Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org

Volume 25, Issues 5, pp. 3268–3276, DOI 10.12694/scpe.v25i5.3059

RESEARCH ON INTELLIGENT BUILDING INTEGRATED CABLING SYSTEM BASED ON INTERNET OF THINGS AND DEEP LEARNING

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Abstract. In order to solve the problem that the traditional integrated wiring system has many inconveniences in management, which affects the stability and efficient operation of the entire system, an intelligent building energy management control system in the Internet of Things era is proposed. In terms of hardware, design intelligent building switches, and in terms of software, plan the IP address of intelligent building wiring based on the Internet of Things, formulate comprehensive backbone wiring layout structure of intelligent building, set up auxiliary power distribution horizontal lines, and connect intelligent building wiring data, so as to realize intelligent building integrated wiring .On this basis, the architecture design of the wiring assistant design system is carried out, and the artificial intelligence building integrated wiring assistant system is realized with the help of the Net platform, and the system test is carried out. The experimental results show that the PM10 concentration parameters and the energy consumption simulation curve are highly consistent with the actual value curve. According to the calculation of the data volume points, the coincidence degrees can reach 96.4% and 98.9%, respectively. The experimental results show that the designed wiring system is superior to the traditional wiring system in terms of energy saving, and has certain reference value.

Key words: IoT technology, intelligent building, system integration, artificial intelligence, general wiring

1. Introduction. Cabling system refers to the network transmission, design time Attention should be paid to the connection of various devices, including voice, data processing equipment. Adopt An integrated wiring system, which connects equipment to the interior and exterior of the same building, is The general idea of the current design.The Internet of Things and digital technologies are developing rapidly in the current environment. In the good state of the momentum of the Internet of things, the modern construction industry is also gradually inclined to intelligent development. Simply put, intelligent building is a combination of information technology and modern building technology, with a new way of display to provide a service platform, so that people become more comfortable in the use of the process, instead of the traditional method, so that the display is more comprehensive. Following the emergence of computer, Internet and mobile communication network information control technology, the rise and development of Internet of Things technology has promoted the third scientific and technological revolution, which is also an important part of information technology under the new situation [1]. One after another, all parts of the world have taken the lead in launching research plans for the strategic development of the Internet of Things. Under the influence of the global Internet of Things trend, the Internet of Things was written into the Chinese government work report for the first time in 2010, and it was officially listed as one of the five emerging development strategies of the country, and was given a high degree of attention and policy support [2,3]. In recent years, the Internet of Things technology has gradually become a new hot spot for development, and it also presents a huge development prospect, penetrating into all aspects of people's lives. Traditional wiring techniques often lack reliability and energy saving in terms of transmission Also not satisfactory, can not meet the current needs of smart buildings, can not replace the end End equipment, and has high maintenance and renewal costs, the overall is also very ugly.

In the field of construction, usually shallow geothermal energy needs to be collected and exchanged by ground source heat pump system before it can be utilized. After years of research and practice, ground source heat pump technology has proved that this technology is suitable for the requirements of sustainable development, and has the advantages of high efficiency, energy saving and environmental protection.

Traditional intelligent buildings are based on integrated wiring and use computer networks as bridges. Most of them use an extensive three-layer structure, which is the field control layer, the automatic control layer and

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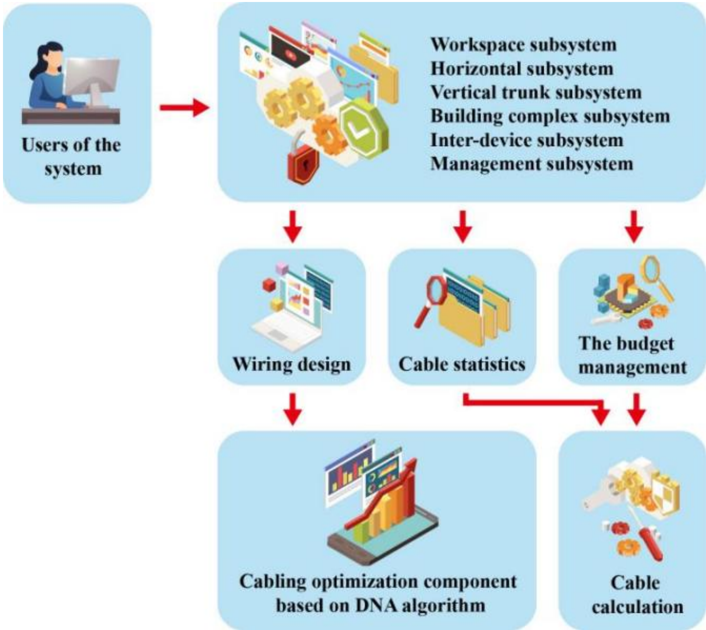

Fig. 1.1: System integration architecture diagram of integrated wiring of intelligent building

the top management layer. Various subsystems in the building (elevator, water supply and drainage, HVAC, power distribution, intelligent lighting, security, etc.) are configured through various communication protocols, and the system integration method of a unified protocol is often used to realize the integration of various systems in the building. Comprehensive management and centralized monitoring of various equipment and subsystems. The traditional integration method is easy to cause problems such as difficult coordination and operation between subsystems, heavy configuration workload, poor openness, and poor flexibility [4-5], so it is not conducive to the development of building intelligence. The object in the Internet of Things is the basic unit. If this concept is applied to the building, the electrical equipment can be regarded as a basic information unit and is endowed with "wisdom", then the network is connected to the Internet of Things system according to the unified communication protocol. All information perceived by the underlying device can be received. Therefore, the Internet of Things technology solves the existing drawbacks from the bottom device side, and the information exchange and information communication based on the Internet of Things technology become much easier. Therefore, to realize system integration of intelligent buildings, the overall structure will change, and the emergence of a new integrated system architecture based on the Internet of Things is an inevitable trend. Figure 1.1 is a system integration architecture diagram of integrated wiring of intelligent buildings. The traditional cabling method makes the reliability of each line is poor, and the cost is high Design of intelligent building cabling system based on Internet of Things. In terms of hardware, I designed intelligent building switches; in terms of software, I planned intelligent building wiring IP address based on the Internet of Things. Formulate the intelligent building comprehensive trunk wiring layout structure, set the auxiliary distribution horizontal line, connect the intelligent building wiring data, so as to realize the intelligent building comprehensive wiring.

2. Literature review. Qian, H. et al. proposed that in recent years, the application field of the Internet of Things has become more and more extensive, and it has been widely used in fields such as smart home, smart transportation, agriculture, environmental protection, industry, medical and health, etc., and has achieved good results. Demonstration effect [6]. According to the research report by Zhu, Z. M. et al., during the 12th and 13th Five-Year Plan period, the Internet of Things technology has developed rapidly, has received strong support from national policies, and has become the driving force for the economic development of China's key industries. Under the influence of the global trend of smart earth and smart city, China has also put forward the slogans of "perceive China" and "smart city" based on the Internet of Things [7]. Xiao, B. et al. proposed that, as the most basic unit of a smart city, smart buildings can effectively promote the development of smart cities with the help of the Internet of Things [8]. Liu, Z. and others believe that the Internet of Things makes the various subsystems of intelligent buildings "smart", and each system can freely increase or decrease the corresponding functions and services according to the needs of users, turning "intelligent buildings" into "Smart building" realizes the integration of "management, control and operation" to build a smart city [9].

X, He. et al. pointed out that a large number of sensors are installed in various subsystems in the building, such as lighting, HVAC, and security systems, and the data measured by the sensors constitute the information basis. The Internet of Things technology can realize the collection and transmission of data., computing processing, and the structure of the Internet of Things system is shown in Figure 2.1 [10]. According to the research of Qin, N. et al., on the one hand, the comprehensive perception and intelligent analysis of Internet of Things technology provide technical support for intelligent buildings. New intelligent buildings should be open, equipment can self-organize, and the system should be flat to meet the needs of different manufacturers[11]. On the other hand, with the continuous maturity of the Internet of Things, big data, and artificial intelligence technologies, the intelligent era of the Internet of Everything and the integration of the human-machine-object ternary world have become inevitable, "connection + big data intelligence + personalization" "Service" will become the basic paradigm of building intelligence.Tong, Y. U. et al. proposed that the application of the Internet of Things in the field of intelligent buildings is very limited, and generally there are only four aspects: intelligent monitoring, intelligent security, smart home and energy saving and emission reduction. For example, various sensors are installed in home equipment, information is transmitted through the network, and users are monitored through B/S access mode [12]. Therefore, Ren, L. et al. pointed out that through the perception layer device, the building can fully perceive the data information generated by people/environment, and store, analyze and learn, and can think independently [13]. Abdulraheem, AS et al. believe that people-oriented, in addition to the standards of building equipment itself, pay more attention to people's needs; at the same time, it solves the problems existing in traditional intelligent buildings, and a new type of intelligent building architecture that adapts to the Internet of Things era emerges as the times require [14] . Guo, L. et al. proposed that IoT buildings apply IoT technology to realize comprehensive perception of various physical parameters in buildings. Through heterogeneous network fusion, information aggregation, decision-making diagnosis, online control, big data analysis and other means, Form an integrated service management system from the bottom equipment to the upper application, and realize the comprehensive optimization management of energy saving, comfort, safety, health and other objectives in the whole life process of the building [15].

3. Research method.

3.1. Design and implementation of artificial intelligence DNA algorithm based on Internet of Things. The design idea of integrated wiring system is mainly structure and modularization, and adopt Hierarchical star topology is used for integrated wiring of the whole building. From the machine room to The structure of each floor adopts the star topology, the wiring cabinet of each floor and each work Regional information points are no exception. The data communication and signal transmission of the 3A system of a smart building requires a complex wiring system to provide transmission support. The signal cables are routed from the trenches. Interleaving can negatively affect network performance and signaling [16]. The solution to cable crossover is to perform layered wiring: if crossover cables occur, route them to different layers of the trunking, while ensuring that cables on the same layer do not cross. In order to reduce the amount of wiring construction, it is required to control the number of wiring layers to a minimum. The hierarchical problem can be mapped to the vertex coloring problem of the graph. Vertices of the same color can be routed to the same layer, and vertices of different colors need to be routed to different layers. Compared with the traditional computing mode, the artificial intelligence DNA sorting algorithm based on the Internet of Things has the advantages of fast computing speed, low power consumption, high storage capacity and high degree of parallelism. At present, the fastest supercomputer operates at an order of magnitude of 1012 operations per second, while the speed of DNA computers can reach 1014 operations; the biggest problem of traditional computers is power consumption, and the power consumption of DNA computers is only one billionth of that of traditional computers; the information stored in one gram of DNA is equivalent to 2.5 million optical discs; traditional computers have the characteristics of seriality, while DNA has native support for parallel

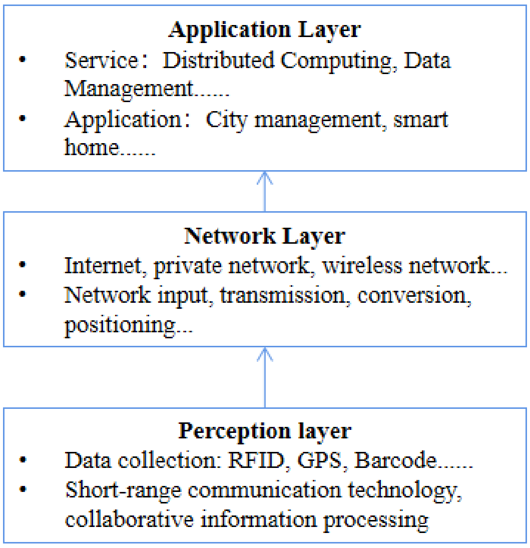

Fig. 2.1: IoT Architecture

computing [17].

Firstly, the basic model composition of artificial intelligence DNA algorithm is described. The first problem that needs to be solved is the coding problem. The coding in the artificial intelligence DNA model is realized by single-stranded or double-stranded DNA molecules. DNA molecular strand is a storage complex, which consists of storage strand and sticking strand. A storage chain can be formed by concatenating n heterogeneous sub-chains, each sub-chain contains m bases, and each pasting chain also contains m bases. Firstly, the basic model composition of artificial intelligence DNA algorithm is described. According to the principle of base complementarity, it can be determined that there is a complementary relationship between the pasted chain and a certain sub-chain in the storage chain. Therefore, it can be agreed that when a single chain exists in the storage complex, it means 0, and if it is a double chain, then Represents 1[18]. On this basis, four basic operations of the storage chain are defined:

1) Set: Set the non-zero storage location to "1", represented by Set(T, i);

2) Clear: change the storage location from non-zero to "0", represented by Clear(T, i);

3) Merge: Use the ligation reaction to merge the two DNA single-stranded or double-stranded DNA, that is, merge the two storages into one, expressed as T=T1UT2;

4) Decomposition: Decompose the storage T represented by the single-stranded or double-stranded DNA molecule into two sets +(T, i) and -(T, i) as needed, where +(T, i) represents the storage bit A combination of bit strings of 1, similarly -(T, i) represents the set of bit strings of 0 [19].

The vertex coloring algorithm for solving the graph can be expressed as the algorithm of deleting uncolored points and deleting adjacent same-color points, which are described in Table 3.1 and Table 3.2 respectively:

In the above code, r and t are the subscripts of the two vertices that make up the edge ei, respectively, and abandon represents the deletion operation. After the above iterative operations, the DNA strand in the test tube T0 is a feasible coloring scheme for the graph G, and the desired result is obtained after decoding[20]. The core of this computational model is to use a library of magnetic bead probes with biomarkers to implement continuous separation of non-solutions in the initial solution space, and finally find the target solution, where the initial solution space is composed of library chains (that is, DNA representing all possible coloring schemes) sequence) and probe library strands representing the structural information of the graph.

Table 3.1: Remove unshaded points algorithm

Remove unshaded vertices pseudocode
GranphColoring(T0,n,m,k)
For t←1 to n do
Separate+(T0,(i-1)*k+1) and-(T0,(i-1)*k+1)
T0←+(T0,(i-1)*k+1)
T1←+(T0,(i-1)*k+1)
For j←2 to k do
Separate+(T1,(i-1)*k+j) and-(T1,(i-1)*k+j)
T0←Merge(T0+(T1,(i-1)*k+j))
T1←+(T1,(i-1)*k+j)
End
abando T1
End

Table 3.2: Delete adjacent same color point algorithm

Pseudocode for deleting adjacent points of the same color
For i← 1 to m do
For j←1 to k do
Separate+(T0,(r-1)*k+j)and-(T1,(r-1)*k+j)
T0←-(T0,(r-1)*k+j)
T1←-(T1,(r-1)*k+j)
Separate+(T1,(t-1)*k+j)and-(T1,(t-1)*k+j)
T0←Merge(T0+(T1,(t-1)*k+j))
abando+(T1,(t-1)*k+j)
End
End

3.2. Design of intelligent building integrated wiring system based on IoT artificial intelligence DNA algorithm. When all kinds of new energy are introduced into intelligent buildings to be used, the automatic operation and management of all kinds of application systems will naturally be included in the intelligent building equipment management system. This not only increases the content of building equipment monitoring system, but also expands the scope of energy management services. The intelligent building work area system consists of information sockets, adapters, and cables connecting the user terminal equipment to the sockets. The terminal office environment of the intelligent building is provided directly to the end user, and its design is relatively simple. When the user's network usage requirements are not accurate, an independent work area can be estimated based on the area of 5-10 square meters. The second core problem of workspace design is to count the number of information points. A work area in an ordinary office area is usually equipped with 2-3 information points. For work points with special needs (such as setting up services such as server, fax, video, network printing, etc.), 3-5 dedicated information points can be added. In terms of transmission cable requirements, conventional office areas can lay 10-100M twisted pair cables, while for business or technology development office areas with high bandwidth requirements, fiber optic information points that support more than 100M can be laid. In terms of socket design, the information points are mainly composed of standard RJ45 sockets, and the selection of other sockets must comply with EIA/TIA standards. In scenarios with special requirements, various types of adapters can be selected for connection according to needs [21]. The workflow of the workspace subsystem design is as follows:

1) Determination of design level and work area information points: Determine the number of information

points in the work area according to the design level selected by the user. The design of the number of information points N must consider the future development needs, and the number of information sockets corresponding to different design levels can refer to the national standards for integrated wiring and related manuals [22];

2) Calculation of working area: Calculate the area of each working area according to the building plan, and count the total area S of the working area of the building [23];

3) Calibration of the number of sockets and their positions: First determine the area P of the work area. If there is no special requirement, it is usually calculated according to $P = 5 \sim 10m2$, then the number of sockets is $M = (S \div P) \times N$, where S is the total work area. area, P is the area of a single workspace, and N is the number of information points in a single workspace [24];

4) Calculation of socket type and the number of associated devices: the type of socket can be surface-mounted or embedded[25]. New buildings usually use the embedded method; the sockets installed on the floor have two types: fixed type and movable type. User needs and costs to choose. Associated equipment includes bottom boxes, covers, panels, etc. The type and quantity of sockets and related connectors can be determined according to user needs and architectural drawings.

4. Result analysis.

4.1. Realization of intelligent building integrated wiring system based on IoT. In order to realize the integrated wiring of intelligent building, it is necessary to distribute the integrated wiring system To the various parts of the smart building. Design cabling for various types of hardware Standard information sockets for equipment need to be provided by capital engineering and open systems. Practical design of integrated wiring system and The installation will be on the building , structure and other industries make many requirements when designing The comprehensiveness of the cabling system must be considered to meet the needs of modern intelligent buildings Demand. Thus, the information transmission between various automatic systems is stable. The system is implemented according to the three-layer structure. The presentation layer, in the form of a local client, provides users with a visual cable routing auxiliary interface. This section focuses on the implementation of the business logic layer. The business logic layer includes core parts such as cable routing optimization design module and database access module, which are encapsulated in the form of reusable components. The database access component provides the encapsulation of the database Create, Retrieve, Update and Delete operations. In terms of coding implementation, the database access operation is divided into three steps: first, create and obtain a business logic object; then create a persistent object related to database access and a business class for storing data through the business object; finally, the business object Call the methods of the persistent object to perform operations such as searching, inserting, deleting, and updating the database. On the .Net platform, database access operations are designed to database-driven loading, connecting to the database, and database operations.

4.2. Test results of integrated wiring system of intelligent building based on Internet of Things. In order to ensure the correctness, reliability and safety of the system, a scientific test strategy must be formulated in the test link. For the test of this system, the project team has formulated the following test links and test strategies:

(1) Functionality and robustness testing: Whether the software system meets user requirements is the primary indicator that needs to be confirmed during software delivery. The functional test is carried out according to the software requirements analysis specification, and the method of black-box testing is used to assess whether the system functional modules meet the requirements of the requirements specification, and whether they can be expected under the given input; Robustness test: robustness test Used to ensure the robustness and stability of the system. During the test, illegal values are entered manually to judge the response of the system. The system should provide feedback for wrong input, and it will not crash; (2) User interface test and performance test: In order to facilitate the use of users and improve work efficiency, the system should have a friendly human-machine interface, which is convenient, intuitive and beautiful and concise; performance test: this system belongs to a typical C/S mode application, the client side involves editing the building structure diagram, and is used to realize the wiring and routing design; the server side mainly involves database operation. This system does not have large server-side load and pressure requirements, and the client

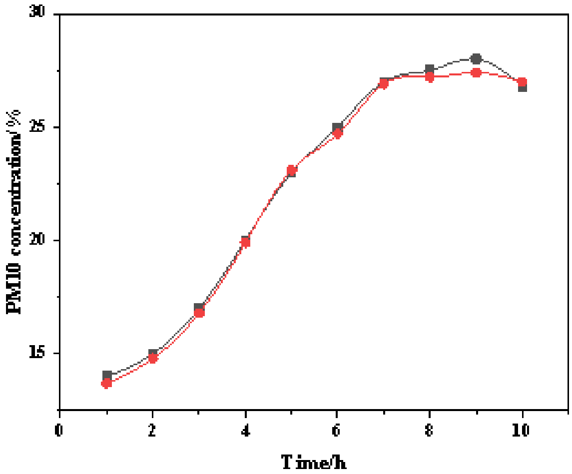

Fig. 4.1: Contrast curve of PM10 concentration in experimental room of passive experimental building

hardware configuration can currently meet the requirements. Therefore, this system can theoretically meet the performance test requirements in most environmental scenarios. The test results for system functionality and robustness are shown in Figure 4.1. In the experiment, the actual PM10 concentration curve was obtained through traditional measurement methods, and the measurement curve was transmitted back to the system in this paper through the artificial intelligence building wiring system based on the Internet of Things. It can be seen from Figure 4.1 that the PM10 concentration parameters obtained by the experimental measurement are highly consistent with the actual value curve, and the degree of agreement can reach 96.4% according to the calculation of the data volume points, indicating that the system has the conditions for measuring various parameters and verifies its functionality; the actual saturation value The difference from the measured saturation value of the system is 6.4%, which verifies that the system has good robustness.

For the user interface and its performance, the energy consumption prediction interface is called to test the prediction accuracy and performance of the system. The obtained prediction model curve and the actual energy consumption curve are compared as shown in Figure 4.2. It can be seen from Figure 4.2 that the energy consumption prediction interface The predicted energy consumption simulation curve coincides with the actual energy consumption curve measured in the experiment at multiple sampling points. The calculated curve fitting degree is as high as 98.9%, which verifies the accuracy and efficiency of the interface of the artificial intelligence building wiring system.

By analyzing the comparison curve between the above prediction model and the measured value, the following conclusions can be drawn: In the module testing process, the project team conducted a black-box test on the remaining functional modules of the integrated wiring auxiliary system. Description of functional requirements. Before functional testing, the system conducts unit testing by means of code walk-through to avoid coding errors. In addition, user interface testing was carried out to ensure that the user interface is friendly, straightforward view. In order to ensure the good compatibility of the client, a platform compatibility test is also carried out, and the test results show that, thanks to .Net The platform naturally supports the Windows platform, and the system can run stably on the Windows series operating system platform. At present, the integrated wiring auxiliary system has been in trial operation in the laboratory, showing good performance and effectively improving the efficiency of design work. A character is designed Integrated environment of intelligent building wiring system, after design, the system experiment, According to the experimental results, the intelligent building wiring system designed in this paper is based on the Internet of Things The system is superior to the traditional wiring method in energy saving and has been popularized to some extent Meaning.

5. Conclusion. Up to now, the concept of the Internet of Things and the idea of "smart energy" have made clear the future development direction of intelligent buildings, especially in the aspect of energy management. It

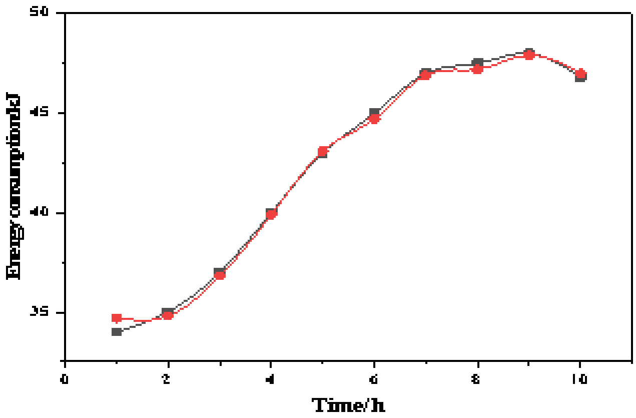

Fig. 4.2: Comparison of the predicted model curve and the actual energy consumption curve of the energy consumption prediction interface

will break through the shackles of single buildings or independent parks, and stride forward to the broader and more integrated field of "smart city" energy management. Aiming at the problems existing in the traditional intelligent building system architecture and the development of the Internet of Things technology in intelligent buildings, this paper improves the system architecture of the traditional intelligent building, and proposes an artificial intelligence building control system based on the Internet of Things technology. Comprehensive perception of various physical parameters in the system, information fusion and aggregation of heterogeneous data, through service decision-making, system diagnosis, online monitoring, big data analysis and other means, to form an integrated service management system from the bottom equipment to the upper application., to achieve multi-objective optimization and comprehensive optimization management of energy saving, comfort, safety and health in the whole life process of the building.

This paper has completed the design and implementation of the IoT artificial intelligence building system, and has achieved certain results by applying it to the passive experimental building, but the research on the energy saving of the IoT in buildings needs to be further deepened. In the following work, the factors affecting building energy consumption, such as the environment, building envelope, building shading, indoor heat gain, etc., should be analyzed first; then the energy consumption correlation model should be established, and the energy consumption data of building monitoring should be analyzed by regression analysis. Or neural network technology can establish energy consumption model, and use big data analysis technology to predict the energy consumption of the entire building. Finally, the system is optimized considering the comfort requirements of green buildings. Under the background of advocating rational use of traditional energy and active exploitation of green renewable energy, intelligent buildings have added new contents: introducing new energy application systems such as solar energy, geothermal energy and wind energy into intelligent buildings to reduce the consumption of traditional energy in buildings; At the same time, it is integrated into the construction equipment management system to make the application of new energy more transparent and reasonable.

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Edited by: B. Nagaraj M.E
Special issue on: Deep Learning-Based Advanced Research Trends in Scalable Computing
Received: Dec 20, 2023
Accepted: Feb 27, 2024