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Research Article

Structural Optimization of Architectural Environmental Art Design Based on Multiagent Simulation System

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Underthe background of the new era, the architectural environment design is constantly changing. Architectural environment design is to beautify the environment and provide people with a pleasant architectural environment. No matter what time, beauty is the eternal theme and the pursuit of people. Structural bionic design is based on the natural prototype, which is transformed into understandable digital or technical models by extracting relevant structural and behavioral features as design elements. The application of this design technique in architectural devices not only has strong structural logic but also artistic beauty, and can form novel spatial form and structural form of architectural devices. By analyzing the present situation and existing problems of theoretical research and simulation experiment of multiagent system, the necessity of designing a multiagent system planning algorithm and developing distributed real-time simulation experiment system is pointed out. A good environmental art design scheme can be designed in many different styles, and the performance of the design renderings will also appear in different pictures. The really chosen design scheme depends on the designer's conception theme and then look at the performance of the renderings. In recent years, the emergence of multiagent has had a great impact on building environment design. Multiagent technology is a comprehensive information technology that integrates artificial intelligence, network, digital, and other technologies.

1. Introduction

A multiagent system is composed of multiple agents working together. Its basic unit is the agent, which can interact with its environment. The agent consists of three functional layers: management and organization layer, coordination layer, and execution layer. The management and organizational levels are mainly responsible for obtaining objective definitions or queries, as well as relevant constraints, including implementation plans, functional evaluation, and learning. The task of the coordination layer is to activate the execution of actions according to the basic process definitions and action steps from the management and organization layers. The coordination layer can extend actions to respond to events. The execution layer is the execution of a series of actions, followed by the inspection of actions. In recent years, multiagents are active in various technical fields. Nowadays, multiagent has gradually become the new favorite of the architectural environment design industry. Multiagent is a modern computer system, which can form a three-dimensional and vivid diversified information space [1]. With the application of complex adaptive system theory (complex adaptive system) to analyze the complexity of organizations, researchers gradually realize that the complexity mainly comes from adaptive individuals, so the organization can be designed by changing itself to deal with the inconsistencies of the environment certainty and improve organizational performance [2]. However, the high cost of physical simulation brings great difficulties to the identification of multi-agent cooperative strategies [3]. Using digital simulation to simulate the cooperation process can not only save money greatly but also provide a platform for agent cooperation to check the design defects and deficiencies of cooperation strategy and control algorithm, which is an auxiliary means to identify the feasibility of cooperation strategy [1]. The agent can call the natural language processing module to generate language string information and send it by messenger, or it can directly send some special instructions or simple messages. The predecessors' explorations in different design fields always return to nature at a certain stage, which may be related to the characteristics of natural creatures [2]. After a long period of evolution, natural organisms continue to experience "survival of the fittest" so that they can live in harmony with the surrounding environment [3]. In this process, the biological structure has gradually formed a "modern structural aesthetics", striving to achieve the maximum efficacy with the most limited materials and technologies [4]. The good design concept and materials of environmental art design are inseparable from life, and sketch is to help us develop the good habit of observing life, and cultivate good observation ability and modeling ability. Sketch is indispensable in the environmental art design process, especially before the design inspiration is generated, the designer draws some forms related to his own design thinking on the manuscript paper [5].

Multiagent is applied to architectural environment design and displayed in three-dimensional space, which can not only improve the efficiency of architectural environment design but also innovate and reform the technology of architectural environment design, change the concept, and make full use of the advantages of modern information technology to improve the architectural environment design [6]. If a single agent is an imitation of human individuals, a multiagent system is an imitation of human groups and even human society [7]. Obviously, multiagent systems have many advantages that single-agent systems do not have. This is mainly reflected in the following aspects: (1) multiagent system is distributed in space, that is, multiple agents can work in various positions of the workspace at the same time. (2) Multiagent system is parallel. Some tasks can be further decomposed into several subtasks, which are independent of each other and can be processed at the same time. The multiagent system with a parallel structure has advantages over a single agent in completing such tasks. (3) Multiagent system has strong fault tolerance. The functions of individuals in a multi-agent system can overlap each other, so when an agent fails, it is easy to compensate for the system performance degradation caused by the failure through task reallocation.

The innovation contribution of the research lies in pointing out the necessity of designing a multiagent planning algorithm and developing distributed real-time simulation experimental system. Based on the most advanced methods and theories, two task assignment algorithms and a path planning algorithm for multiagent systems are proposed and implemented. At the same time, as a tool to realize and verify the cooperation algorithm, a robot is designed to carry goods at the wharf. A simulation experiment system of distributed planning using LAN. This paper analyzes the application of multi-agent technology in building environment design in detail. Construction personnel can use virtual reality technology and design drawings to simulate the operation process in advance, which is conducive to the smooth development of the project. Its value and significance are expounded. I hope it will be helpful to environmental designers and construction workers.

2. Related Work

Up to now, in the few research studies on this problem, multiagent simulation models based on the NK model have been established many times. Xue's research points out that the situational interaction between the organization and the environment originates from the process that the organization constantly seeks the best organizational design form to adapt to the uncertainty of the environment. Their research also verifies the existing theoretical assumptions and draws some testable extended assumptions [8]. Based on the theory of computable organization, Zikirov et al. established a computable model for the situational interaction between the environmental uncertainty represented by the task environment and the individual cognitive ability and other organizational design variables to study this problem [9]. Aiming at the highly uncertain environmental characteristics of organizations, Wang et al. pointed out that the dynamic characteristics and high competitiveness of the environment faced by modern organizations make organizations change from traditional fixed level organizations to flexible network organizations to varying degrees [10]. Pit et al. have made valuable attempts in the research of discourse comprehension in computational linguistics (especially in the aspect of combined semantics) and achieved certain results [11]. In the design process, designers such as Solievich et al. should take into account people's living habits according to natural factors such as geographical location and climate and integrate aesthetic concepts to create an environment for people to enjoy [12]. Zikirov et al. focus on the embellishment of the overall environment and the beautification of the environmental atmosphere for the sculpture in the environmental design and also convey a certain commemorative meaning and space for the association. Modern sculpture works focus on new materials, most of which are shaped by abstract elements, with simple shapes and thought-provoking. No matter how perfect a sculpture is, it needs to be set off by the overall environment in order to convey the original intention [9]. The hierarchical structure of transportation network proposed by Xu et al. Flexible manufacturing: for example, the dynamic scheduling protocol of the manufacturing system established by Ramos uses two types of agents to complete task scheduling and resource management, respectively and solves the scheduling of production tasks through the interaction between agents [13]. Kowalska et al. study the integration of technology and art, the functional requirements of structural design, technical means, economy and other necessary engineering considerations, but they canno't do without the artistic aesthetics of the structure. Through aesthetics, a structural design can organically combine rationality and sensibility, so that the audience can feel the beauty of art while enjoying the structural beauty [14]. Through some microexperiments, Lyu et al. conducted more systematic and in-depth simulations of the techniques, skills, and morphological elements of the "building" methods of different animal nests, and through a systematic analysis of the simulation results [15]. Pouralkhas et al. pointed out that the spiritual function of interior design is more obvious in the internal space of ancient palaces and religious buildings. The layout of internal space, the choice of color, and other factors give people different feelings. In interior design, it is necessary to master not only basic drawing techniques but also some basic knowledge of construction materials [16].

In the process of research, this paper mainly adopts various research methods such as literature review, case analysis, interdisciplinary research, and exploratory research. Through the network library, the school library, the local library, etc., the relevant theoretical research results of structural bionic design have been comprehensively consulted and sorted out, and the main points of which have been comprehensively sorted out and summarized. Based on this, a preliminary grasp of Structural biomimetic design features and several types and morphologies of biological nests. The concept of structural bionic design is summarized through the cross analysis of biology, public art, architecture, bionics, and other disciplines, and the shape of the nest can be expressed and explained in a more artistic way.

3. Methodology

3.1. The Basic Functions to be Realized by the Multiagent Simulation System. The working mode of multiagent negotiation requires that the natural language processing module can accurately understand and express information and try to avoid ambiguity. The actual multiautonomous mobile robot systems are mostly composed of independent robots. Each robot is controlled by its own computer system and communicates with each other through wireless communication equipment or wired communication equipment. In order to simulate the control and communication between robots well, and facilitate the algorithm transfer to the actual physical system, we adopt a multicomputer simulation system based on LAN, which combines centralized and distributed. For a computer simulation system, the interface with the actual physical system is not necessary. However, if there is an interface with the actual physical system, the simulation system can easily transfer the parameters obtained through the simulation or the verified algorithm into the actual physical system for verification. Moreover, the multimobile robot computer system has a standard set of interfaces that will help it to be applied to real physical systems of different structures. In the simulation of different algorithms for multimobile robot system, some important environmental states and internal states of the robot in the system play an important role in improving the algorithm, adjusting the structure and load of the mobile robot system, and finding the "bottleneck" that affects the efficiency of the system. Therefore, the analysis function of the system is an important auxiliary function of the multimobile robot simulation system. The client computer can simulate the robot with the following functions: receiving the user's settings and modifications of its parameters, sensor information, communicating with the server and other robots, making real-time decisions on the received information and transmitting it to the server, etc. The system designed in this paper consists of several simulation nodes. The map is stored in the form of an adjacency list, and the topology map is abstracted from the map information stored in the database, which describes the connection relationship between each plate, thus forming the hardware structure shown in Figure 1.

The simulation experiment system adopts c/s structure. Among them, the server is responsible for the environment and human-computer interaction, and the client is used to simulate other entities related to the simulation. Generally, the client can be either a physical object equipped with a communication interface board or an ordinary computer running simulation software. They are independent of each other, and can independently execute various client control commands, or complete some common tasks through some advanced cooperation strategies.

The task of the real-time simulation system is completed by multiple robots, so as to meet certain performance indexes (such as the shortest time). In the actual system, each robot is heterogeneous, and their carrying capacity and ability to obtain information are not exactly the same. Moreover, the types and requirements of tasks are different. This requires the system to decompose and assign tasks according to certain principles. According to the structure of the simulation environment system, the simulation environment of multiagent cooperative handling objects can be divided into three modules: cooperative handling system, animation simulation, and interface display. The characteristics of 3D animation include accuracy, authenticity, and operability, but compared with virtual reality, the interactivity and immersion are low. The interface display is not limited by time, space, place, condition, and object. Complex and abstract program contents, scientific principles, and abstract concepts are expressed in concentrated and vivid forms through various forms of expression. As shown in Figure 2.

Each module is relatively independent, and the cooperative handling system is the core part of the cooperative simulation environment, which is responsible for searching for objects to be handled, handling objects, and communication between agents. Animation simulation and interface display belong to the simulation display part. The former is responsible for the dynamic simulation display of the handling cooperation process, while the latter provides the interface for setting initialization parameters (number of agents, number of objects, etc.) and the real-time output of relevant information (running times, running speed, etc.) of each agent and the whole system during the operation, and outputs the information executed by the system in the form of separate windows. The difference between the two is that the latter provides an interface for human-computer interaction. Each agent has a unique number to distinguish it from other agents, as well as a two-dimensional coordinate position and the orientation of the current agent.

3.2. Agent Behavior Algorithm. A multiagent system is a computing system formed by several agents interacting or cooperating to achieve a specific purpose. This paper will discuss the dynamic 0-1 optimization problem, so each agent

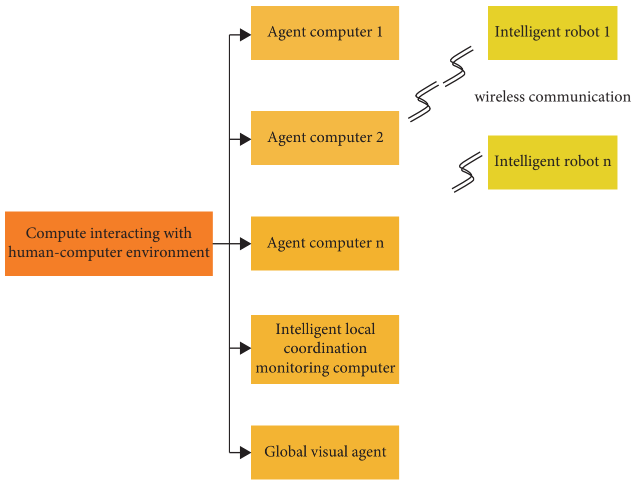

Figure 1: System hardware structure.

represents a candidate solution, that is, a 0-1 sequence. In order to make agents have local awareness, the living environment is defined as a grid structure (Agent Grid LL). Each agent is fixed on a grid point and can only interact with the agents in its neighborhood. Suppose that the agent at position (I, J) is marked as L_{ij}, and the agent that can interact with it is.

$$L_{k1}, i - R_s \le k \le i + R_s, j - R_s \le 1 \le j + R_s. \quad (1)$$

The perception range of each agent is 1, that is, there are 8 agents in the neighborhood of each agent. For an agent, if its energy is the largest in the neighborhood, it can survive; Otherwise, it will die, and its place will be replaced by the offspring of the most energetic agent in its neighborhood. Let $L_{ij} = (L_{ij}^1, L_{ij}^2, \ldots, L_{ij}^n), L_{\max} = (L_{\max}^1, L_{\max}^2, \ldots, L_{\max}^n)$, and $\forall L \in N_{ij}, E(L) \le E(L_{\max})$. If $E(L_{ij}) \le E(L_{\max})$, $L_{\max}$ will be used to generate a descendant $L_{ij} = (L_{ij}^1, L_{ij}^2, \ldots, L_{ij}^n)$ instead of L_{ij}. In the first competition mode, the information of L_{ij} and $L_{\max}$ is used to generate the descendant L_{ij}, and some bits different from L_{ij} are randomly selected to modify the corresponding bits of $L_{\max}$.

$$L_{ij}^k = \begin{cases} L_{\max}^k, \ k \notin D, \ k \in D, \ \text{random}\,(\,) = 0, \\ 1 - L_{\max}^k. \end{cases} \quad (2)$$

The third way of competition is bitwise variation.

$$L_{ij}^k = \begin{cases} L_{\max}^k, \text{rand}\,(\,) > \dfrac{1}{n}, \\ \\ 1 - L_{\max}^k. \end{cases} \quad (3)$$

Since resources in the environment are limited, an agent can only gain learning opportunities if its energy is not less than that of any agent in its self-neighborhood. SANUM (statistics based adaptation nonuniform mutation) and SANUX (statistics based adaptation nonuniform crossover) use convergence information as feedback information to control mutation and crossover. $p(i)$ can be calculated by f1i.

$$P(i) = p_{\max} - 2|f_{1i} - 0.5|(p_{\max} - p_{\min}). \quad (4)$$

On a 64 bit string containing 8 consecutive 8 bit building blocks Fitness calculation of function.

$$f(x) = \sum_{i=1}^{8} c_1 \sigma_i(x). \quad (5)$$

Strong Connection Deceptive Function Strong Connection Deceptive function is constructed by 10 identical six-order two-stage Deceptive functions DF1.

$$f(a) = \sum_{i=1}^{n/6} f_{\text{bipolar6}}(a_{6i-5}, a_{6i-4}, a_{6i-3}, a_{6i-2}, a_{6i-1}, a_{6i}). \quad (6)$$

This paper uses the XOR method to generate dynamic test functions. Assuming that the environment changes every T generation, the dynamic environment is constructed as follows:

$$M(k) = M(k-1) \oplus T(K). \quad (7)$$

Since there is no unique optimal solution in the dynamic optimization problem, it is not enough to compare the optimal solution obtained by the algorithm. It is also necessary to compare the tracking ability of the algorithm to the optimal solution and the adaptability to the environment in the whole iteration process. Here, the commonly used evaluation indicators in the dynamic optimization problem are used, That is, fmogt (meanbest of generationfittness) is used as the evaluation index.

$$\overline{F}_{MOG_1} = \frac{1}{t - K\tau} \sum_{i=k\tau+1}^{t} \left(\frac{1}{100} \sum_{j=1}^{100} F_{BOG_{ij}} \right), \quad (8)$$

where $K = Ft/\tau - 1$, $F_{BOG_{ij}}$ is the optimal value obtained in the jth operation and the ith generation. $F_{MOG_{ij}}$ is the cumulative average of the average of 100 runs of the algorithm in each generation in each cycle.

4. Result Analysis and Discussion

Because the environment changes dynamically; that is, the information value of each subtask of decision-making changes dynamically. In a stable environment, the subtasks rarely change or have a long period of change; in a turbulent environment, the opposite is true. The activities that members of the organization carry out when making decisions mainly include uploading information, reading information, communication, and decision-making. According to Carley's work, the model simplifies the simulated time units used in the above-given activities, as shown in Table 1. According to the actual situation, one time unit can represent 1 second or other real-time measurement units as shown in Table 1.

The system data obtained from the simulation model provides many meaningful inspirations for analyzing the

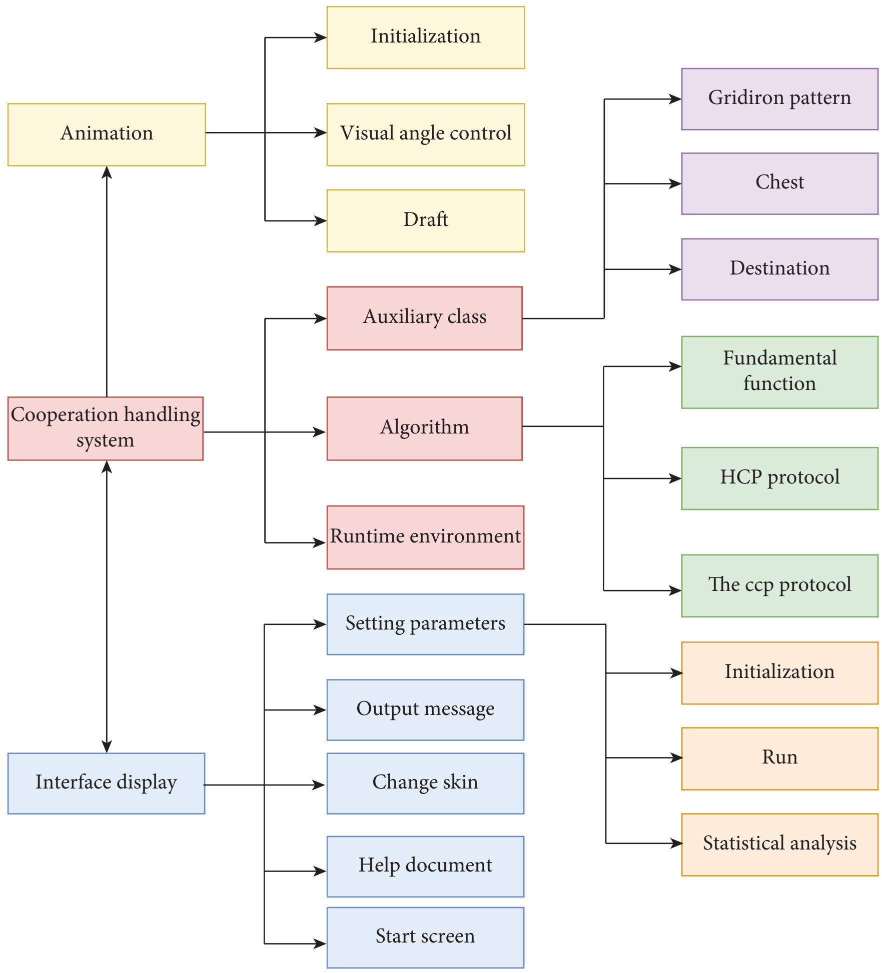

Figure 2: Simulation environment structure.

interaction between environmental factors and organizational design elements. System simulation is based on the purpose of system analysis to analyze the properties of various elements of the system and their relationships. On this basis, a simulation model which can describe the system structure or behavior process and has a certain logical or quantitative relationship is established. Based on this, experiments or quantitative analysis are carried out to obtain various information required for correct decision-making. This paper analyzes the simulation data from multiple dimensions. The change chart of organizational decision-making performance under different combinations of K, T, and I for four organizational forms when the influence of capacity limits is temporarily ignored (that is, the average of organizational decision-making performance under each capacity limit is taken) is shown in Figure 3.

It can be seen from the above group that the decision-making performance in a single organization decreases with the increase of environmental turbulence. When the environment is very stable, the organizational performance reaches the optimal level and is not affected by the environmental complexity; When making a horizontal comparison of various organizations, it can be found that different organizations have different organizational performance under the same K and T, indicating that the appropriate organizational form can cope with the impact of environmental uncertainty. By analyzing the incentive mechanism that two kinds of organizations should adopt in different task environments, respectively, in order to ensure high performance of organizations, the following conclusions can be drawn: first, no matter what task environment or how the organization is designed, it is inappropriate to adopt organization-oriented incentives when the level of organizational culture construction is low; second, for type ii organizations, organization-oriented motivation, and better organizational culture construction are suitable for the environment where the task complexity is very high and the task environment changes to a certain extent as shown in Figures 4 and 5.

Through the analysis of the above-given simulation results, the design of the organization matching with the organizational elements according to the characteristics of the task environment (complexity and information change degree) is given, as shown in Table 2.

When the matching variables selected by the optimal organization do not meet the requirements, the organization shall select the "suboptimal" organization shown in the table. No marking indicates that there are no special requirements

Table 1: Decision time pressure.

Power distribution	Activity	Preactivity	Time required	Explain
Centralization of power	A1: Upload information	A1	I	I is an analog step. The time pressure of each activity is related to the individual performance SP of employees, while SP is related to motivation, cultural characteristics, and ability. The time pressure corresponding to high sp is low, and vice versa.
	A2: Read information	A2	I	
	A3: Decision Making		I	
Decentralization	A1: Read information	A1	I	
	A2: Communication	A2	I	
	A3: Decision making		I	

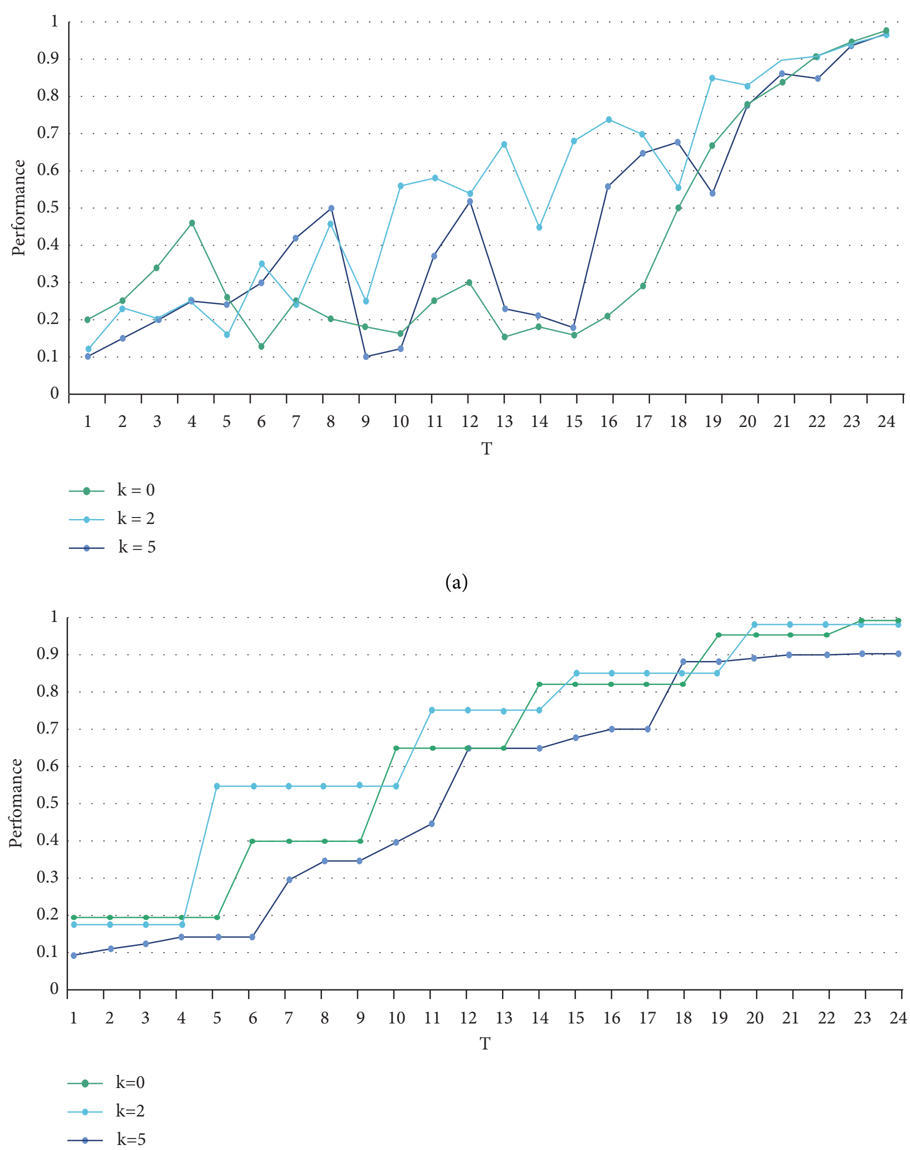

Figure 3: The impact of task complexity and information change cycle on organizational decision-making performance. (a) Type I organization. (b) Type II tissue.

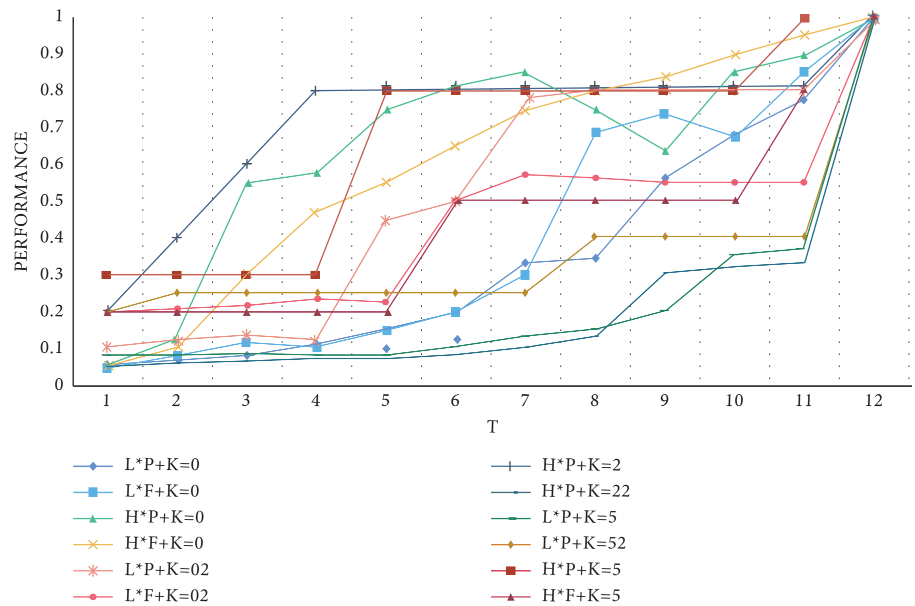

Figure 4: Influence of incentive mechanism on organizational decision-making performance.

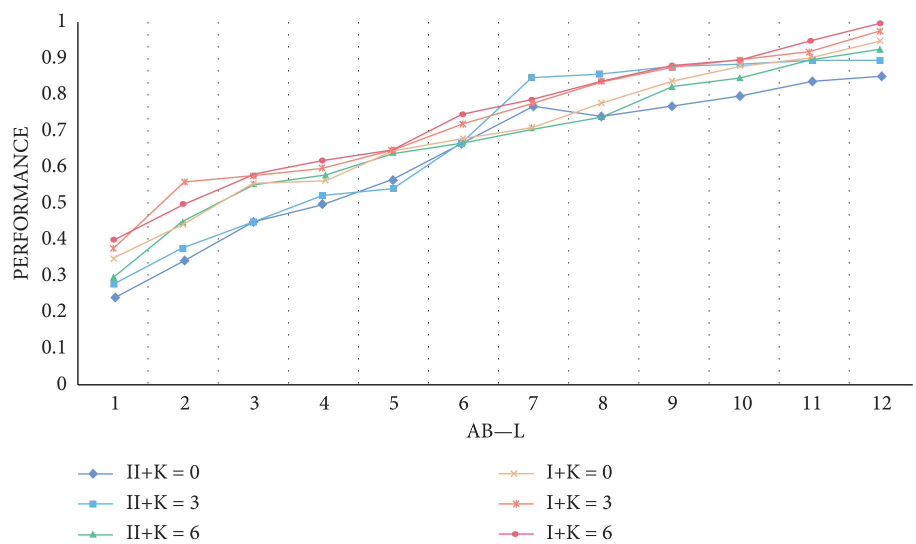

Figure 5: Analysis of the relationship between member capabilities, power models, and task complexity of various types of organizations.

Table 2: Matching analysis of design elements and contingency elements of the organization.

Task complexity	Task environment changes			
	Extra high	High	Middle	Low
Low	III-①	III-②, II-③ suboptimal	II-③, III-suboptimal	II-③, III-suboptimal
Middle	Random decision	III-①, II-③ suboptimal	II-③, III-suboptimal	II-③, III-suboptimal
High	Random decision	III-①, II-④ suboptimal	IV-④, II-④ suboptimal	III-②

for the corresponding design elements of the organization. Through the application of multiagent in building environment design, we can restore the building environment scene through the simulation screen, so we can add our own ideal design to the simulation scene. In architectural environment design, greening is an important part of environmental design. In the environmental design, the plants designed in greening have a good effect at first, but with the passage of time, the shape of plants will change. We do no't know the shape of plants after growth. Some green plants may grow normally, and they will grow very tall and luxuriant. Some plants will grow short because of malnutrition. Of course, these plants will vary with different seasons. Then, the application of multiagent can successfully avoid the occurrence of this problem. The construction personnel can simulate the operation process in advance by applying the virtual reality technology combined with the design drawing, which is conducive to the smooth development of the project.

The 3D virtual collaboration simulation environment we designed can basically realize the collaboration process of agents. The user can set parameters and selection strategies in the form of a menu, and the simulation process and related information can be output in the form of a graphical window. The user can also directly control the operation of simulation on the interface, output statistical results, change the interface skin according to personal preferences, change the view window, adjust the viewing angle, field of vision, etc.

5. Conclusions

In this paper, multiagent simulation is used to quantitatively model the analysis framework of organization's response to environmental uncertainty. With the continuous development of the times and the progress of science and technology information technology, it is necessary to make more rational use of multi-agent technology in order to make the architectural environment design work better. In the new era, the technology and concept of architectural environment design are constantly advancing with the times, constantly changing and innovating, and multiagent technology is constantly playing an important role. The multiagent cooperative simulation environment provides a visual platform for further research and discussion of agent cooperation, provides great help for verifying and testing algorithms, and also lays the foundation for the next physical simulation. Hierarchical implementation, with good portability. The environmental art design is to create and plan a space more in line with human nature with human society as the main body. Students studying environmental art design not only need to learn natural environment, regional and ethnic characteristics, and other knowledge related to nature but also need to master professional knowledge and mapping technology related to environmental art design. Based on the most advanced methods and theories, two multiagent system task allocation algorithms and a path planning algorithm are proposed and implemented. At the same time, as a tool to realize and verify the cooperation algorithm, we have designed a simulation experiment system which takes the task of robots carrying goods at the dock as the experimental background and makes distributed planning by using LAN. In this paper, the application of multiagent technology in architectural environment design is analyzed in detail, and the value and significance are expounded. It is hoped that it will be helpful to environmental designers and builders of architectural construction. The data acquisition method studied has certain feasibility, but its workload is large, the efficiency is low, and it is easy to make mistakes. Therefore, there is still a lack of a comprehensive general technical platform for building energy consumption monitoring and data collection. Further analysis on this issue is needed in future research.

Data Availability

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

Conflicts of Interest

The author declares that there are no conflicts of interest.

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