Application of artificial intelligence technology in architectural computational design

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Abstract: In the construction industry, the rational application of artificial intelligence technology in the construction of intelligent buildings has become the focus of the construction industry at this stage. At present, the main application means is to apply the neural network system, fuzzy control system, expert system, intelligent decision-making system and other technical means in artificial intelligence to the internal system construction of intelligent buildings, so as to achieve the purpose of intelligent building services. This paper analyzes the overall application of artificial intelligence in intelligent buildings at the present stage, and makes a detailed study on the application of artificial intelligence system in various aspects of intelligent buildings, hoping to be helpful to the construction and development of intelligent buildings.

1. Introduction

Artificial intelligence technology is a new technology, which ADAPTS to the development and demand of today's society and applies to many fields. And for the application of artificial intelligence technology, different people have different views, many people give a positive attitude to artificial intelligence technology, think it will make the human production and life more convenient, at the same time, there are many people think that the widespread use of artificial intelligence may

There are real problems. Generally speaking, the use of artificial intelligence technology still has more advantages than disadvantages. At present, artificial intelligence can greatly improve their operation efficiency in some fields. In recent years, the development speed of the construction industry is very fast, and with the continuous improvement of artificial intelligence technology, the construction field is also developing towards intelligence.

Artificial intelligence, abbreviated as AI, also known as machine intelligence. It is an emerging technology that combines artificial intelligence with artificial intelligence, and it is a comprehensive subject developed by using computer science, information theory, cybernetics, psychology, linguistics, neuropsychology and other disciplines. Artificial intelligence studies the behavior rules of human intelligence, such as learning, calculation, thinking, reasoning, planning, etc., and constructs artificial systems with certain intelligence ability to complete the work that normally requires human intelligence to be competent. Artificial intelligence is also a branch of computer science, it attempts to understand the essence of human intelligence, and produce an intelligent machine that can make similar behavior to human intelligence. The research in this field includes phase L human, language recognition, image recognition, natural language processing and expert system, etc. Since the birth of artificial intelligence technology, the theory is that the technology is increasingly mature, and is gradually used in many fields, the future people use artificial intelligence products, will be the container of human wisdom.

Architecture is an indispensable part of modern society. If the modern advanced artificial intelligence system is applied to the construction engineering, People's Daily life can enjoy the humanized and scientific services brought by the intelligent system, which will greatly improve the quality of human life. The application time of artificial intelligence technology in the field of architecture in China is relatively short, only more than ten years until now, but the development of the field of intelligence in China is very fast, many intelligent factors have been added in modern buildings, such as: intelligent office system, communication automation system and building

automation system. With the continuous development of intelligent buildings, modern residents have higher requirements for humanized services, so intelligent buildings must also make corresponding upgrades, such as: a variety of control system upgrade, communication means automation, scientific service demand quality improvement, which also leads to the development of modern intelligent buildings into a slow development stage. The application of artificial intelligence technology in intelligent buildings is also the mainstream trend of the combination of artificial intelligence and intelligent buildings.

After several years of rapid development, China's modern intelligent building construction has been initially integrated with simple artificial intelligence technology, the formation of the corresponding artificial intelligence automation system such as: building automation system, communication automation system (CAS), office automation (OAS) system. With the continuous upgrading of modern human needs, simple artificial intelligence system can no longer meet People's Daily needs. However, at present, the application of artificial intelligence optimization technology in intelligent buildings in China is still very immature and still faces many important problems and difficulties.

Modern construction enterprises and construction units have no overall concept of artificial intelligence technology and lack of coordination and application of each optimization subsystem of artificial intelligence optimization technology. When a single subsystem or service function is embedded into the building during construction, it is called an intelligent building, which lacks system integrity and cannot meet the psychological expectations of residents or building users. Relevant construction units must control the advantages of artificial intelligence optimization as a whole, and apply these conveniences to intelligent buildings as a whole, instead of making a mere appearance.

Many tech bubble, intelligent building also has many technical application is still in its infancy, many artificial intelligence control system, is only a mathematical logic operation of auxiliary control system, and can't really personified the thinking logic of learning and judgment, once the work environment or external factors influence is too big or beyond the scope of logic operation, the system will in blind operation state, the light failure or system crash, only back to input parameters, in addition to system is hard to maintain and repair and complicated to operate, and other negative effects, Application technology is single, far from the requirements of artificial intelligence.

Modern artificial intelligence technology in our country, the computer inside the main control system and various sub control system mostly run independently control method is applied, each system have their own database and port transfer database, the artificial intelligence technology and computer network control technology in our country at present stage, the main system and each subsystem can run independently, disjointed, intelligent building intelligent overall service quality is low. The internal hardware of the building cannot control each other and lacks communication interfaces. Therefore, at present, China's artificial intelligence system still needs intelligent technology innovation to integrate the rationality of "each fighting for itself" subsystem. Optimize the service subsystem, improve the service efficiency and fault tolerance and stability of the system, improve the intelligence level, transition from semi-artificial intelligent system to full intelligence, and build a real intelligent building.

2. Experimental procedure

Due to the rapid development of China's economy, the construction industry as the foundation of human society has also achieved rapid development. The construction of the building, the first is to carry out architectural appearance design, followed by the structural design of the building. Architectural structure design is divided into three stages: structural scheme stage, structural design stage and construction drawing design stage. Traditional architectural structure design relies on structural engineers to calculate the rationality, comfort and safety of the building structure, and to build comfortable, beautiful and economic buildings with appropriate materials. Architectural structure design is more inclined to technical design, more inclined to concretization, unlike

architectural appearance design is more inclined to Abstraction. The traditional design relies on the logical operation ability of human beings. Obviously, computers are more capable in operation. But when the artificial intelligence and the building structure unifies, according to the human thought, then according to the computer formidable computation ability to be possible to obtain the reasonable design result more easily, has greatly facilitated the human life. With the further development of science and technology in the future, the technology of artificial intelligence will become more and more mature, which will have a greater impact on the architectural structure design industry. At the same time, it will inevitably bring some social problems.

With the continuous development and maturity of artificial intelligence technology, the application prospect of artificial intelligence technology in the field of building structure has been widely recognized. Many people have changed their attitude because of the convenience brought by artificial intelligence, from the initial doubt to the current dependence. The application of artificial intelligence technology in building structure design has become the main trend of intelligent building structure development. More and more people are optimistic about the combination of artificial intelligence technology and life field. Nowadays, artificial intelligence technology has also been applied in building structures. In building structure design, the choice of materials is essential, with the progress of science and technology, more and more economic and effective new material gradually applied in life, such as intelligent building materials, intelligent building materials in the field of civil engineering has great applied potential, in terms of civil engineering, the rise of intelligent materials development not only means the increase of structural function, in the form of structure design optimization, it is more important is to update the traditional design concept. In application, smart materials can monitor the status of building structures in real time to ensure the safety and reliability of facilities and reduce their maintenance costs. Another example is the application of Expert System in the structure design, Expert System is an artificial intelligence computing program, it can be in some specific areas, using a large number of expert knowledge and their reasoning method to solve the problem. Expert system is to simulate the reasoning thinking process of human experts. It stores the experience and knowledge of experts in a certain field into the computer with a special expression mode. The computer judges and makes decisions on the input facts. In the structural design, a series of parameters of the building structure, such as the environment, area, material, building style and so on, are input into the computer. In addition to expert system, there are also many research fields of artificial intelligence, including problem solving, natural language understanding, intelligent robot, machine learning, automatic theorem proving, pattern recognition, intelligent decision-making system and automatic program design, which are gradually applied in some fields of life. Despite the rapid development of smart building structure, there are still some problems in the development of smart buildings, which hinder the development of smart buildings.

Artificial neural network control system is the current intelligent technology development of core technology, its system in intelligent building system function design, autonomous learning huge function, structure optimization, etc. And in speech recognition, pattern recognition and optimal calculation, intelligent information processing, complex control, widely used in many fields such as image processing, but with the development of intelligent building, architectural function is increasing, the structure of the intelligent building complex, equipment energy consumption increasing, for such a building management system has powerful data processing ability and multi-level way of system management, artificial neural network control technology with the learning and adaptive ability, Control ability is very strong in systems and control, and management staff to provide supervision and unsupervised training, strengthen the control ability of complex events, and the device controller in the intelligent building requires such control ability, make the autonomous learning the structure of the artificial neural network control system features, to automatically adjust the system parameters the system simple model, to adapt to the different characteristic parameters of a building construction applications, for building intelligent equipment real-time signal detection, control, protection, regulating mechanism of autonomous learning, makes the intelligent building control system have the function of self-learning, adaptive, self-organizing, And meet the current

intelligent building equipment control requirements.

3. Results and discussion

Artificial neural network (Ann) is a mathematical model of information processing using a structure similar to the synaptic connections in the brain. Neural network is an operational model composed of a large number of nodes connected with each other. The connection of each node represents a weighted value of the signal passing through the connection, which is called the weight, similar to the memory of artificial neural network. The output of the network depends on the change of network connection mode, excitation function and weight value. The network itself is often the simulation of an algorithm in nature, which has obvious effects in modelling and optimization calculation of architectural system. Then the application of expert system in the design, expert system is to simulate the thinking process of experts in the field of structural design, and store their knowledge and experience in this field into the system with a special mode for the calculation and processing of rule prediction. Obviously, the expert system has a big defect; the expert system can only imitate the expert to solve the problem under the rule, but can't carry on the reasoning by itself.

With the development of technology, the improvement of neural network technology level is also within sight. Compared with expert system, neural network is more intelligent and closer to the way of thinking. Intelligent structure design is also a premise under the rapid calculation, is to ensure the accuracy of the design results, artificial neural network can improve the accuracy. So for those complex or no human experts prescribed by the problem, obviously artificial neural network can solve the problem

Intelligent technology, data mining technology, test data and field measurement data, digital mode construction method of structural construction state, and a series of criteria used to match similar structural properties, graph construction/prediction of structural behavior/response constitute the "building structure artificial intelligence experimental analysis environment". Experimental data is processed by data mining technology and then becomes a digital model suitable for artificial intelligence. When a new/unknown structure model is placed in this "building structure artificial intelligence experimental analysis environment", its working behavior or reaction, also known as its experimental expression, can be constructed or predicted according to the existing test data and field measured data.
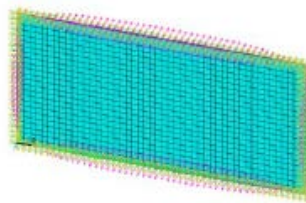

Figure 1 Finite element model of laterally loaded base model

The "building structure artificial intelligence experimental analysis environment" analysis system further explores the application of test data and artificial intelligence in structural analysis of high nonlinear and other difficult problems, such as the relationship between the failure mode and failure load of the structure and how to model the behavior of the structure. The structural analysis system further explores the application of the test data and AIT in the highly nonlinear structural analysis and other problems, such as the relationship between the failure mode and the failure load of the structure and how to model the behavior of the structure.

The boundary condition of the foundation plate is four-sided constraint, and the loading method is lateral uniformly distributed load outside the plane. Deformation mainly occurs in: direction, x and y direction can be ignored, so SHELL181 unit is selected for modelling. This unit has four nodes, each node has 6 degrees of freedom, namely, x,y,: line displacement in three directions and angular displacement around x,y,: three axes. The material constitutive relation is defined as ideal Elastoplast, and the elastic modulus E=1.7 X109N/m^2 and poison's ratio a =0.2. The width,

thickness and height of the model are 6000mm×110mm×3000mm, and the unit size is 12mm× 12mm. The uniformly distributed load outside the plane is 3.2 KN/m². The finite element model is shown in figure 1.

Through Ansys finite element analysis, the z-direction deformation contour diagram of the foundation model under transverse load is obtained, as shown in figure 2.
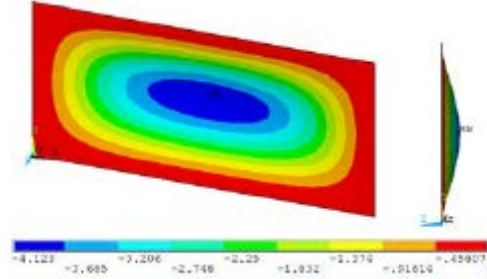

Figure 2 Lateral deformation of laterally loaded base model

Intelligent building system in addition to the autonomous learning ability, also to building of simulation model and accurate, sensitive control, the traditional control system because of its complexity, makes the system will not be able to online building simulation model, and in the new learning model of neural network system with dynamic modelling method of learning, thereby lowering the complexity of the model, can effectively enhance the efficiency of the intelligent control system, and for the artificial neural network control system hardware is by micro controller, the so-called neural network chip, implement management on the level system, the model is applied to various types of intelligent building, At the same time, the artificial neural network control system also needs to improve its autonomous learning ability, to provide the response speed and accuracy of the system, combined with the application of microcontroller, optimize the control system structure, make the system more stable.

With the development of modern artificial intelligence technology, the functions of intelligent buildings have been constantly optimized and upgraded, and the occupation of system equipment resources has been continuously intensified, thus complicating the overall structure. Based on this, the modern intelligent building management system must have a strong ability to deal with problems and multi-angle problem monitoring capabilities. Artificial neural network control system with a strong independent learning and independent testing function, strengthen the independent of sudden events and complex intelligent control, the control can provide supervision and the supervision and training, the former including training the weighted coefficient of adjusting the output neurons, which provides automatic organization function, thus the complex control of the intelligent building possible. On the other hand, in principle, the control of intelligent building needs to rely on the simulation and analysis of the building simulation model, which requires the corresponding control system to be sensitive, accurate and highly adaptive. The traditional intelligent control system cannot run program line according to the simulation model, while the artificial neural network control system can establish the simulation model by means of dynamic simulation to reduce the complexity of the model and improve the operation law and control rate.
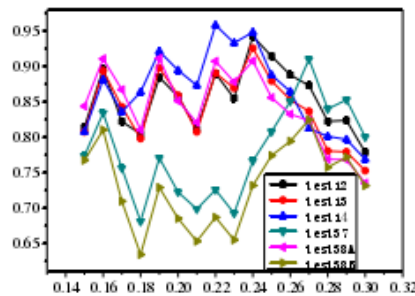

Figure 3 Transition coefficient-similarity level curves between B1-N1 and experimental failure patterns

In order to eliminate noise interference such as secondary cracks, the standardized wallboard 1 to wallboard 6 were selected to establish the basic model, and the transfer coefficient was set to 0.1_5 to 0.3, all values with a step length of 0.01. The failure modes of the new models 1 and 3 are predicted by using the basic model 1, 3 and 5. The basic models 2, 4 and 6 predict the failure modes of the new models 2 and 4. By comparing the failure mode obtained with the failure mode of the test wallboard with similar structure, the corresponding similarity value is obtained, and a series of transfer coefficient and similarity curves are obtained to study the variation law of the failure mode.

The figure 3 shows that the curve with the change of the transfer coefficient of similarity of powder usually appear obvious fluctuation, in some cases, volatility is very large, Testl15 curve similarity of fluctuations in the range of [[0.27, 0.90], it is quantitatively explained as the change of transfer coefficient powder, the failure modes of the new model to show the variation characteristics of the obvious. And, in this study, to predict the failure mode is used as the neural network model of the destruction of the input to calculate the corresponding load. Therefore, choose the appropriate transfer coefficient value of the powder, It is very important to improve the accuracy of "building structure artificial intelligence experimental analysis environment".

Most of the graphs have intersecting curves. In other words, with the change of the transfer coefficient powder, the failure mode of the test wallboard that is closest to the predicted failure mode of the new model is constantly changing, and the degree of similarity with the test is what the research focuses on, so it leads to the regression analysis of the envelope of the similarity curve.

4. Conclusion

Scientific and technological level in gradually improve, but at the same time, intellectual property rights protection of artificial intelligence works also become particularly important, artificial intelligence era is a the great age of the data sharing, it is the main power source and collection of data mining, and in the process, may appear without permission to get the data behavior, violated the privacy and intellectual property rights of others, then need to have a clear legal protection for intellectual property of artificial intelligence, in order to protect innovation at the same time, promote innovation. At the same time, for copyright works created by computers or robots, it is necessary to put forward the standard of "independent intelligence creation" in the field of artificial intelligence, and make clear the ownership of copyright.

Artificial intelligence technology not only has great influence on building structure field, at the same time, it has also been gradually affect every aspect of life, the application of artificial intelligence technology is a tendency in today's society conform to the trend of The Times, in spite of the current application in the field of artificial intelligence in the building, there are many different voices, under the present construction level demand rising, however, relies on artificial intelligence for the design of more efficient and accurate is accord with a choice of The Times. Artificial intelligence has advantages and disadvantages; the technology itself is also in constant development and improvement, as long as we use the right, steady development, artificial intelligence will bring many conveniences to our lives.

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