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Computer-Aided Design AND APPLICATIONS

Innovative Fusion Method of Internet of Things Algorithm and Interior Design

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Abstract. Due to the growth of sci & tech and the improvement of people's living standards, the demand for indoor environment has shifted from simple food and clothing to comfort and health. In this article, how to realize the intelligent identification and regulation of indoor environment has become a hot issue. Internet of Things (IoT) technology and computer aided design (CAD) have been widely used in many fields. The purpose of this study is to build an intelligent identification system that can monitor the indoor environment in real time, collect data, process data, extract features, classify and predict and control automatically by using IoT. The purpose of this article is to explore the innovative integration method of IoT algorithm and indoor CAD design, and to construct an intelligent and adaptive indoor environment by effectively integrating IoT algorithm and indoor CAD design. The results show that the intelligent identification system designed in this article can accurately and timely monitor and control the indoor environment. Compared with traditional methods, the system has higher accuracy and stability, and can effectively improve the comfort and health of indoor environment. The research work provides a feasible solution for intelligent identification and regulation of indoor environment.

Keywords: Internet of Things Algorithm; Interior Design; Computer Aided Design
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1 INTRODUCTION

In interior design, the combination of IOT and CAD has great potential. The introduction of IoT algorithm can greatly improve the intelligence and adaptability of indoor environment, and indoor CAD design can make the design process more efficient and accurate. In intelligent buildings, optimizing the layout of routers is the key to improving the performance of indoor wireless sensor networks. This includes optimization of network topology and optimization of data transmission paths. The optimization of network topology mainly involves adjusting the location, number, and connection mode of routers to improve the coverage and stability of the network. The optimization of

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data transmission paths is achieved by selecting data transmission paths reasonably to reduce network latency and improve data transmission efficiency. Practical cases are the best way to understand router layout optimization. Taking a certain intelligent building as an example, the building uses Zigbee wireless communication technology to construct an indoor wireless sensor network. Alanezi et al. [1] achieved real-time monitoring and intelligent control of the internal environment of buildings through the rational layout of routers. Reasonable layout of indoor wireless sensor network routers is the key to improving the performance of intelligent. In the past few years, IoT has become a ubiquitous technology, connecting various devices, objects and environments. IoT algorithm is the key factor to realize this connection and intelligence. These algorithms can process a large quantity of data and make decisions according to various parameters, which makes them have broad application prospects in many fields. Designers need to have sharp insight and imagination, be able to flexibly apply innovative thinking, and Alimin [2] can think and solve problems from different perspectives and levels. In interior design education, attention should be paid to cultivating students' creative thinking ability, so that they can learn how to propose creative and practical design plans based on actual needs. Interior design is a combination of art and science, and designers need to possess a unique understanding of beauty and aesthetic literacy. Interior design education should improve students' aesthetic judgment and artistic cultivation through continuous practice and accumulation, and cultivate their perception and application abilities of colors, lines, and space. Successful interior designers not only need to possess innovative thinking and aesthetic literacy, but also need to master relevant technical skills. In interior design, IoT algorithm can be used to monitor environmental parameters and automatically adjust equipment to create a more comfortable and energy-saving environment. The design team can identify potential problems and optimize design solutions in the early stages, thereby reducing the time and cost of later modifications and rework. Altohami et al. [3] use IoT technology to monitor the performance of building equipment and systems in real-time, improve equipment operational efficiency, and reduce energy consumption. At the same time, IoT technology can also be used for intelligent management of building equipment and systems, improving operational efficiency. Through facility management, comprehensive planning, design, operation, and maintenance of facilities during the renovation process are carried out to ensure the smooth progress of the project and minimize the impact on the surrounding environment and facilities. In addition, facility management can also optimize project progress and resource utilization, improving the overall efficiency of the project. Integrating BIM, IoT, and facility management technologies has significant advantages and application effects in renovating existing buildings. By improving design efficiency, intelligent monitoring and management, and optimizing facility management, the efficiency of the renovation process can be significantly improved and costs can be reduced. With the continuous development of technology, these technologies have broad application prospects in the construction industry. Indoor CAD design has become an important tool for interior designers, which can realize the functions of rapid modeling, scheme adjustment, material selection and effect display. Donkers et al. [4] design plays a crucial and challenging role in indoor environmental quality assessment. Ontology is a shared, collaborative, and reusable knowledge representation method that can effectively improve knowledge sharing and reuse. In the evaluation of indoor environmental quality, ontology design needs to achieve unified modeling and standardized description of knowledge, in order to achieve effective sharing and reuse of knowledge. In addition, ontology design also needs to consider how to combine semantic web technology with indoor environmental quality evaluation to achieve a comprehensive and accurate evaluation of indoor environmental quality. The current problems and challenges of ontology design in indoor environmental quality evaluation include: how to achieve comprehensive representation of knowledge, how to achieve inference and processing of knowledge, and how to improve the maintainability and scalability of ontology. In addition, the current ontology design also faces the challenge of combining semantic web technology with indoor environmental quality assessment. However, most of the existing indoor CAD design software only has basic design functions, and cannot be effectively integrated with IoT. For example, how to effectively integrate IoT data into CAD environment, and how to adjust and optimize the design according to these data. Duan [5] considered the impact of marine climate on indoor 3D design research and proposed a theoretical

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framework that incorporates climate factors into indoor design. This framework can help designers better understand the impact of ocean climate on interior design, thereby creating a more comfortable, healthy, and energy-efficient indoor environment. The feasibility and effectiveness of the theoretical framework have been verified through experimental methods and on-site investigations. However, this study still has certain limitations, such as not considering the effects of different marine climate types and extreme climate conditions. Future research directions can include expanding the theoretical framework to adapt to more complex and extreme marine climate conditions.

Excellent indoor CAD design works should be measured from several angles: excellent light and shadow, real texture, reasonable composition and dyeing visual effect. In order to satisfy these points, in addition to the skillful use of this dyeing software, we must also find a key factor that can enhance the artistic appeal of the work. This article aims to explore the innovative fusion method of IoT algorithm and indoor CAD design, in order to optimize the design process and improve the overall effect of indoor design. By effectively integrating IoT algorithm and indoor CAD design, an intelligent and adaptive indoor environment can be constructed. In this environment, IoT algorithm can monitor and adjust environmental parameters in real time, and adjust the working state of indoor equipment according to the needs and behaviors of residents, thus making the indoor environment more comfortable, energy-saving and environmentally friendly. Moreover, indoor CAD design can provide powerful tools and support for this process, including rapid creation, modification and evaluation of design schemes and seamless integration with IoT equipment.

Each artistic expression has its own unique way of expression. As an indispensable artistic expression in indoor CAD design, images not only inject new vitality into works, but also present perfect visual aesthetic effect for scenes. The research has made the following innovations:

(1) This study introduces IoT algorithm into interior design, which expands the research field of interior design and provides a new research perspective and method for the innovative growth of interior design.

(2) In this study, IoT algorithm and indoor CAD design are innovatively integrated, which breaks through the limitations of traditional indoor design and provides new ideas and methods for intelligent and adaptive indoor design.

(3) The feasibility and effectiveness of the new method are verified by experiments, and the new method is continuously improved according to the experimental results, which improves the intelligence and adaptability of the indoor environment.

The chapters of the study are arranged as follows:

Introduction: Introduce the research questions and assumptions, and outline the research objectives and methods. Literature review: Summarize the current situation of IoT algorithm and indoor CAD design, and discuss the advantages and disadvantages of existing fusion methods. Innovative integration of IoT algorithm and indoor CAD design: Describe the application of IoT algorithm in indoor design, and discuss how indoor CAD design can support this. Experimental verification and result analysis: describe the experimental design and implementation process, and show the practical application effect of the proposed fusion method. Conclusion: Summarize the conclusions and innovations, and look forward to the future research direction.

2 RELATED THEORETICAL BASIS

Accurately capturing and understanding changes in animal posture is crucial in biomechanics and animal behavior research. However, most current research mainly relies on expensive 3D motion capture systems, which limits their widespread application. In recent years, the development of deep learning technology has provided new ideas to solve this problem. Gosztolai et al. proposed a deep learning based method for converting two-dimensional poses of laboratory animals into three-dimensional poses, aiming to improve the accuracy and efficiency of animal behavior research. The proposed deep learning model is based on Convolutional Neural Networks (CNN), which accepts

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two consecutive frame images of laboratory animals as inputs and outputs corresponding 3D poses [6]. Gotlib et al. [7] represented the internal structure and spatial information of buildings as a three-dimensional spatial model, and then used spatial transformation algorithms to convert the three-dimensional spatial model into a two-dimensional plan view. This can greatly simplify the process of creating internal maps of buildings. During the conversion process, there may be some structural information loss or distortion issues, so it is necessary to use image restoration algorithms to repair and optimize the converted flat view. This can make the floor plan more accurate and clear. The experimental results show that the simplified method proposed in this article can effectively convert the internal map of buildings from 3D to 2D+format, while maintaining high accuracy and visualization effects. During the simplification process, we lost some detailed information, but the impact of this information on navigation applications was relatively small. With the continuous development of Building Information Modeling (BIM) technology, multi model applications have gradually become an industry trend. However, multi-model applications also bring some challenges, such as data integration, conflict resolution, and model collaboration. Hmidah et al. [8] explored the role of interfaces and interface management in optimizing BIM multi model applications, with the aim of providing useful references for research and practice in related fields. BIM technology is a building information representation and management method based on 3D models, which accurately simulates buildings, infrastructure, etc. through digital technology, achieving high integration and sharing of information. Interface and interface management play a crucial role in optimizing BIM multi model applications. Secondly, interface management can effectively manage and coordinate collaborative relationships among multiple disciplines, solve potential conflicts and collisions, and ensure the accuracy and completeness of the model. With the continuous development of computer technology, computer-aided design software will have more application prospects. Jin and Yang [9] utilize artificial intelligence technology to automatically identify defects in design solutions and propose improvement suggestions. By utilizing virtual reality technology, software can enable students to design in a virtual environment, enhancing the immersion and realism of the design. The development of these technologies will have a profound impact on the teaching of environmental art and design. Overall, computer-aided design software plays an important role in environmental art design teaching. It improves teaching efficiency and makes it more convenient for students to design schemes, draw renderings, and create models. With the continuous improvement of graphic input devices and the optimization of drawing software, the accuracy and quality of CAI technology will be further improved. José et al. [10] expressed their creativity more finely and generated higher quality works. In the future, CAI technology will become more intelligent, able to automatically identify and interpret designers' intentions, thereby better assisting designers in completing design tasks. CAI will be integrated with advanced technologies such as virtual reality (VR) and augmented reality (AR) to expand its application range. For example, designers can use virtual reality technology to present and review design works in a more intuitive way, thereby improving design efficiency and accuracy. With the continuous development of CAI technology, more customized solutions targeting different industries and fields will emerge. For example, professional design software for different industries will pay more attention to the integration and application of CAI technology to meet the special needs of the industry. Intelligent building refers to the intelligent control of building equipment, lighting, air conditioning, security and other systems by combining building, automation, information and communication technologies. Intelligent buildings have advantages such as improving energy efficiency, reducing operating costs, enhancing building comfort and safety. Kim et al. [11] summarized the system design, implementation technology, data interaction, standards and specifications of intelligent buildings. The system design of intelligent buildings mainly involves building automation, communication networks, system integration, and other aspects. Currently, researchers are committed to developing more efficient, reliable, and flexible system design methods to achieve energy management and equipment control in intelligent buildings. The implementation technologies of intelligent buildings include the Internet of Things, cloud computing, big data, artificial intelligence, etc. The application of these technologies in the field of intelligent buildings continues to deepen, providing strong support for the system design of intelligent buildings. Computer assisted technology refers to the use of computers and related equipment for various

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designs, simulations, and analyses. In the field of graphic design, computer-aided technology mainly includes digital tools, image processing software, vector drawing software, etc. These technologies enable designers to express their creativity more accurately and quickly during the creative process, improving design efficiency. Virtual reality technology provides new possibilities for visual aesthetics in graphic design. In a virtual environment, designers can more intuitively experience and evaluate the visual effects of the design. When Lin and Liu [12] use virtual reality technology for UI design, designers can preview and adjust the layout, color, and font elements of the interface before actually building the application, ensuring the practicality and aesthetics of the design. At the same time, through virtual reality technology, users can also more intuitively experience the creativity and ideas of designers, enhancing the interactivity and experience of design. In today's society, people's demand for indoor space is increasing, requiring space not only to meet basic living needs, but also to provide comfortable, beautiful, and personalized experiences. Therefore, interior designers need to constantly update their design concepts to meet market demands. Design visualization is a process of presenting innovative ideas in visual form. Rashdan and Ashour [13] communicate their creativity and ideas to the audience in a more intuitive and vivid way through this approach. At the same time, visual design can also improve the feasibility and operability of the design, helping designers better achieve design goals. Intelligent reconfigurable surface assisted secure spatial modulation technology is a significant technology in the security field, which dynamically adjusts the propagation direction and power of signals to improve the security and performance of communication systems. Beamforming and transmission power design are key components of this technology, which are crucial for achieving secure spatial modulation. Shu et al. [14] provided a detailed introduction to the design methods and related technologies of these two parts. Beamforming is one of the core functions of intelligent reconfigurable surfaces, which generates electromagnetic beams with specific shapes and directions by controlling the phase and amplitude of array antenna elements. Array antennas are composed of multiple antenna elements that need to be arranged according to specific rules. Yang [15] introduced the significance, principle, process, and effectiveness of indoor design optimization teaching based on 3D computer-aided simulation, as well as analyzed the advantages and disadvantages of this teaching. Interior design is a design work carried out by people to create a comfortable living environment. Traditional interior design mainly relies on the manual drawing and experience of designers, but due to the limitations of designers' time and energy, it is often difficult to achieve optimal design. The emergence of three-dimensional computer-aided simulation technology has provided new optimization tools for interior design, enabling designers to more accurately evaluate and optimize design solutions. Therefore, indoor design optimization teaching based on 3D computer-aided simulation has important practical significance. A client's home is a modern and minimalist style residence, requiring the designer to carry out reasonable layout and design within a limited space. Yanxing [16] used 3D modeling software to construct a 3D model of the residence and simulated the real-life scene of the client using virtual reality technology. By simulating walking and observing the perspective, the designer discovered that the originally designed partition between the kitchen and living room would hinder visual permeability, so they promptly adjusted the design plan. A commercial center needs to undergo a comprehensive upgrade, requiring designers to rearrange and renovate the internal space without changing the main structure. Designers use 3D virtual technology to simulate the new design scheme and invite mall managers and tenants to conduct virtual tours. Through this approach, designers can obtain feedback from all parties on the design plan before it is determined, thereby optimizing the design plan. Yigitcanlar et al. [17] utilized artificial intelligence technology to intelligently transform urban infrastructure and improve its operational efficiency and service level. For example, intelligent transportation systems can achieve intelligent scheduling and management of traffic flow through AI technology, improving the efficiency of urban transportation operations. Using artificial intelligence technology to achieve intelligent urban management, such as intelligent security systems that can monitor and identify security risks in real-time through AI technology, improving the level of urban security management. Provide more convenient and efficient public services for urban residents through artificial intelligence technology. For example, intelligent medical systems can achieve early screening and diagnosis of diseases through AI technology, improving the level of medical services. Intelligent reconfigurable surface

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assisted secure spatial modulation technology has significant advantages in terms of security. Firstly, by dynamically adjusting the beam direction and transmission power, the risk of malicious attacks can be effectively reduced. In addition, this technology also has good concealment, making it have broad application prospects in protecting complex communication networks from interference and eavesdropping. However, like other security technologies, intelligent reconfigurable surface assisted secure space modulation also has some shortcomings. For example, advanced malicious attackers may still be able to crack their defense mechanisms, posing a threat to the system [18]. Zhao et al. [19] use the Internet of Things as the core technology and utilize multiple communication interfaces to achieve real-time monitoring and data transmission of indoor air quality. By combining sensor technology with the Internet of Things, key air quality indicators such as temperature and humidity, CO2 concentration, and VOCs (volatile organic compounds) can be remotely monitored indoors. This design adopts various communication interfaces, including WiFi, Bluetooth, and Zigbee, to adapt to different application scenarios and environments. Users can choose the most suitable communication method based on their actual situation. This module is responsible for receiving data collected by sensors, processing, analyzing, and storing the data. At the same time, it is also responsible for providing alarm prompts for abnormal data based on the set threshold. The upper computer interface can display the current indoor air quality data in real time and provide a friendly interactive interface for users, facilitating data query and device control.

3 METHODOLOGY

IoT algorithm is an algorithm based on IoT. Its basic principle is to convert all kinds of information in the physical world into digital signals, and then process and calculate these signals through the algorithm, and finally realize intelligent decision-making and control. The characteristics of IoT algorithm include real-time, intelligence, adaptability and security. Among them, real-time means that IoT algorithm can process and transmit data quickly and make timely response; Intelligence means that IoT algorithm can gradually have independent decision-making and control ability through learning and training; Adaptability means that IoT algorithm can adapt to different environments and scenarios, and has certain adaptability and universality; Security means that IoT algorithm can ensure the security and privacy of data and avoid information leakage and attacks. According to different application scenarios, IoT algorithms can be divided into many different types, including data mining, machine learning, deep learning and so on. These algorithms can realize intelligent decision-making and control by continuously processing and learning data.

Indoor CAD design is an indoor design method based on computer technology. Computer software is used to model, simulate and analyze indoor design, so as to better carry out the work of scheme conception, scheme expression, scheme evaluation and scheme optimization. The characteristics of indoor CAD design include high efficiency, accuracy, visualization and optimality. Among them, high efficiency means that indoor CAD design can quickly complete the design scheme and improve the design efficiency; Accuracy means that indoor CAD design can accurately express the design scheme and reduce errors and ambiguities; Visualization means that indoor CAD design can present the design scheme in the form of visualization, which is convenient for communication and exchange between designers and customers; Optimality means that indoor CAD design can optimize and analyze the design scheme and improve the quality and sustainability of the design scheme. Common indoor CAD design methods include three-dimensional modeling, renderer, virtual reality and so on. These software tools can achieve the goals of high efficiency, accuracy, visualization and optimization by modeling, rendering and analyzing the design scheme.

The integration of IoT algorithm and indoor CAD design refers to the combination of IoT algorithm and indoor CAD design to realize the intelligence and adaptability of indoor design. This fusion method can include applying IoT equipment to interior design to realize functions such as automatic control and environmental parameter monitoring; Moreover, CAD software can be used to model, simulate and analyze the design scheme.

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Using IoT sensor, the room size and environmental parameters, such as temperature, humidity and illumination, can be obtained in real time. These data can be processed by IoT algorithm to get more accurate measurement results of environmental parameters and automatically update the CAD model. In this way, designers can know the actual situation of the room more accurately and optimize the design by using IoT algorithm. The design scheme in CAD software can be simulated by IoT to present the design scheme more truly. Designers can optimize the virtual simulation through IoT algorithm to improve the visualization effect and presentation quality of the design scheme.

Through this fusion method, designers can use IoT equipment and CAD software to realize intelligent decision-making and control functions and improve the quality and efficiency of design schemes. Moreover, it can also bring better living experience and quality of life to customers.

Indoor environment is the main place where people live and work, and its comfort has an important impact on people's living experience. However, due to the influence of many factors, such as building structure, decoration materials, living habits and climatic conditions, it is often difficult to keep the indoor environment stable, and there are inappropriate problems in temperature, humidity, illumination and air quality. With the continuous growth of IoT, it is possible to monitor and collect indoor environmental parameters in real time. By using IoT, the comfort and health of indoor environment can be effectively improved. This article aims to solve the above problems by studying the indoor ambient intelligence identification system based on IoT.

Indoor CAD design is a method of indoor design using computer technology. In the research, the powerful CAD software is used to carry out interior design modeling, simulation and evaluation. Firstly, the indoor environment parameters and user behavior data are obtained by IoT equipment, and then the three-dimensional model of indoor design is created by using these data. In the stage of modeling, it can also be adjusted and optimized according to users' needs and behavior habits to achieve the best interior design scheme. IoT algorithm model is an algorithm model for processing IoT data and monitoring environmental parameters. When constructing the IoT algorithm model, data processing, machine learning and deep learning are used to process, analyze and learn a large amount of data obtained from indoor environment. These data include but are not limited to environmental parameters (such as temperature, humidity, illumination, etc.), user behavior data (such as location, activity, etc.) and other sensor data (such as air quality, sound, etc.). Specifically, the data is preprocessed first, including data cleaning, noise elimination and other operations to ensure the quality and accuracy of the data. The frame of indoor ambient intelligence identification system based on IoT is shown in Figure 1.

By analyzing the processed data, real-time monitoring and prediction of environmental parameters can be realized. For example, the algorithm can learn and predict temperature changes, humidity changes, etc., thus providing a basis for the adjustment of indoor environment. After obtaining the information of environmental parameters, the system can automatically make decisions and adjust environmental parameters based on the set conditions or the prediction results of the algorithm. For example, if it is predicted that the indoor temperature will rise soon, the system can automatically turn on the air conditioner or adjust the window. Moreover, the intelligent identification system also has a feedback mechanism, which feeds back the results of decision-making and control to the environment, thus forming a closed-loop control system. Finally, through indoor CAD design software, the above process can be visually presented, so that designers can intuitively understand and control the indoor environment. Moreover, designers can also adjust and optimize the design as needed.

In the initialization stage, V, P generates random numbers N_V, N_P of y bit and sends them to each other. Upon receiving the corresponding random numbers, V, P respectively passes through the pseudo-random number generator f. Calculation:

$$a_0 \| a_1 = f_k\left(N_V, N_P\right) \tag{1}$$

In which a_0, a_1 is n bit and k is the shared key between V, P.

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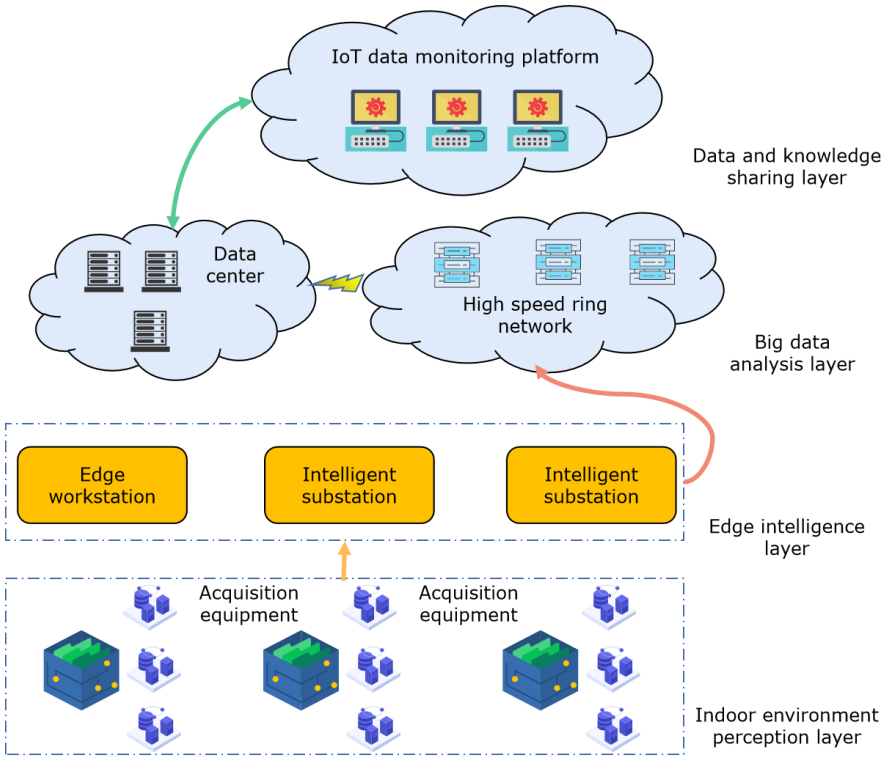

Figure 1: Framework of indoor ambient intelligence identification system.

The selection rule of the response bit $r^{(i)}$ of the prover P in each round is :

$$r^{(i)} = \begin{cases} a_0^{(i)}, c^{(i)} = 0 \\ a_1^{(i)}, c^{(i)} = 1 \end{cases} \tag{2}$$

That is, when P receives the i th challenge bit $c^{(i)} = 0$, the corresponding response bit $r^{(i)}$ selects the i th bit in the vector a_0 ; On the contrary, if $c^{(i)} = 1$, the response bit $r^{(i)}$ selects the i th bit in the vector a_1 .

In IoT algorithm, back propagation neural network (BPNN) can be used to train and learn to extract useful features from a large quantity of data, so as to realize accurate monitoring and prediction of environmental parameters. This process will be repeated until the performance of the neural network meets the expected requirements. The topology of BPNN is shown in Figure 2.

The activation function $f(x)$ is a unipolar Sigmoid function.

$$f(x) = \frac{1}{1+e^{-x}} \tag{3}$$

$f(x)$ has the characteristics of continuous derivable, and has:

$$f'(x) = f(x)(1 - f(x)) \tag{4}$$

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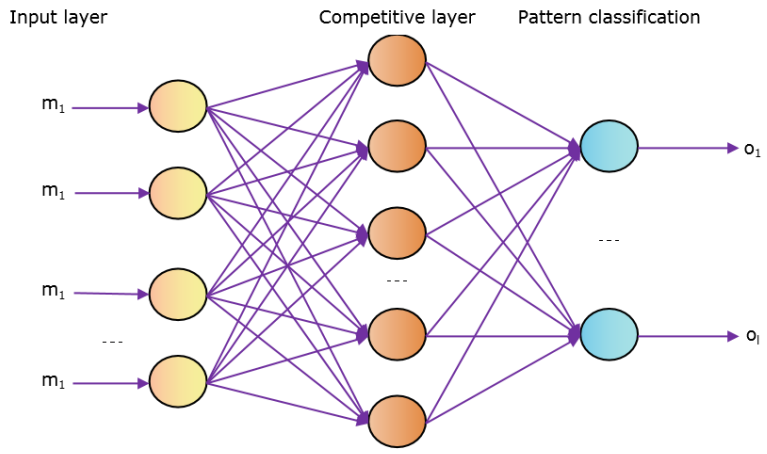

Figure 2: Topological structure of BPNN.

According to the application requirements, the bipolar Sigmoid function can also be used:

$$f(x)=\frac{1-e^{-x}}{1+e^{-x}} \tag{5}$$

Through automatic learning, the original data is transformed into more useful features, and the accuracy and efficiency of classification are improved. By controlling the neurons in the output layer, the indoor environment can be automatically adjusted to achieve a more comfortable indoor environment. In the indoor ambient intelligence identification system based on IoT, one of the key steps to monitor and predict the environmental parameters is to classify the monitoring signals. Extract useful features from the preprocessed data, which will be used to train the classification model. After the optimization, the classification model can be applied to the actual IoT monitoring system to realize real-time monitoring and prediction of environmental parameters. The classification stage of IoT monitoring signals is shown in Figure 3.

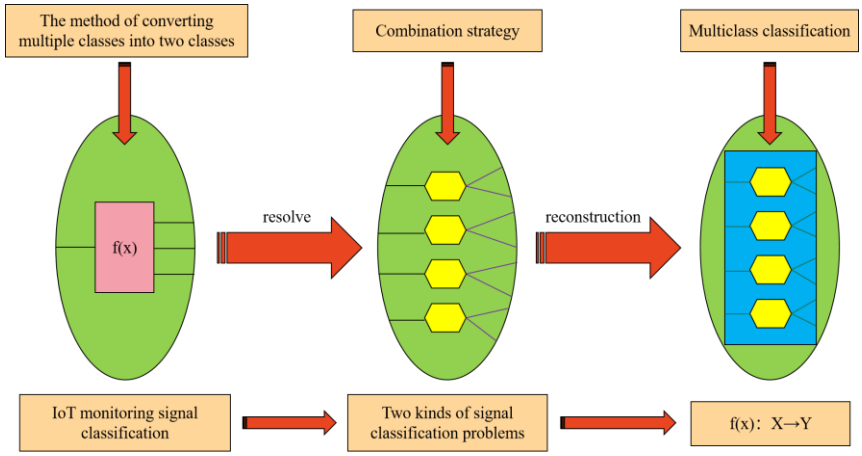

Figure 3: Classification of IoT monitoring signals.

In this article, $D_r(P)$ is used to mark the redundancy rate of attribute path partition method:

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$$D_r(P)=\frac{1}{\sum_{e\in E}\sum_{a\in A}\left|u_e^a\right|}\sum_{e\in E}\left(\left|P(e)\right|*\sum_{a\in A}\left|u_e^a\right|-1\right) \tag{6}$$

u_e^a refers to the quantity of attributes of e on the attribute graph. $|P(e)|$ refers to the quantity of partitions containing edge e in the attribute path partitioning scheme P.

According to the conflict probability of each evidence and the conflict probability of the whole identification space, the weight is adjusted. The collision probability of the whole recognition space is expressed as:

$$k_0=\frac{1+\frac{1}{m}\sum_{i=1}^{m}k_i}{2} \tag{7}$$

The original node weight is introduced, and the total weight W is determined according to the conflict probability:

$$W=m\times k_0\times w_{\min} \tag{8}$$

Where $w_{\min}$ is the minimum of the original weights.

The intersection of all reduced attribute subsets is defined as the core of B, denoted as $Core(B)$:

$$Core(B)=\cap Red(B) \tag{9}$$

$Core(B)$ contains the core of all reduced attribute subsets of B.

Let Q and P be equivalent relation clusters on the domain of discourse, and the positive domain of P of Q is denoted as $Pos_P(Q)$:

$$Pos_P(Q)=\bigcup_{X\in U/Q}P(X) \tag{10}$$

Let P and Q be equivalent relations on the universe of discourse, $a\in P$, if there is a relation:

$$Pos_{Ind(P)}(Ind(Q))=Pos_{Ind(P-\{a\})}(Ind(Q)) \tag{11}$$

Then a is the redundant attribute of Q in P, otherwise a is the necessary attribute of Q in P.

4 EXPERIMENTAL RESULT ANALYSIS

An actual residence is selected as the research object, and its field measurement and data collection are carried out, and the environmental parameters are monitored and analyzed in real time by IoT algorithm. Because the data may have abnormal values, missing values or duplicate values, it is needed to clean the data set to improve the data quality. If the data set has the problem of unbalanced categories, it is needed to over-sample or under-sample the data to balance the quantity of all kinds of data and prevent over-fitting. BPNN is used to extract features and transform the original data into more useful features. With the help of indoor CAD design software, the graphic design of residence is modeled and simulated. Figure 4 compares the recognition efficiency of the method proposed in this article with that of the existing methods. The horizontal axis represents the quantity of experiments and the vertical axis represents the recognition efficiency. With the

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increasing quantity of experiments, the recognition efficiency of this method is always higher than that of the traditional method. This shows that this method has high accuracy and stability when dealing with a large quantity of data.

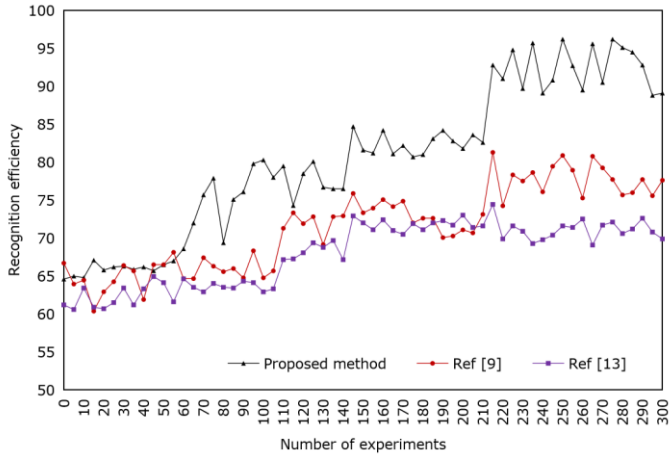

Figure 4: Comparison of recognition efficiency.

Compared with the existing methods, the advantage of this method is that it adopts IoT, can monitor environmental parameters in real time, and process and analyze the data through machine learning and deep learning algorithms. This enables this method to identify the changing trend and abnormal situation of environmental parameters more accurately, thus improving the comfort and health of indoor environment. With the help of indoor CAD design software, this method can quickly establish a three-dimensional model of indoor design, and adjust and optimize it according to user needs and behavior habits. This makes this method better meet the personalized needs of users and provide a more comfortable, healthy and intelligent indoor environment.

Figure 5 shows the recognition accuracy of this method after running for a period of time. With the passage of time, the accuracy of this method shows a steady upward trend. This shows that the performance and accuracy of this method are gradually improved in the stage of continuous data processing.

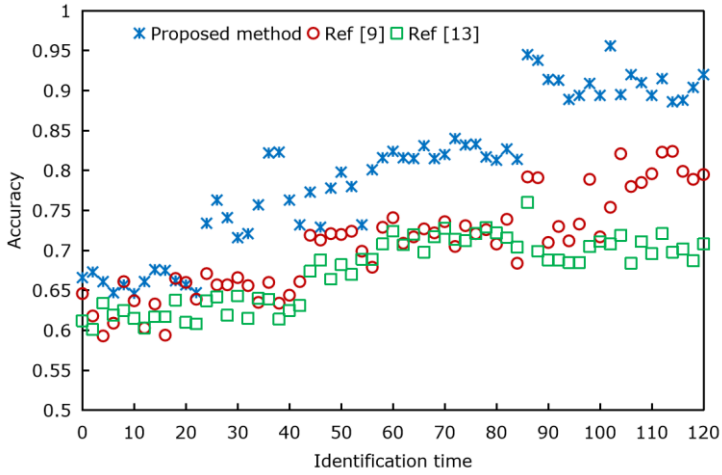

Figure 5: Recognition accuracy.

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With the passage of time, the amount of data collected by IoT devices is increasing, which provides more abundant training data for machine learning and deep learning models. These models can use these data to learn, thus gradually improving their ability to monitor and predict environmental parameters. With the continuous training and optimization of the model, it can better capture the changing rules and trends of environmental parameters, and thus predict the future parameter changes more accurately.

Figure 6 compares the average recognition time of three different indoor environmental state recognition methods.

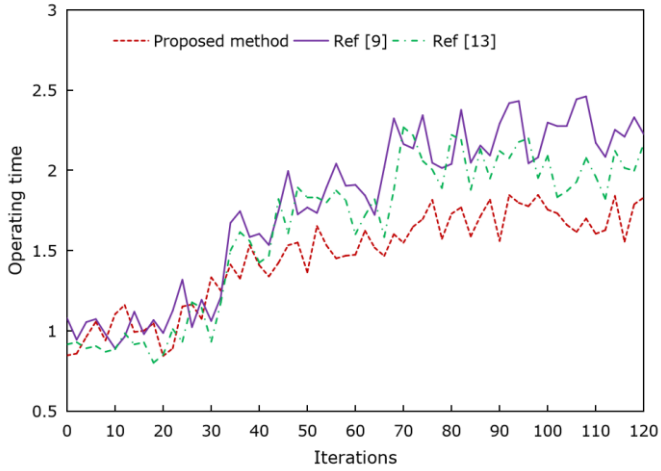

Figure 6: Identification time-consuming comparison.

The proposed method has advantages in the average recognition time, which can quickly and accurately identify the indoor environment state and improve the speed of real-time monitoring and feedback. The stability of the proposed method is good, and its average recognition time fluctuates slightly, while the traditional method has good performance in the early stage, but it fluctuates greatly in the later stage and is not stable enough. Figure 7 shows the relationship that the time required for the fusion process increases with the increase of the quantity of fusions.

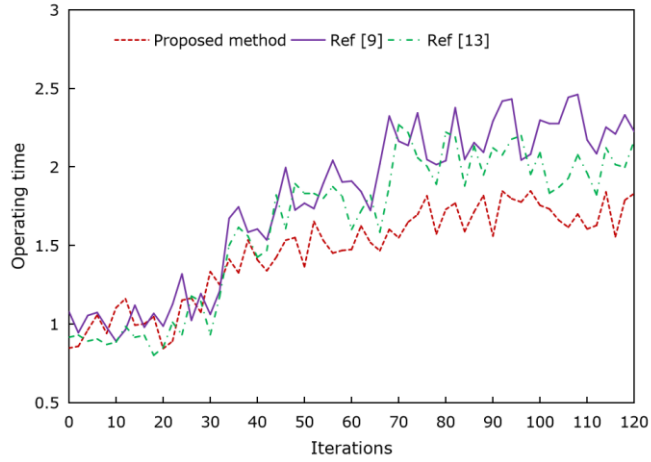

Figure 7: Time consumption of data fusion under different missing rates.

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Under the same deletion rate, with the increase of the quantity of fusion, the time required is also increasing. More data fusion means more calculation and comparison, so more time is needed. When there are more missing samples, more time is needed to process and complete these missing data. By combining IoT algorithm with indoor CAD design, the following effects can be achieved:

Accurate monitoring of environmental parameters: IoT algorithm can monitor and predict the changes of environmental parameters in real time, thus providing accurate design basis for designers.

Adaptive design scheme optimization: With the help of indoor CAD design software, the design scheme can be optimized according to the changes of environmental parameters and the needs of users, so as to improve the adaptability of design.

Improve design efficiency: Through automatic design and simulation, the effects of different design schemes can be quickly compared and evaluated, thus improving design efficiency.

Meet personalized needs: IoT equipment and CAD software can acquire and analyze users' behaviors and needs, thus providing personalized design support for designers.

An innovative fusion method is proposed, which combines IoT algorithm with indoor CAD design. The results show that this fusion method can improve the intelligence and adaptability of interior design and improve the accuracy and efficiency of design. In the future research, we will further explore how to improve this fusion method and expand its application fields, and apply this method to more practical projects to verify its actual effect.

5 CONCLUSION

In this article, how to realize the intelligent identification and regulation of indoor environment has become a hot issue. Indoor CAD design has become an important tool for interior designers, which can realize the functions of rapid modeling, scheme adjustment, material selection and effect display. In this article, through the application of IoT, an intelligent identification system is constructed, which can monitor the indoor environment in real time, collect data, process data, extract features, classify and predict and control automatically. The system can not only accurately and timely reflect the changes of indoor environment, but also automatically adjust the indoor environment according to environmental parameters, providing a more comfortable and healthy environment for people's life and work. This fusion method can include applying IoT equipment to interior design to realize functions such as automatic control and environmental parameter monitoring; Moreover, CAD software can be used to model, simulate and analyze the design scheme. The results show that this method can improve the intelligence and adaptability of interior design and improve the accuracy and efficiency of design. In the future research, the performance of the system will continue to be optimized and improved to provide a better indoor environment for human life and work.

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