technology, as a medium of visual symbolic communication with the times, can not only expand and extend the depth and breadth of visual communication professional teaching but also promote the improvement of teaching methods and modes. This paper proposes that, against the background of continuous technological innovation, it is very necessary to further integrate multimedia technology into the teaching of visual communication majors. This paper discusses and analyzes and studies the application of multimedia technology in the teaching of visual communication from the aspect of innovative development in the teaching of visual communication.

1. Introduction

In recent years, China's science and technology and humanities education have achieved rapid development; technology is developing in the direction of high-end, and education is progressing in the direction of modernization; the development of education and technology promote each other and cannot be separated [1, 2]. Along with the rapid development of multimedia technology, the carrier tools for visual information communication are also being updated, and along with this is the teaching of visual communication design, using various cutting-edge media technologies such as multimedia, digital media, new media, and other means to carry out unique and innovative education and teaching, giving full play to the advantages and role of media technology in the teaching of visual communication design to cultivate modern comprehensive talents effects [3, 4]. In the new round of teaching reform, the school proposes not only to innovate in teaching methods but also to completely change the traditional teaching mode of the past. To cultivate composite and application-oriented talents, we should increase the training of practical courses, constantly expand teaching resources, reduce the in-class hours, effectively increase the second and third classroom auxiliary teaching, increase the multimedia teaching methods, carry out online and offline synchronous teaching modes, and implement a multidimensional practical teaching mode.

The traditional way of teaching visual communication education has been continuously impacted by digital multimedia technology, and it has reached the point where it has

no choice but to change [5]. The form of visual communication is also gradually changing from the previous flat and static to the dynamic and networked direction. The form of communication also develops from single media to multimedia, extends from a two-dimensional plane to three-dimensional, and transforms from the previous print design to the network information image communication design. The visual communication design, which is mainly in the form of disseminating flat information, has also, under the impetus of digital multimedia technology, produced qualitative changes [6, 7]. Digital film and television advertising, Internet advertising, multimedia electronic display, interactive multimedia, and other new generations of advertising visual communication methods have quietly penetrated into every aspect of social life.

The rapidly developing digital technology and network communication technology have completely changed the thinking method, communication method, design mode, and appreciation mode of art design in real life, and multimedia technology has become an indispensable part of our life [8, 9]. We should integrate visual communication with multimedia technology and use it extensively in the teaching process.

Therefore, in the new round of talent training program, in order to meet the needs of society and the industry market for visual communication professionals, professional teaching should adjust the curriculum construction at the right time and keep up with the market requirements of advertising design, digital image processing, film and television choreography, brand packaging design, brand image design, animation design, environmental visual design, display design, public art media, cultural and creative brand design, network advertising design, interaction design, and other practical courses interspersed in different teaching processes.

2. Multimedia Technology and Visual Communication Design

2.1. Overview of Multimedia Technology. Multimedia technology has been developed rapidly with the popularization of high-speed information network [10, 11]. The technology can form an interactive logical connection system in the application process, and the objects contained in the system are mainly text, graphics, images, video, and sound. In view of the integrated role of the technology, multimedia technology itself is also a collection of diverse technologies, including writing technology, audio information processing technology, communication technology, and remote technology, etc. The development and application of these technologies have enabled all aspects of human social work and life to bask in the sunshine they bring.

Since ancient times, the media has been an important channel for the transmission and communication of information in society. With the development and innovation of information technology, diversified media with multiple functions of storage, processing, dissemination, and presentation have gradually become the tools and media for people to transmit information. Driven by the rapid development of technology, media technology is developing in the direction of digitization, popularization, and intensive high-end and gradually becoming an important auxiliary tool in the fields of education and training, exhibition, and display. The development of media technology not only changes people's lives but also gives birth to new teaching methods. From the initial embedding of media projection in the classroom to simplify the process of image and text presentation and enhance teaching efficiency to the current use of networked and digital multimedia in teaching, the development of media technology is also promoting the transformation of teaching methods, on the one hand, providing modern tools and means for teaching; on the other hand, providing technical guarantee to promote the improvement of teaching mode.

2.2. Overview of Visual Communication Design. The rise of the visual communication design profession is inseparable from the development of China's economy and culture. Simply speaking, the visual communication design major cultivates design-oriented talents, which intend to vividly express the designer's ideas through certain expressions so that the receiver of information can fully understand a series of visual symbols [12, 13]. However, how to avoid the design from falling into the commonplace and to give the work contemporary, social, and cultural values is the key and most difficult point of teaching in this major. Visual communication is mainly the systematic, regular, and artistic arrangement of visual symbols and their presentation in the form of two-dimensional images to achieve the purpose of conveying, persuading, or teaching information by interacting with the audience's vision. Visual communication happens all the time, and people arrange visual symbols in different ways according to the laws of visual aesthetics to give people different visual experiences and thus gradually form visual communication design [14]. To a large extent, visual communication design emerged from the printing art design in Europe and the United States in the middle of the 19th century, and then passed through several stages such as decoration design and graphic design, and was driven by the evolution of media technology to form a comprehensive design discipline that includes not only traditional graphic design but also film and animation design. Looking at the development history of visual communication design, we can find that the emergence and development of media technology have pushed visual communication design to gradually evolve from flat and static to dynamic and comprehensive, and the application of media technology in visual communication design has provided multiple media for visual communication design and expanded the space of visual communication design (see in Figure 1).

The integration and development of multimedia technology and visual communication design is not only reflected in the practice of design but also in the teaching of design. More and more media technologies and their tools are applied to classroom teaching, becoming the medium for visual symbols to be conveyed. For visual communication design teaching, modern media technologies such as new

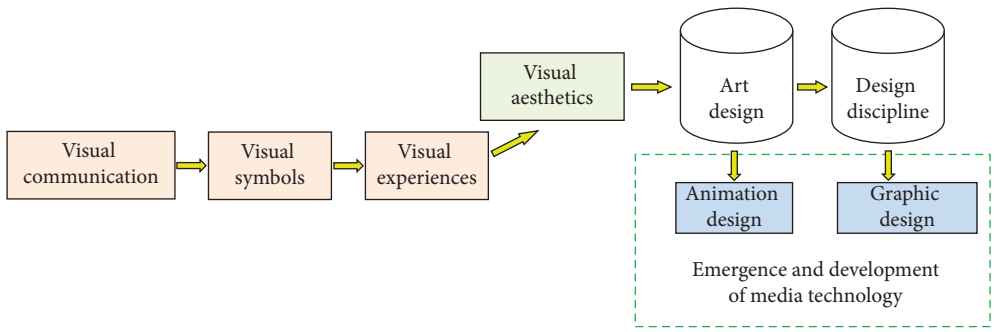

Figure 1: Visual communication design concept flow chart.

media and digital media have gradually become the means to update their teaching methods and improve teaching effects.

3. Problems Faced by Visual Communication Majors

3.1. The Old and Obsolete Teaching Mode. Most of the visual communication majors are developed from the former graphic design majors, so the teaching mode is still in place. Although the name has been changed, the teaching mode is still roughly the same as graphic design. This old and obsolete teaching mode has cultivated students who cannot adapt to the needs of social development, and many students have found that they have learned a very narrow employment after graduation. Although visual communication design is literally "visual" design, many people think that the focus is on the word "visual," but in fact, the focus should be on "communication" [15, 16]. The focus of the teaching of visual communication should be to solve the problem of "how to communicate abstract and complex content information in an accurate and effective way to consumers." The means of communication are diverse, if only at the "visual" level of meaning, which is very difficult to convey in information. It is difficult to stand out in the transmission of information if it only stays at the "visual" level. Today's new media development is actually an era of multisensory development. As long as we can accurately communicate the information in place, it is possible to use a variety of ways, but many teachers have not been able to clearly see this. Teachers habitually teach graphic design thinking to teach the visual communication profession, so that students have a distorted concept of their own professional definition, which will lead to many students thinking that scribble uniformity and regularity of drawing are the focus.

3.2. Inaccurate Professional Target Orientation. At present, the visual communication majors in most colleges and universities still have the problem of inaccurate positioning of training objectives, which will lead to the curriculum system of the visual communication majors is not well-constructed. Nowadays, entering the era of multimedia development, visual communication design should not only focus on the basic courses of graphic design but also on information interaction and multidimensional and multisensory design [17]. Most colleges and universities do not make much effort to reform the visual communication profession, mainly because of the understanding that visual communication is graphic design on the one hand and the weakness of the faculty on the other hand, which does not strengthen the construction of the faculty, resulting in many teachers not having enough insight into the professional foreword and not being able to make accurate judgment on the direction of professional development and training goals.

3.3. Irrational Curriculum Setting. In many colleges and universities, the curriculum design of visual communication majors fails to make systematic adjustment and modification, most of them still follow the traditional curriculum design system, although some institutions have made some adjustments for the development of multimedia, such as opening corresponding software courses, or opening multimedia courses in visual communication majors, in fact, these modifications are treating the symptoms but not the root cause, multimedia is a strong professional and Multimedia is a professional, content of a wide range of systems, a single increase in one or two courses will only let students know a little skin, so to adapt to the background of the development of multimedia era visual communication courses should start from the reform of the basic courses, only then the reform is meaningful, the students will have systematic learning.

Given a rational curriculum setting, the curriculum design of visual communication majors is defined as a set $\chi = \{\kappa_j\}_{j=1,2,3}$, where J is the number of 3 multimedia courses, and the traditional curriculum design system (u, v) of the jth a-student in the multimedia environment is denoted by the vector $\kappa_j \in x$. The background of the development of multimedia era visual communication courses consists of the basic courses $\varphi_t(\kappa)$ at each stage providing confidence $S_{jt} \in \mathrm{Rw} \times h$ for each course j, where w and h are the breadth and depth of the systematic learning, respectively, and t denotes the tth stage. The first stage of the corresponding software courses uses visual communication majors to provide confidence scores.

$$\varphi_t = \prod\prod\prod (\kappa|I),$$
$$\varphi_t \longrightarrow \left\{s_1^j\left(\kappa_j = \kappa\right)\right\}_{j=1,2,3}, \quad (1)$$
$$\varphi_t = \prod\prod\prod (\kappa|I) \longrightarrow \left\{s_1^j\left(\kappa_j = \kappa\right)\right\}_{j=1,2,3}.$$

All subsequent stages generate new confidence scores using the contextual information from the previous stage.

$$\varphi_t > \prod\prod\prod [\kappa|\mathbf{I}, \psi(\kappa, S_{t-1})],$$
$$\prod\prod\prod [\kappa|\mathbf{I}, \psi(\kappa, S_{t-1})] \longrightarrow \left\{s_t^j\left(\kappa_j = \kappa\right)\right\}_{j=1,2,3}, \quad (2)$$
$$\varphi_t > \prod\prod\prod [\kappa|\mathbf{I}, \psi(\kappa, S_{t-1})] \longrightarrow \left\{s_t^j\left(\kappa_j = \kappa\right)\right\}_{j=1,2,3},$$

where $S_t \in Rw \times h \times (J+1)$ corresponds to the confidence score map of all students and the background of stage t; $\psi(\kappa, S_{t-1})$ denotes the teacher-student communication from the confidence map $S_{t\text{-}1}$ to a wide range of systems x. According to the above formula, we can get the curve relationship between setting of multimedia course and reform of basic courses, as illustrated in Figure 2.

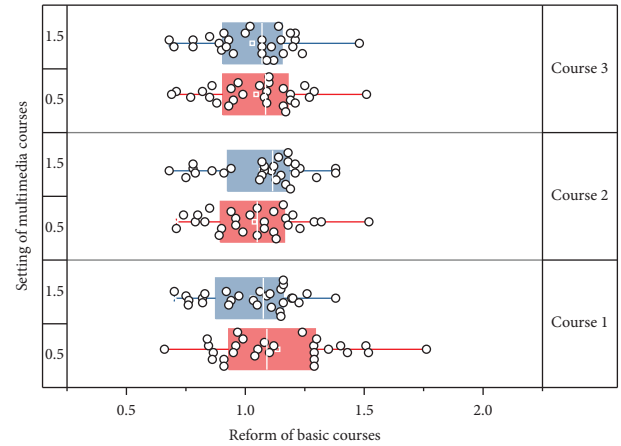

Figure 2: The relationship between the setting of multimedia courses and the reform of basic courses.

4. The Role of Multimedia Technology in the Teaching of Visual Communication

4.1. Enrich the Form of Visual Communication Design Classroom Teaching. After a long period of development, visual communication design has become a comprehensive and applied discipline with unique advantages in improving the visual expression effect. Visual communication design mainly takes visual symbols as the carrier, artistic design as the means, and innovative display as the purpose and represents the visual symbols after arranging them to achieve some kind of communication, implication, and teaching [18, 19]. Of course, after the arrangement and design of visual symbols, it is also necessary to rely on certain media to display the design results. The current medium for displaying the results of visual communication design is mainly based on multimedia tools developed by media technology, which make the graphic display of visual communication design more three-dimensional and intuitive. Therefore, visual communication design is also gradually applying media technology and multimedia tools for teaching, improving the way and effect of graphic display in the classroom.

4.2. Expanding the Capacity of Visual Communication Design Teaching. The application of media technology in the teaching of visual communication design can not only change the way classroom teaching, but also expand the capacity of classroom teaching and the total amount of course teaching, which can be reflected in the depth and breadth of teaching. First of all, the use of media technology and media tools in the classroom of visual communication design can refine and condense the course content so that the course can be simplified, eliminating redundancy and leaving the essence. Secondly, the course content of visual communication design is extensive and complicated, covering a wide range of areas. In the teaching process, with the help of media technology, teachers and students can always consult for a certain problem, and the classroom questions are answered in the classroom. In addition, teachers can use media tools to access content related to classroom teaching and expand the breadth of their teaching.

4.3. Optimize the Teaching Mode of Visual Communication Design. Teaching mode is closely related to teaching effect and talent cultivation, which not only directly affects the effect of classroom teaching but also indirectly affects the discipline cultivation goal [20]. In the current era of rapid development of information technology, we should make full use of advanced technology to improve teaching tools and teaching methods so as to enrich teaching contents and resources and improve teaching effectiveness. First of all, multimedia technology, as a platform for visual symbol innovation display, can help teachers and students understand the current development trend of visual communication design; secondly, multimedia technology has penetrated into every aspect of visual communication design teaching, becoming an essential auxiliary tool for students' learning and practice. From in-class to out-of-class, the application of media technology makes the teaching mode of visual communication design break the limitations of time and space, stimulates students' enthusiasm for independent learning, and optimizes the teaching mode of visual communication design. Figure 3 shows the flowchart of optimizing visual communication design as a teaching mode.

5. The Advantages of Using Multimedia Technology in Teaching Visual Communication

5.1. To a Large Extent, It Enriches the Teaching Content of Visual Communication. Visual communication design is a comprehensive application discipline that mainly uses graphic information as the carrier and has its own unique advantages in the expression of visual effects. Visual communication design is mainly through the visual media and visual symbols and other information to reexpress, in the performance of knowledge, and the graphic way will be more

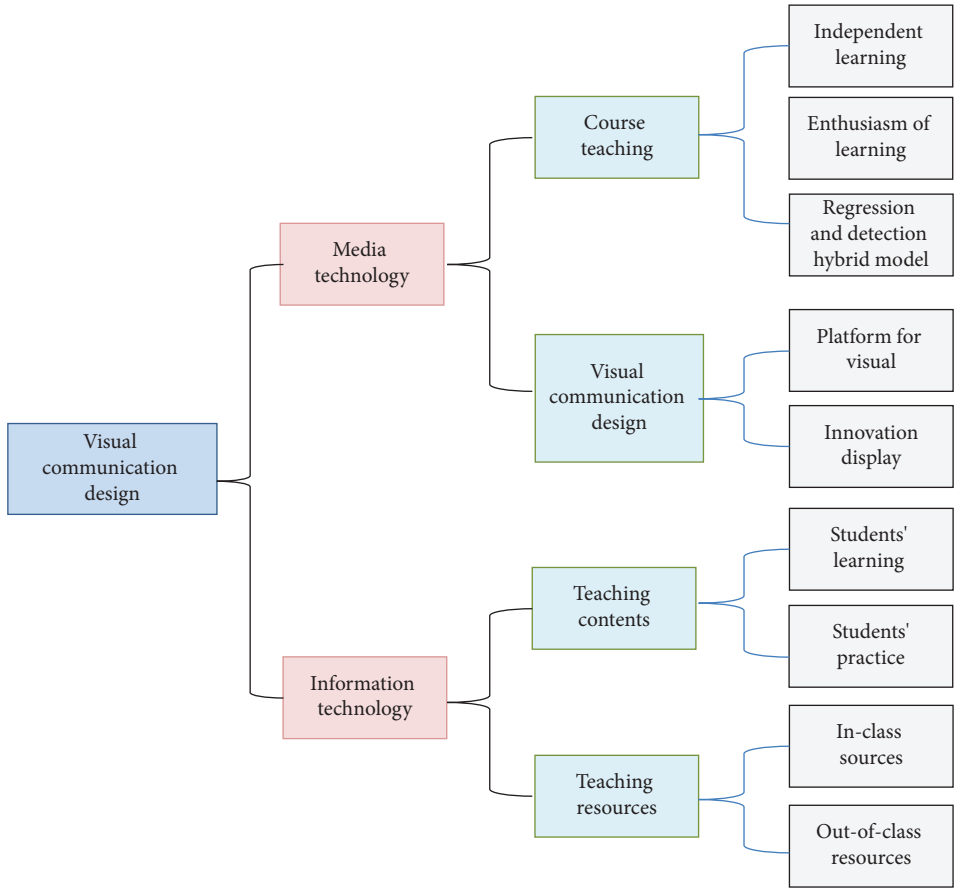

Figure 3: Flowchart of optimizing visual communication design as a teaching mode.

three-dimensional and more intuitive [21, 22]. Therefore, in the process of teaching visual communication design, multimedia technology should be used to make students have a more comprehensive understanding of the knowledge learned through images, animations, etc. The in-depth application of media technology will greatly contribute to the overall development of China's education.

5.2. Optimize the Teaching Mode of Visual Communication. The teaching mode is very crucial for students, and as the communication platform of visual communication design, it should fully reflect its value, actively use the rich information resources of the Internet to achieve efficient operation, and adopt the way of graphic presentation to achieve the purpose of further promoting the development of the subject teaching. When training talents, the basic concept of education includes conceptual, quality, and skill-based, among which quality is the education method often used in visual communication effects, and its main purpose is to cultivate students' comprehensive abilities in design. When visual communication design is reasonably applied in classroom teaching, it can effectively ensure the efficiency of classroom teaching and also create a good interactive learning environment for students so that students will not be restricted by time and place, thus largely stimulating students' interest in independent learning.

6. The Effective Application Strategy of Multimedia Technology in Teaching Visual Communication Design

6.1. Combine Multimedia Teaching with the Teaching Theory of Visual Communication Design. The ways of communication have expanded as a result of the modern society's ongoing advancement of information technology. The use of modern teaching methods can effectively improve the quality of teaching, but the actual application of the process of paying attention to teaching quality at the same time should also be certain to improve the quality of students and their personal comprehensive abilities. To ensure the quality of teaching indicators, it is crucial for universities not only to use modern teaching equipment in the teaching process but also to accurately grasp the learning interests of students at this stage. In addition, teachers should also continue to improve their own teaching philosophy and the teaching content and teaching methods to make certain adjustments. From the current stage of China's education career, the actual situation, the visual communication design teaching concept has gradually penetrated into the comprehensive course of teaching, and its overall innovation has been greatly enhanced. Teachers can effectively enhance students' independent learning ability by guiding them in teaching and also play a certain role in promoting students' personalized growth.

6.2. Combining Multimedia Technology to Establish a New Curriculum System. Media technology at each stage of development will produce different media tools, thus creating different visual communication contexts. At present, new media and digital media are developing vigorously. In this media technology context, visual communication design teaching should find new innovation points and focus points to realize the integration and innovative development of media technology and visual communication design teaching [23]. As a comprehensive discipline, visual communication design involves a lot of contents, and the relationship between its discipline branches is like a cross-existing relationship network, with interconnection, interpenetration, and mutual influence between each node. Therefore, the primary task of innovative development of visual communication design teaching is to combine and use cutting-edge media technology to establish a new visual communication design teaching curriculum, so that the teaching content and teaching logic are more in line with the needs of talent training in the new media context and make visual communication design teaching more reasonable and scientific. The construction of the new curriculum system should fully consider the training objectives, training mode, training program and specific curriculum system so as to align visual communication design education with the market-oriented talent needs and fit with the new media context. After determining the training objectives, training mode, and training program, the design of specific curriculum system should not only conform to the logic of gradual depth from basic to professional but also add corresponding practical and innovative courses in combination with media technology, fully explore the role of media technology in different teaching courses, and finally form a systematic and scientific new visual communication design teaching curriculum system that can cultivate students' comprehensive abilities.

According to Rabiman et al. [24], visual communication design V_j is constructed to represent the deviation from cutting-edge media technology G to the needs of talent training (each deviation i corresponds to a coefficient, representing, the x and y coordinates of the position of media technology deviation respectively), and then training objectives, training mode, training program, and specific curriculum system F_k are fused to select corresponding practical and innovative courses f_k from the predicted deviation h_k. The mathematical relationship is as follows and is illustrated in Figure 4.

$$V_j = \sqrt{G\left[x_j + F_k\left(x_j\right) - x_i\right]h_k\left(x_j\right)},$$

$$f_k\left(x_k\right) = \sum_j \frac{1}{\pi R^2} V_j, \tag{3}$$

$$f_k\left(x_k\right) = \sum_j \frac{1}{\pi R^2} \sqrt{G\left[x_j + F_k\left(x_j\right) - x_i\right]h_k\left(x_j\right)}.$$

6.2.1. Adapt to the Requirements of the Times and Improve the Construction of the Curriculum System. The establishment of a multilevel, cross-sectional elective course system, the promotion of high-quality, application-focused, and sustainable curriculum group construction, and the formulation of mandatory courses as the program's core all contribute to its new talent training initiative. In the general implementation of the "advertising design" "logo design" "packaging design" "corporate image design" On the basis of the main professional courses in "book design," the courses with integration and intersectionality are added at the right time to expand the structure system of the main professional course group. For example, in the course group of advertising design, add the course "network advertising design" to meet the higher demand for advertising design talents in the network information era. For the course group of visual communication design, the courses of "information visualization design, environmental visual design, public art media, and interactive design" are added to meet the demand for talents in the dynamic visual communication industry. In the area of film and television editing, "digital image processing," "animation design," and "film and television editing" have been added to improve the skills of visual communication design students in multidimensional space and dynamic film production and performance skills.

6.2.2. Case Study Teaching. The visual communication design major started late in the development of education in China, so it should give full play to the later advantages of the teaching of the major and draw on some relatively mature and instructive design cases based on a full understanding of the actual situation of students and the current domestic teaching environment. In the process of selecting teaching cases, it can reduce the phenomenon of teachers directly copying online teaching courseware and also allow students to see the difference between domestic and foreign design works and be able to take the essence and remove the dross. The process of case teaching not only requires the use of multimedia technology to find suitable cases in the vast amount of online information but also requires further use of multimedia technology to dissect, decompose, and imitate the design of the target case. To the fullest extent possible, students' initiative should be used in this process, not only to listen, watch, and record but also to require students to do a good job of analyzing the cultural value and emotion of the design cases, in order to ensure that students' designs are consistent with the fundamental principles of our nation.

6.2.3. Activity Teaching. The typical feature of the visual communication design major is that it is more practical and requires more hands-on skills from students. Multimedia technology itself is an operation-oriented technology, so the close cooperation between the two is even more indispensable to the students' repeated practice [25]. Therefore, diverse activities can be carried out in the teaching process, such as innovative design competitions with

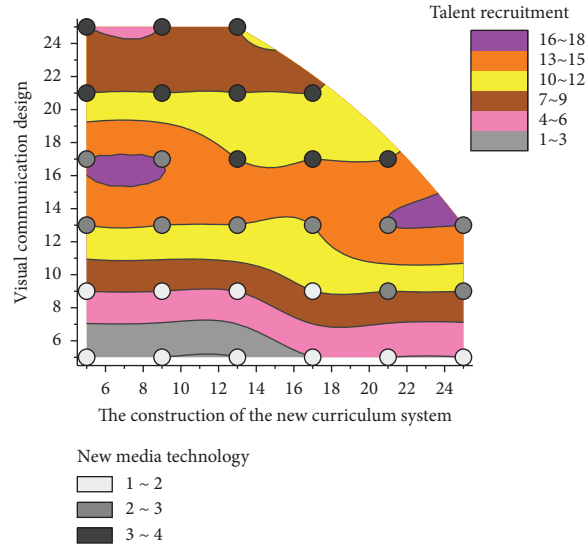

Figure 4: The cloud-point diagram of visual communication design and the construction of the new curriculum system using new media technology.

different themes, and the activities can target a specific knowledge point, such as text design. The rules of the competition should be as detailed as possible, including design requirements, design principles, and some finished drawings under different design difficulty factors, so as to stimulate students' exploration and pursuit of difficult designs. Multimedia technology operation activities can also be carried out in the form of competitions, which can be divided into two parts: the theoretical part is to test students' mastery of the basics of certain specific technologies, and the practical part is to test students' hands-on ability and their ability to apply the relevant technologies.

Students can do in-depth social, focused research and practice on all facets of design and development projects outside of the usual closed classroom setting, breaking the traditional closed classroom teaching model, in order to master the first-hand knowledge of the design project. At present, how to form the characteristics of the profession, visual communication design professional reform and innovation, and professional subject selection should be given full attention. This can be learned from the studio teaching model, learning to do in the middle, where the subject exists in the form of teaching can be real design projects or nonpractical project exercises, where the leading core of the art design course teaching process is the subject. The selection of the content of the topic is related to the final result of design teaching but also reflects the level of teaching ability and responsibility of the teacher. The main content of teacher preparation is to effectively make the selection of the topic and guide the teaching. Figure 5 illustrates the typical feature of the visual communication design major of activity teaching. The practice-based classroom is a supplement to activity-based education, which can also be utilized as an alternative classroom style. Teachers should respect students' subject positions while acting as instructors in the activity teaching classroom.

6.3. Change the Training Goal in Line with the Development of Multimedia Technology. Although the application of visual communication design to media technology is increasing, in the final analysis, visual communication design is still an artistic discipline [26]. Therefore, in the process of teaching, it is more important to cultivate students' innovative design consciousness and develop their design thinking. In the current teaching of visual communication design, the traditional teaching objectives and contents are still followed, and students mainly learn the basic theory of visual communication design and basic design practice. Although students can master modern design concepts and methods and skills, they lack the most important innovative design consciousness and ability, and the concept of "emphasizing skills but not innovation" has always occupied the main seat of visual communication design teaching. Even though media technology has been widely used in teaching, it has not changed this situation. Therefore, to achieve the innovative development of media technology and visual communication design teaching, it is necessary to clarify the goals of visual communication design teaching under a new curriculum system, to clarify the primary and secondary goals, and to divide the short-term and long-term goals. For students, the skills and methods of visual communication design are short-lived, while the awareness and ability of innovative design are the most important and long-term in their career. Nowadays, media technology continues to deepen and develop, generating more and more new concepts of media technology. We should follow the trend of media technology development, apply new media technology, such as digital media, to the teaching of visual communication design, and implant media technology into the goals and processes of visual communication design talent training. For example, on the basis of the cooperative relationship between schools and enterprises in talent cultivation, multimedia equipment is used for distance learning, thus linking school cultivation and enterprise cultivation

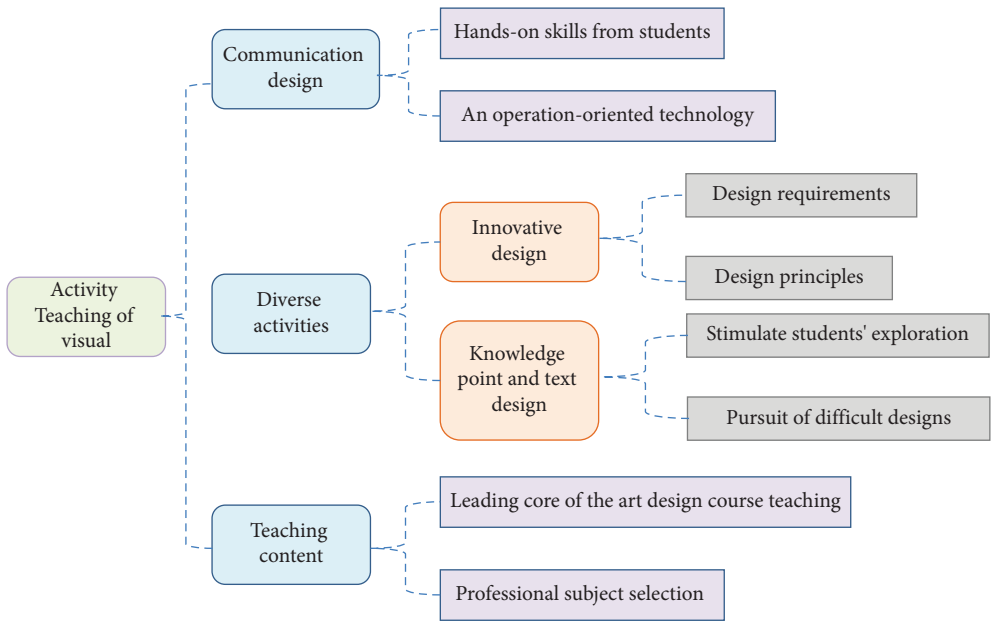

Figure 5: The typical feature of the visual communication design major of activity teaching.

more closely and enhancing the mobility and sustainability of both cultivations, so that students can clearly understand the changes in the talent market and the demand for talents in the visual communication design market, so that they can follow up their studies with direction and goals and improve their professional ability. According to the statistical data, the relationship between the demand for talents and the development of multimedia technology is drawn (Figure 6), including the separation and close relationship between schools and enterprises. It can be seen from the Figure that the closer the relationship between schools and enterprises in talent training, the more accurate the demand and guidance for market talents.

6.3.1. Forming Professional Characteristics with Clear Training Direction. This major cultivates high-quality applied professionals with integrity and professionalism, innovation and entrepreneurial consciousness, solid basic theoretical knowledge of visual communication design, mastery of the basic operation knowledge of enterprises and markets, and strong abilities in graphic design, new media design, brand image design, and production to meet the needs of the Internet era and the development trend of integration of art and design with other disciplines and professions. Visual communication design is the main research direction of graphic information communication in two-dimensional and three-dimensional space. The training of talents should meet the market demand of traditional industries such as books, advertisements, packaging, and brand image while at the same time meeting the new demand for visual communication design in the current digital multimedia era.

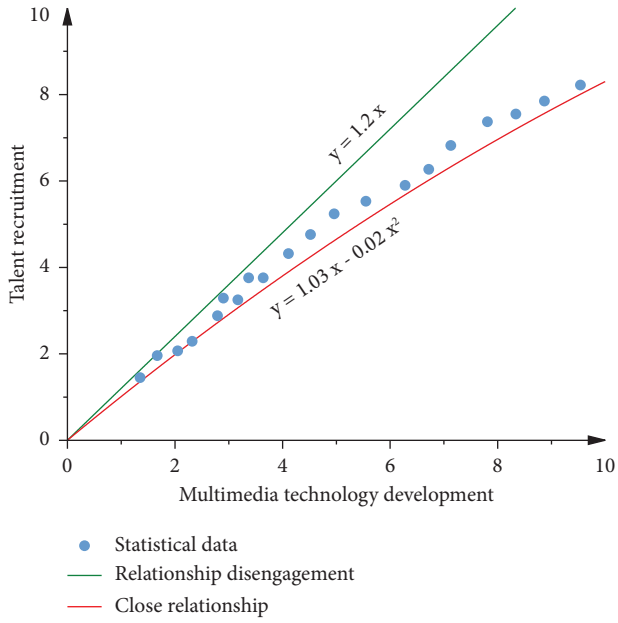

Figure 6: The relationship between the demand for talents and the development of multimedia technology.

6.3.2. Focus on Cultivating High-Quality, Compound, and Application-Oriented Talents. In response to the current demand specifications of society for visual communication professionals, we promote the intersection and integration of multiple disciplines and expand the scale of cultivation of applied, composite, and skill-oriented talents. The visual communication design major expands on the highly complex intersection and integration of natural disciplines and the humanities, social life and economic life, art and

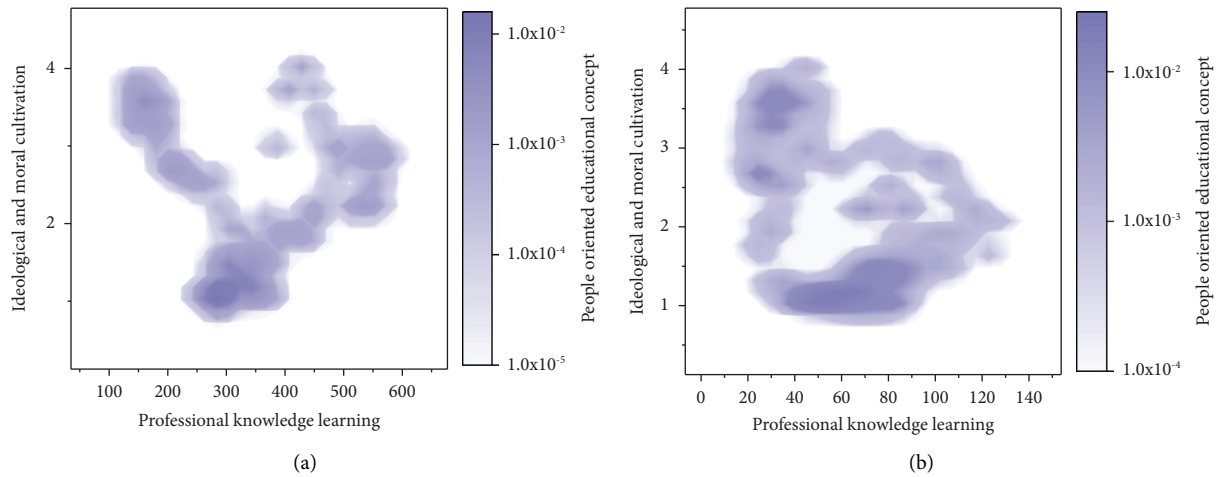

Figure 7: Cloud chart among people-oriented educational concept and professional knowledge learning and ideological and moral cultivation. (a) Teaching units A. (b) Teaching units B.

technology, etc. Cultivating high-quality applied professionals with multidimensional knowledge structure and comprehensive cross-application talents who can adapt to the development trend of art and design and other disciplines and professional integration is the focus of talent cultivation in the visual communication design major. The cultivation of talents in visual communication design is not only to make students master the knowledge and skills in the technical field of the profession but also to focus on the cultivation of comprehensive ability, humanistic quality, and self-development so as to realize the cultivation goal of high-quality, application-oriented professional talents.

6.4. To Pay Attention to the Coordinated Development of Science and Technology and Humanities in the Process of Developing Multimedia Teaching. The rapid development of multimedia technology also makes it more convenient and intuitive for people to understand information, but also because of the highly developed information technology, many people have a blind worship of multimedia technology, the applications of multimedia technology are expanding, people's daily lives began to rely too much on multimedia information technology, and the connection between people began to dilute. In the process of classroom teaching, over-reliance on multimedia technology will lead to the gradual dilution of the relationship between teachers and students, which is also not conducive to the development of educational teaching activities. Therefore, it is very important to realize the coordinated development of technology and the humanities. At this stage, as the level of China's technological development continues to rise, many students' moral concepts and their awareness of understanding the world around them have gradually become weaker, and some students appear to value skills over morality and have prejudice against cultural knowledge, which is not conducive to students' future healthy growth. Therefore, when teachers carry out teaching activities, they should not only focus on the teaching of relevant professional knowledge but also pay attention to the teaching of ideology and moral culture, find a balance between the two, and strive to put the "people-oriented" teaching concept throughout the entire education and teaching activities, which will greatly help to improve the overall quality of students.

A people oriented educational concept (P) is chosen to measure the comparability between the teaching of professional knowledge and the teaching of ideological and moral cultivation, and the formula is

$$R_i = \sum_i e^{\left(-d_{pi}^2/2S_p^2\sigma_i^2\right)\delta} + \ln\left[\left(-\frac{d_{pi}^2}{2S_p^2\sigma_i^2}\right)\delta\right]$$

$$P = \frac{R_i}{\sum \delta}, \tag{4}$$

$$P = \frac{\sum_i e^{\left(-d_{pi}^2/2S_p^2\sigma_i^2\right)\delta} + \ln\left[\left(-d_{pi}^2/2S_p^2\sigma_i^2\right)\delta\right]}{\sum \delta},$$

where p is the ID of the certain student; i is the ID of the key point of students' moral concepts; d_{pi} denotes awareness of understanding the surrounding world between the i-th models predicted by the p-th comprehensive quality of students; S_2 denotes the healthy growth of students; o denotes the normalization factor of prejudice against cultural knowledge; v denotes the development of science and technology and humanities; and δ is the selection function of goals of healthy growth of students. According to the above formula, it is easy to see that the use of multimedia means can effectively improve students' writing ability and significantly narrow the gap between the sample writing and students' own works (see Figure 7, taking two sample teaching units a and B as examples for details).

Therefore, in the process of seeking innovative development of media technology and visual communication design teaching, the relationship between media technology and visual communication design in teaching should be well

coordinated so that students understand that media technology is only a means and tool to achieve innovative presentation and innovative design of visual communication. To sum up, at this stage, teachers in the process of teaching visual communication design should make use of media technology and information resources to fully improve the course content and maximize the choice of teaching methods that are compatible with the discipline.

6.5. Pay Attention to the Interface between Traditional and Innovative Teaching Methods. The traditional teaching concept has a very obvious reflection in the process of unfolding educational activities in China. Although the modern multimedia visual communication teaching method has many obvious advantages compared with the traditional teaching method, it does not mean that it can completely replace the traditional teaching method. Some technologies and application theories for multimedia are still in the early stages of development. To ensure the overall stable development of the education sector, it is important to effectively integrate traditional teaching methods and modern teaching methods.

7. Conclusion

In addition to being the result of the economy and the market, modern visual communication design is a product of culture. Visual communication design will have a ton of room to grow as we transition into the information society, and while it does so, it will also face a number of fresh obstacles. With the continuous development of science and technology in China, visual communication design has been applied in many advanced platforms and has achieved more ideal results. However, for China, this technology is still in the development stage, and there are still many places that need to be improved. Teachers should pay attention to the active application of multimedia technology and resources when teaching visual communication design in order to ensure the quality of teaching on the premise of achieving the purpose of efficient teaching. This has a great effect on cultivating students' interest in learning, and the application of multimedia technology in the teaching of visual communication design will certainly be recognized by more people.

To achieve the innovative development of multimedia technology and visual communication design teaching, perfect multimedia equipment, constantly updated multimedia technology and scientific and professional teaching activities and teaching content are indispensable. Therefore, schools should improve relevant teaching facilities and enrich teaching activities; teachers should improve their professional quality, strengthen their ability to select topics and prepare lessons, and improve their operation level of multimedia technology; students should give full play to their subjective initiative, explore their creative potential, and ensure the close integration of theory and practice. We must constantly reform the previous teaching mode with a new concept, keep up with the market dynamics, make visual communication design education develop with the society, economy, market, culture, industry and aesthetic needs, and keep pace with the design market while keeping pace with international visual communication design education.

Data Availability

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

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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