Research on Building Intelligent Technology Based on Modern Information Artificial Intelligence Building Concept

Ke Zhang¹,*
¹Henan College of Industry & Information Technology, 454000, Jiaozuo, Henan, People R China

*Corresponding author e-mail: hnjzzhk2021@haut.edu.cn

Abstract: This article selects artificial intelligence technology as the research object, and specifically analyzes the application of this technology in intelligent buildings. On the basis of clearly defining the concept of artificial intelligence technology, an analysis of the way to realize the intelligentization of intelligent buildings is carried out. Select specific examples to conduct simulation experiments on the application of artificial intelligence technology in intelligent buildings, and provide practical reference for the construction industry.

Keywords: Modern Information, Artificial Intelligence Architecture, Artificial Intelligence Technology

The progress of society must depend on the continuous development of science and technology. The construction engineering field can improve the quality level, and must also rely on the continuous progress of construction technology. Under the background of modern information, artificial intelligence technology has been widely used in various fields of society. The application of artificial skills in the field of construction engineering can not only greatly improve the quality of construction projects, but also greatly save working hours and improve work efficiency [1]. In order to better develop domestic construction industry and continuously improve people's living standards, it is necessary to further study artificial intelligence technology in the construction industry so that artificial intelligence technology can better serve human society.

1. Introduction

1.1. Artificial Intelligence Building
Incorporating intelligent information control technology into traditional building technology to maximize resource utilization to improve the quality of construction projects, this is intelligent building [2]. The computer system is the key to the operation of the building system. Under the control of the computer, the sensors installed inside the construction project will always detect the operation of the project, and will always return the detection data information. The computer can judge whether the project operation is normal through calculation, so as to achieve the goal of intelligently controlling the
building. At present, many buildings have applied smart technology, such as the Olympic venues built in Beijing in 2008. The key to the development of intelligent building technology is to establish a complete building intelligent system, that is, to build an automatic control system in the building that integrates management control, fire safety, lighting and temperature control, etc., to realize the automation and intelligent control of the building, and to provide people with more convenient and reliable services.

1.2. Artificial Intelligence Technology

Artificial intelligence technology, also known as AI technology, is a technology system that integrates intelligence and technology. Intelligent technology is a modern technology formed by means of advanced intelligent equipment, which has similar response characteristics as human intelligence. At present, artificial intelligence technology mainly includes image recognition, speech recognition, robots and other components [3]. The application of artificial skills and technology, that is, the use of advanced equipment that has been developed to make thoughts and behaviors similar to human beings to solve a certain job need. Since the birth of artificial intelligence technology, there has been considerable development, and its influence and role in various fields of society are gradually expanding. In the future society, the influence of artificial intelligence technology will further increase and make greater contributions to the development and progress of human society.

2 Application of Building Intelligence Technology Based on Modern Information Artificial Intelligence Building Concept

2.1. Expert Control System Technology

Expert control system technology is a data information system control technology based on an expert database [4]. The expert database has the most advanced artificial intelligence technology data, which is the basis and basis for technology research and development and application, as well as a guarantee for intelligent technology to have a higher level of intelligence. The expert database has a more professional way of thinking and a stronger problem-solving ability, which can make the computer intelligent software system more perfect. The introduction of an expert control system in an intelligent building can effectively improve the level of building intelligence. Its simplified model is shown in Figure 1.

![Figure 1. Simple model of expert control system](image)

Based on the rational use of knowledge to express technology, the expert knowledge and expert experience are combined to form a knowledge base, and the database contains data information to conduct in-depth analysis, formulate measures to improve the system intelligence level and system operation efficiency, and focus on completion The design of several parts of control systems such as building fire protection and security automation, heavy current automation, and building control automation ensures that the building automation control system can operate normally and provides conditions for intelligent building management.

2.2. Artificial Neural Network Control System Technology

The artificial neural network control system is a key part of the system with intelligent functions, which has a huge impact on the control, learning and optimization of the system. Its image recognition and voice recognition functions are also the basis for intelligent buildings to achieve complex brake control
[5]. With the support of the artificial neural network control system, the building intelligent control system can collect information more accurately and perform complex logical analysis of the information, which greatly saves the system running time and improves the efficiency of the system in processing problems. This system has good adaptability and control ability in various complex environments, and it is the guarantee for intelligent buildings to realize the characteristics of intelligence. The equipment control device is the basis for the realization of the system control of the intelligent building project. It can ensure the timely transmission and reception of various equipment signals in different operating environments, providing a guarantee for the intelligent control of buildings. At present, the common equipment system control requirements of intelligent buildings are relatively high. The structure of the intelligent building fire automatic alarm system in this design is shown in Figure 2.

**Figure 2. Structure of the automatic fire alarm system for intelligent buildings**

In addition to learning, the intelligent building system also needs to have considerable simulation and analog control functions. The learning process of the new nervous system has dynamic characteristics, and its simulated operation is more complicated, which effectively improves the operating efficiency of the system. The currently used artificial neural network system hardware uses a microcontroller with good hierarchical management and hierarchical control functions. This structure is more conducive to the realization of intelligent and almost automated management and control, and to improve its own functions at any time, to ensure the speed and accuracy of system operation, and to achieve optimal configuration while maintaining operational stability [6]. The artificial neural network control system composition structure in this design is shown as in Fig. 3. The article gives an example to illustrate the application of artificial neural network in high-rise building structure control. The damage indicator uses the frequency change of the mode shape, and uses this as a parameter to simulate and identify the damage of a high-rise building structure using BP neural network. The modeling tool used in this simulation experiment is the construction engineering design finite element software PKPM. The simulation principle is: when a high-rise building is damaged to varying degrees, the parameter changes caused by it are transmitted to the database system and saved. The test modal parameter changes are matched and compared to make a judgment on the damage to the building [7].

The object of this simulation experiment is an engineering example, the building height is 14 floors, and the structure is a shear wall. The heights of the first to fourth floors are 4.95m, 5.4m, 4.5m, 4.5m, and the heights of the fifth to fourteenth floors are all 3.9 m, the total height of the building is 58.35m, with 995 columns and 6625 beam elements. The wind pressure in the simulation environment is 0.55kN/m², and the seismic wave of RH1TG025 is selected to vibrate with a period of 0.25s. The
building structure will be damaged to different degrees under different vibration modes. The damage value is calculated with the help of structural meta-program to determine the period and frequency of different vibration modes, and on this basis, the change characteristics of the vibration frequency of different vibration modes are calculated.

(1) Simulation of structural damage

The building structure parameters used in this experiment include: elastic modulus $E=3\times10^4$ MPa, Poisson's ratio $\nu=0.3$, and material density $\rho=2500$ kg/m$^3$. The stiffness changes of the root columns on different floors are realized by changing the cross section. The loss of building components is divided into two types, and there are 14 damage positions. When the cross-sectional area of the root column is $800\times800$ mm, the condition of the root column is normal. When the root column component is removed, it means that the building has a large damage condition. When the cross section of the root column is reduced to $692.8\times692.8$ mm, it means that the building component has a small damage condition. Each floor uses the above method to simulate the damage of a certain component, while keeping other parameters unchanged, the damage conditions of the building components of each floor are simulated and calculated, and the building structure is in fixed frequency of the first 14 modes under different damage conditions, which are ready for testing the neural network system.

(2) BP network vector for damage identification

Choose the Matlab program to build a neural network, use the fixed frequency calculated in the above link to form training samples, and use the fixed frequency when the building components are not damaged to form test samples to complete the building damage identification experiment. A matrix of 28 columns $\times$ 14 rows is used as the column damage input vector. Different positions and different degrees of damage are the column vectors. The 14 fixed frequencies calculated in the above link are the row vectors. The target vector is determined as a matrix of 14 columns $\times$ 2 rows, the floor corresponding to the damage location is the first row, and the corresponding damage degree is the second row.

① Input vector

The input vector is composed of fixed frequencies corresponding to different damage situations, but the calculated 14 fixed frequencies need to be processed by formula (1), and the result obtained represents the frequency before and after the damage:

$$
NRF_i = \frac{(f_{ui} - f_{di})}{f_{ui}}
$$

In the above formula, $f_{ui}$ and $f_{di}$ respectively represent the fixed frequency before and after damage to the building component.

Use the following formula (2) to normalize the calculation result:

$$
NFRN_j = \frac{NFR_i}{\text{MAX}(NFR_i)}
$$

The processed result is the input vector in the simulation experiment.

② Target vector

A damage condition of a building structure is a column vector of the target vector. The target vector is expressed as

$$
T = T\{T_1,T_2,\cdots,T_i,\cdots,T_n\}
$$

In formula (3), $0 \leq T_i \leq 1$, if $T_i=1$, then it can be concluded that the current damage of the building structure is the $i$-th type; if $T_i=0$, then it can be concluded that the current damage is not the $i$-th Kind.

In order for the established BP neural network to be able to recognize the damage of buildings, it is necessary to implement learning and training. The training parameters are as follows:

The learning rate $\eta=0.01$, the momentum term coefficient $\alpha=0.9$, and the number of training steps is 10,000 times.

③ Network test
The performance test of the trained neural network is to use the test sample as the input vector to analyze whether the system is accurately classifying the output vector. To ensure the validity of the test, the test samples of the input vector should be as diverse as possible. The steps and methods for obtaining training samples can be used to obtain test vectors and input them into the neural network. The output vector whose vector element is close to 1 is selected to identify the damage degree of the building, and the recognition results are shown in Table 1.

Table 1. Recognition results

| Test conditions | Recognition location | Recognition degree | Damage location | Damage degree     |
|-----------------|----------------------|--------------------|-----------------|------------------|
| Condition 1     | 3rd floor            | 98.0%              | 3rd floor       | 100%(missing columns) |
| Condition 2     | 3rd floor            | 24.3%              | 3rd floor       | 35%              |
| Condition 3     | 2nd floor            | 98.7%              | 2nd floor       | 100% (missing columns) |
| Condition 4     | 2nd floor            | 24.4%              | 2nd floor       | 25%              |

According to the above table, the recognition results of the BP neural network are basically the same as the actual damage situation, indicating that the neural network system can identify the damage of building components, and its recognition function can be used to identify the damage location and damage degree of building components. The various indicators selected in this experiment are valid.

2.3. Intelligent Decision Support System Technology

Intelligent buildings are inseparable from the support of the intelligent decision-making system. At present, the intelligent decision-making system mainly includes several parts such as computer, network technology, and database [8]. Among them, the database is the key technology of the intelligent decision support system. Choosing a database with a higher technical level and professional level is an important support for intelligent buildings to realize decision-making intelligence. The further development of an intelligent decision support system on the basis of modern technology can further optimize the implementation plan, make the system model more perfect, and improve the overall level of intelligent building technology. At the same time, it can effectively solve the system operation problems caused by technical limitations.

3. Conclusion

Artificial intelligence technology is an important technology category in the modern information society, and it has been widely used in artificial intelligence architecture. Combining artificial intelligence technology with buildings can realize automated management and automated control of buildings, continuously improve management and service levels, and enable people to get a better experience and life experience. The development of artificial intelligence technology to make it play a greater role in the construction industry will surely bring about new changes in human society.

References

[1] Wei Likai. Architectural Digital History: Artificial Intelligence-Oriented "New Archaeology" of Architectural Big Data [J]. Architecture Journal, 2020(02): 79-85.

[2] Xiong Xiangyang, Ma Xiaoguo, Ouyang Qiang. The Construction and Application of a Comprehensive Evaluation System for Green Intelligent Buildings[J]. Science and Technology Management Research, 2017, 37(03): 95-99.
[3] Li Xiuquan. Current Innovation Characteristics and Evolution Trends of Artificial Intelligence Technology [J]. Journal of Intelligent Systems, 2020, 15(02): 409-412.

[4] Lv Junxia. Introduction to Artificial Intelligence Expert Control System [J]. Precision Manufacturing and Automation, 2020(01): 62-64.

[5] Huang Xiaoyi, Zhao Tian, Chu Jizheng. Analysis and Prediction of Building Energy Consumption Based On AP-BP Neural Network [J]. Journal of Beijing University of Chemical Technology (Natural Science Edition), 2020, 47(04): 101-107.

[6] Wang Quan, Han Qiangqiang, Wang Xiaodong, Yuan Jiawei. Research on Decentralized Neural Network Vibration Control of High-Rise Building Structure Under Earthquake[J]. Chinese Journal of Computational Mechanics, 2019, 36(01): 77-82.

[7] Wang Quan, Wang Wen, Han Xinjie, Han Qiangqiang, Zhou Chaojie. Research on Decentralized Control of Building Structure Vibration Based on Neural Network Algorithm [J/OL]. Chinese Journal of Computational Mechanics: 1-6 [2021-02-22]. http://kns.cnki.net/kcms/detail/21.1373.O3.20201117.1825.032.html.

[8] Wang Jing, Wu Chang. Research on the Framework of Intelligent Decision Support System[J]. Information Recording Materials, 2021, 22(01): 183-184.