Research Article

Integrated Wiring System of Intelligent Building Based on Internet of Things

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In order to explore how the intelligent building can realize the integrated wiring system, the author proposes an integrated wiring system for the intelligent building based on the Internet of Things. This method recommends key technical problems and solutions based on the information represented by the Internet of Things and explores the research on the realization of integrated wiring systems in intelligent buildings. Research has shown that the integrated wiring system of intelligent buildings based on the Internet of Things can solve the shortcomings of traditional buildings, and the happiness index of occupants has increased by about 15%. In the future, a building will be a platform, and each building will be an IoT unit and a cell body, making the Internet of Buildings possible and building a big data platform for the Internet of Buildings.

1. Introduction

China in the 21st century is a rapidly developing China, an era when hundreds of millions of Chinese people realize the Chinese dream [1]. Architecture is a symbol of the development of the times; today, various high-rise buildings in China are springing up like bamboo shoots after a rain. With the development of the times and the advancement of science and technology, architecture has also entered the era of intelligent buildings, and buildings are no longer traditional rigid buildings; it has a certain intelligence, can listen, can see, can perceive, can think, can judge, and has the ability to “think and make decisions”; it represents the latest trend in the development of intelligent buildings. What makes a smart building smart depends on its design. It takes many designers to use their ingenuity to implant a “nervous system” into the building.

With the rapid growth of the number of intelligent buildings, more and more design institutes have set up intelligent majors, or weak current majors [2]. Engineering integrators are also equipped with corresponding intelligent building designers. However, since the starting point of intelligent buildings in China is still relatively late, despite the development of nearly two decades, the development of intelligent buildings is still limited, and most people are still unfamiliar with the concept of intelligent buildings, unlike water supply and drainage, strong electricity, and decoration; even people in the industry may not fully understand the meaning [3].

Building intelligent weak current system has high technical content, long construction period, and complex process. There are many problems in the design of intelligent weak current; for example, the current technical specifications and standards related to the weak current industry are not unified, and with the rapid development of technology and the rapid upgrading of products, some current specifications cannot meet the technical requirements; moreover, in the process of intelligent design, some personnel from other majors and units also interfered with the design, making the design works unreasonable and the construction quality unqualified, and the degree of functional realization of the design is low. Intelligent building designers need to have strong comprehensive strength and practical experience, not only to master various professional knowledge but also to have rich design experience; it is necessary to master not only professional knowledge in many aspects but also rich design experience and mastery of cutting-edge technology and latest products; unfortunately, such designers are
currently in short supply, resulting in unreasonable design of intelligent systems, low design quality, and low recognition from owners [4].

The "smart building" in the 21st century will be an upgraded version of the "smart building," by making full use of communication technology, artificial intelligence technology, Internet of Things technology, and BIM technology to sense and analyze the key information of the core system of the entire building operation, in order to achieve the goal of "efficiency, comfort, safety, and energy saving"; it can respond intelligently to various needs including people's livelihood, environmental protection, and public safety and create a better life for people [5].

A smart building is generally composed of four systems: building system, communication automation system (CAS), building equipment automation system (BAS), and office automation system (OAS). The BAS, CAS, and OAS systems together constitute the brain and nervous system of the building. Its key technologies are Internet of Things technology, BIM technology, artificial intelligence technology, and cloud computing technology.

As a smart building industry closely linked to the Internet of Things, the Internet of Things has a ubiquitous impact on smart building technology, and devices are spread across most subsystems through sensor networking technology [6]. It can be said that many subsystems are already close to the form of the Internet of Things or are already in the form of the Internet of Things, such as monitoring, security, one-card, professional applications, and other systems in building equipment. The interaction between the Internet of Things and smart buildings is realized; especially RFID technology is widely used for personnel management, equipment management, and material management in buildings. However, the applications that are designed today can only be used in the field of architecture, they all define and use the surrounding contacts in a granular manner according to the characteristics of the system; in this way, granular objects of different granularity levels will inevitably form the source of massive data, which requires that we must rely on massive data processing platform to carry out. The Internet of Things has seven key technologies, including hardware and software technology, identification technology, network architecture, network and communication, data representation and processing, energy technology, and security and privacy technology [7], as shown in Figure 1.

2. Literature Review

Ishmael et al. said that intelligent buildings developed earlier in the United States and the research on it was earlier [8]. Murugesan began research to develop a design standard for home electronics, and the following year, the American Smart Building Association was established, conducting basic research work related to intelligent buildings [9]. In 1989, Li et al. introduced the integrated modernization model of air conditioning control, electrical control, and data communication integrated wiring system for the whole unit [10].

Qin and Xie said that as early as 1986 in Europe, the Eureka project integrated home system development research as the focus of research and development [11]. Since the 1980s, the European Committee for Standardization has developed a digital bus standard for household appliances and for the further standardization of smart housing technical standards. Smart buildings in Europe are mainly concentrated in some modern cities, such as Madrid, Frankfurt, London, Paris, and other well-known cities.

In the early 1980s, Japan vigorously promoted household electronic products; in the mid-1980s, Japan proposed a new concept of home automation. In recent years, Wang et al. proposed the concept of a superintelligent building home integration system [12]. In 1996, Japan launched the smart home multimedia technology and obtained important international research results. Japan is one of the representative countries that combine the theory and practice of intelligent buildings, and it is also one of the major intelligent building markets in the world.

Kim et al. believe that in Southeast Asia, Singapore has the leading research level of intelligent building technology. Singapore’s Ruby family intelligent management system has been used in hundreds of residential communities [13]. With the rapid rise of intelligent buildings, the Ministry of Construction of China has issued relevant intelligent building standards, in order to standardize the intelligent design and construction of Chinese buildings. In the early 1990s, Mihoubi et al. carried out research on the quality of intelligent building intelligence [14]. The characteristics of intelligent buildings in various countries in the world are investigated, analyzed, and summarized, and the quality evaluation factors of intelligent buildings are obtained from the aspects of function, economy, and automation. After that, many Chinese experts and technicians in the industry have written a lot of books about intelligent buildings, in order to help more people understand intelligent buildings and raise people’s awareness of the importance of intelligent buildings. At the same time, a large number of intelligent building design institutes, intelligent building consulting agencies, intelligent building system integrators, and intelligent building product suppliers have sprung up in China one after another.

Kouki et al. said that at present, China’s construction industry is developing rapidly. With the continuous progress of science and technology, intelligent buildings have been widely used and promoted, and there are more and more supporting weak current projects, and intelligent weak current design has also improved significantly [15]. Because of the importance of intelligent buildings, intelligent buildings in China have also flourished, especially represented by more developed cities such as China’s coastal areas; after that, cities in other regions are not far behind, and smart buildings have also developed rapidly.

3. Methods

3.1. Structure of BP Neural Network. Calculate the corrected connection weights. If the error function is $\varepsilon$ and the iterative partial derivative of each neuron, $\Delta w_{in}(k)$, is the
corrected connection weight, the formula for calculating the variable value $\Delta w(k)$ is shown in

$$\Delta w(k) = \delta(k)x(k).$$  \hspace{1cm} (1)

If the global error is defined as $E$, the method for calculating $E$ is as shown in

$$E = \frac{1}{2m} \sum_{k=1}^{m} \sum_{a=1}^{q} (d_a(k) - y_a(k))^2.$$  \hspace{1cm} (2)

For example, in the case where the input layer is 8, the relationship between a certain neuron $n$ in the hidden layer and the input layer data can be as shown in

$$f_n = \sum_{i=1}^{8} w_{ni}X_i.$$  \hspace{1cm} (3)

Calculate the fitness value of the population, and find the optimal individual from it, as shown in

$$\text{FitnV} = \text{ranking}(\text{Obj}).$$  \hspace{1cm} (4)

The selection operation is shown in

$$P_i = \frac{F_i}{\sum_{j=1}^{N} F_j}.$$  \hspace{1cm} (5)

The crossover operation is shown in

$$a_{kj} = a_{ij}(1 - b) + a_{kj}b,$$

$$a_{ij} = a_{ij}(1 - b) + a_{kj}b.$$  \hspace{1cm} (6) \hspace{1cm} (7)

The mutation operation is shown in

$$a_{ij} + (a_{ij} - a_{\text{max}}) \times f(g).$$  \hspace{1cm} (8)

$$a_{ij} + (a_{ij} - a_{\text{min}}) \times f(g).$$  \hspace{1cm} (9)

$$f(g) = r^2 \left( \frac{1 - g}{G_{\text{max}}} \right)^2.$$  \hspace{1cm} (10)

3.2. Analysis of Correlation Degree of Smart Building Industry. Industrial relevance refers to the supply and demand of products, and the formation of industry and industry is interrelated, and they are the internal connection of preconditions for each other [16]. The analysis of the correlation degree of the smart building industry is mainly carried out from two aspects: research analysis and consultation of relevant experts. According to the analysis results of these two aspects, a summary table of the correlation degree of the smart building industry is summarized and analyzed. From this chart, it can be seen that the related industries that are mainly related to smart buildings include the Internet of Things industry, construction industry, residential industry, energy conservation and environmental protection, smart home industry, information service industry, smart city, cloud community, communication industry, and electrical industry. A summary table of the correlation degree of the smart building industry is shown in Table 1.

In view of the demand analysis of the smart building market, a survey and questionnaire survey were conducted on an intelligent building system engineering company in the early stage. After consulting relevant experts, a few enterprises, and some relevant technical personnel were interviewed [17]. After this series of investigations, the materials of this period were integrated, and the important value
analysis of the market demand for smart buildings was finally obtained, as shown in Table 2.

From this analysis table, it is not difficult to see that the current market demand for smart buildings requires a good development environment and perfect laws and regulations as support to strengthen publicity efforts and launch model projects to increase the prevalence of smart buildings, thereby expanding the applicable population. In the medium and long term, it is necessary to strengthen the research and development of new intelligent functions and launch new intelligent functions in a timely manner to attract more consumers. It is also necessary to appropriately reduce industrial costs [18], thereby improving the competitiveness of smart buildings in the market.

The application of advanced technologies such as the Internet of Things, cloud computing, and wireless communication to building intelligence will inject wisdom into the building, making various facilities in the building more widely interconnected, information transmission is more efficient and rapid, and decision-making is more efficient. With the gradual deepening of people's understanding and understanding of building intelligence, building intelligence will not only be the design and construction of complex systems but also the mechanical automation of auxiliary functions and auxiliary equipment such as management systems and control systems; it will also be integrated with other architectural concepts to bring about larger, more comprehensive changes, and in order to achieve the coordination and optimization of various functions of the building [19]. Smart buildings will develop in the direction of green, ecological, artificial and natural intelligence, traditional and modern penetration, and architectural.

3.3. Greening of Smart Buildings. When people design buildings, they are different from the past, only for spaciousness and comfort; modern people are now also considering the impact of buildings on their own behavior and whether they consume too much energy and have realized some ideas in reality, with some typical success case. We list a few here well-known devices that can actively and passively manufacture and develop sunlight: the Future House at the Museum of Welsh Living, designed by Jesticot and Whiles, and the London Zero Carbon Pavilion at the World Expo, which can achieve zero-energy operation [20]. Energy-saving smart buildings can be used to develop many things that are beneficial to people’s lives; for example, in terms of enhancing sunlight, there are daylight frames and heliostats, automatic windshields are used to control ventilation, sound-absorbing baffles are used to mute noise, photovoltaic effects are used to generate electricity, and shutters are used for heat insulation; in addition, it also includes its own use of technology to test the life cycle and fully autonomous management of the power system.

Economic development requires huge energy consumption, and the world is facing a severe energy crisis. To this end, the world has put forward the concept of energy saving and advocated energy-saving behavior. Building energy efficiency is an important measure. Green buildings are bound to be one of the trends in the development of smart buildings.

As we all know, the functions of modern green buildings are no longer limited to shelter from wind and rain, ventilation, and lighting like traditional buildings in the past; buildings in the new era must be able to adapt to the environment and achieve the function of protecting the ecology. First of all, it is based on the principles of sustainable development and ecology, which is different from traditional aspects in many aspects, such as what materials to choose, what kind of structure to build, and how to plan and design; at present, the Ministry of Housing and Urban-Rural Development of China has issued corresponding policies in this regard; whether a building is a green building depends on whether it meets the following standards:

1. Is it spacious enough from an ecological point of view [21]

2. The materials used are environmentally friendly materials, which should be absolutely harmless to people and the environment

3. From the ecological principle, the whole house is completely pollution-free when it is designed and constructed

4. Can it be integrated with the surrounding ecological environment

| Numbering | Related industries                        | Average survey score | Processing points |
|-----------|------------------------------------------|----------------------|------------------|
| 1         | IoT industry                             | 8.62                 | 0.657            |
| 2         | Construction industry                    | 11.13                | 0.489            |
| 3         | Residential industry                     | 6.28                 | 0.291            |
| 4         | Energy saving and environmental protection| 7.88                 | 0.175            |
| 5         | Smart home industry                      | 12.66                | 0.366            |
| 6         | Information service industry             | 5.20                 | 0.077            |
| 7         | Smart city                               | 3.14                 | 0.341            |
| 8         | Cloud community                         | 1.31                 | 0.187            |
| 9         | Communications industry                  | 4.91                 | 0.080            |
| 10        | Electrical industry                      | 2.57                 | 0.054            |

Table 1: Summary of the relevance of the smart building industry.
Table 2: Analysis table of important value of smart building market demand.

| Order | Market demand factors                                      | Important value |
|-------|-------------------------------------------------------------|-----------------|
| 1     | Policies and regulations, development environment           | 0.83            |
| 2     | Strengthen publicity                                        | 0.71            |
| 3     | Strengthen the prevalence and applicability of smart buildings | 0.58            |
| 4     | Introducing new smart features                              | 0.27            |
| 5     | The postwork of smart buildings                             | 0.35            |
| 6     | Reduce industrial costs                                     | 0.17            |

(5) The residence should also be environmentally friendly enough during operation, and the energy consumption should be as low as possible

3.4. Realization of Ecology. What is the impact of intelligent buildings on the realization of ecologization? Generally speaking, the architectural forms of intelligent buildings are in line with ecological standards, whether it is the shape of the building or the structure of the building; there are very practical considerations in saving energy, reduced energy consumption for ventilation, heating and cooling, lighting, etc.; as Kalter Kronter said, the so-called intelligent design is the embodiment of beauty, and this kind of beauty is on the surface to make the building integrate with nature and become natural, to keep our buildings high quality, whether conditions are favorable or unfavorable, and in order to keep track of some of its changes; of course, in order to achieve the above, it must be the result of the joint action of various disciplines, including bioengineering, earth science, and bionic science; only by integrating them can we build the green ecological building we want; at present, there are many examples that can embody this concept; here, we list a few: such as the Heliotrope commercial and residential building, which can shine like a sunflower, and the fantasy house in Denmark, which can imitate the closure of petals [22].

At present, many scholars in China are also advocating this concept, incorporating people into the cycle system of nature; this requires the builders of the house not only to care about the construction process of the building but also to pay attention to its life cycle; ecological buildings should generally have the following characteristics:

(1) Humans can feel comfortable and healthy living in it, which requires that the temperature should be suitable, the humidity must be suitable, the air should be clean enough, the lighting effect should be good enough, no noise, and the space should be flexible and spacious

(2) Sufficient consideration should be given to the use of the natural environment, and resources should not be wasted, and absolute land savings should be achieved; in material selection, materials that can be reused or recycled should be used as much as possible; to achieve a sustainable development effect, we should save as much energy as possible

(3) The pollution or damage to the environment should be small enough, which mainly includes proper disposal of garbage and noise reduction

From a technical point of view, ecologicalization can be divided into three technical levels, including low-tech, light-tech, and high-tech. Relatively speaking, low-tech uses less or no high-tech means; it generally uses accurate technical analysis to achieve ecologicalization of buildings. Light technology uses many high-tech components; it aims to make the performance of buildings more excellent, and it is mainly realized in construction technology; generally speaking, saving materials and reducing costs must rely on this level of technology. High-tech uses more high-tech components; it aims to maximize the energy use efficiency of buildings, create a comfortable environment for people, and protect the ecological environment, mainly relying on this level of technology [23]. Of course, high technology is also based on traditional technology; the special thing is that it uses more advanced means. The famous RoofRoof is a good example; its original design concept came from traditional temples in Malaysia and louvers to block intruders, so it was designed as an "environmental filter." It is of great theoretical help for the realization of the ecologicalization of intelligent buildings.

When we stand in front of a building, the first thing we see is the outer wall, which is the first protective layer of the building. Regardless of wind, frost, rain, snow, or fog on a sunny day, the outer wall is always free from the influence of the atmosphere, while adjusting the flow of energy in various forms such as light, heat, and sound, it provides people living indoors with a safe, secret, easy-to-access, wide field of vision. The full name of the outer wall is the intelligent outer protective structure, it is like human skin and is controlled by the "hypothalamus" of the human body, and it can automatically simulate the response of the outer wall to changes in the outside world and can change the shape and material accordingly. The body can also develop routine patterns that best respond to particular conditions. The outer wall can not only control itself but also help or guide the user to control [24].

When developing the potential of intelligent "skin," intelligent technology introduced a large number of plants, which greatly increased the use of space, rather than just staying in the variability of space and cutting aspects that conform to structural and ecological functions in appearance. These have changed the traditional space form while
saving building energy consumption and improving the indoor environment. Contemporary society has higher requirements for smart buildings, and it is necessary to provide more possibilities for space and functions. The specific manifestations are enhancing the interweaving penetration of greening and buildings and performing functional replacements that replace the existing functions of buildings with other functions [25].

With the development of science and technology and the drive of people’s innovative spirit, the future development of smart buildings will be from the intelligence of the internal functions of the building to the intelligence of the entire building including the outer wall, and the building will be endowed with “life.”

4. Results and Analysis

According to the analysis results of the important value of the market demand of smart buildings, the industrial goals of smart buildings are obtained through seminars, and finally, the development goals of smart buildings are analyzed by SPSS software, as shown in Table 3.

According to the ranking of the smart building industry goals reflected in the above table, the time and technical indicators for realizing the industry goals are put forward through analysis, as shown in Table 4.

Although the concept of architecture has transitioned from “intelligent building” to “smart building,” in practice, the construction situation has not reached the expected good. The continuous emergence of new technologies will gradually promote the development process of “smart buildings” [26]. The talent training model is not perfect. Although most architectural design institutes currently have professional facilities, they mainly focus on five majors: architecture, structure, water, electricity, and heating, and there is a lack of personnel who can engage in intelligent building system engineering design. Moreover, system integrators have more intelligent system design personnel than architectural design institutes, and most of them are familiar with the technologies of various subsystems of the intelligent system and are also familiar with equipment products. The problem is that these people start to design construction drawings without design training after they leave the school. These people do not know enough about architectural design, and the quality of construction drawings is of course poor. First, in architectural design, all majors such as architecture, structure, water, electricity, and heating are designed by design institutes, and system integrators specialize in intelligent design. It can be seen that it is difficult to cooperate with various majors [27].

Second, the smart building market lacks the unified management of all government departments, and the smart building design does not have perfect design specifications and standards. At present, the development of smart buildings in China is in a state of disordered management, which restricts the development of smart technology in China. For example, the fire department manages firefighting equipment, the power supply department manages power supply and distribution, the security department manages the security department, the construction department manages buildings, and the post and telecommunications, information, and other departments also want to incorporate “smart buildings” into their own industry management. Each department is in charge of its own piece, and there is no unified department to coordinate and manage it. When the various systems of smart buildings are integrated, it is difficult to meet the requirements of smart buildings [28]. In addition, there is also a lack of design specifications and grade evaluation standards for smart buildings, which is also an important reason for the relative confusion in the smart building market, which makes some buildings with only some smart functions also call themselves “smart buildings.”

There is also the intelligent building industry, which is mainly engaged in the integrated wiring of various buildings, as well as the construction of fire protection, communication, security, equipment management automation, and business support systems. In essence, the intelligent building industry is a system integration business. The market is extremely fragmented due to low technical barriers in the smart building industry in China. According to Handing Consulting, the top ten smart building manufacturers in China only account for about 15% of the market.

As we all know, China’s GDP currently ranks second in the world, and it still maintains a rapid growth momentum. China’s investment in the construction industry is also increasing year by year. In the past seven years, the average annual growth rate of my country’s GDP was 11.07%; during this period, China’s fixed asset investment was also normal; in 2005, it was 8.88 trillion yuan; in 10 years, it has grown to 27.81 trillion yuan, which has nearly doubled in just five years, with an average annual growth rate of 25.73%, in terms of real estate investment; in 2005, it was only 1.59 trillion yuan; in 10 years, it has grown to 4.83 trillion yuan, and this growth momentum is the same as the growth level of social fixed asset investment; it can be seen from this that the development speed of the construction industry is absolutely beyond imagination. Specifically, in 2005, it was only 3.46 trillion, and in 2010, it increased to 9.52 trillion, as shown in Figure 2.

Although China’s smart home market is developing rapidly, there is still a long way to go before it can truly bring people a “smart” feeling. In the future, various types of characteristic TVs will appear, such as TVs that can change the screen size arbitrarily and TVs with movable screens.

TVs can also integrate personal technology, home security systems, and home entertainment centers, realize more powerful functions, and bring convenience and fun to the family.

The next-generation network system is a converged network, which usually refers to a converged network of the Internet, mobile communication network, and fixed telephone communication network that can support voice, data, and multimedia services at the same time with IP as the core. China has made great progress in the research of this fusion network. At present, the application research of the soft-switch technology given to NGN in mobile and multimedia communication has been started.
The next-generation mobile communication technology, the so-called 4G network, has higher speed and better spectrum utilization. The technology has gradually entered the commercial field. The wireless network system between cities and intercity will carry most of the tasks of information transmission. Urban networks will invade all application fields of human society, and most devices will have wireless network interfaces, enabling access to information and control anytime, anywhere.

In the more distant future, with the advancement of technology and the deep development of the human brain, the development of control and information transmission may completely exceed the current camera. Neurons and field transmission can transfer information between different spatial dimensions.

### 5. Conclusion

In the 21st century, with the continuous development of Chinese society, more and more people have gathered in cities. The Nobel Prize winner American economist Stiglitz predicted: There are two major events affecting the progress of human civilization in the 21st century, one is the technological revolution led by the United States, and the other is the urbanization of China. At present, China is in a period of vigorous development of urbanization, but the process of urbanization is not smooth, resulting in many serious problems. In order to solve these problems, the construction of smart cities has become an inevitable trend of urban development in the world today. Smart cities use new-generation information technologies such as spatial geographic information, big data, the Internet of Things, and integration to create new concepts and models in the process of urban planning and construction, management, and service intelligence. As a part of smart city construction, smart buildings will also play a pivotal role in smart cities. For intelligent building design method based on the idea of Internet of Things, it was aimed at providing a new concept for China’s current intelligent building design industry.

Aiming at the main problems existing in the current intelligent building design, a solution based on the idea of Internet of Things is proposed. The intelligent building design method based on the Internet of Things is emphatically expounded, and the Internet of Things topology diagram of common intelligent subsystems is extracted. The figure correspond to the three-layer architecture of the sensing layer, the transmission layer, and the application layer of the Internet of Things, and the Ethernet is used as the link between the various subsystems. For a single building, the front-end equipment of each system is the sensing layer equipment, which is responsible for the collection of data such as video images, audio, temperature, humidity, and operating status of electromechanical equipment; the building, in turn, will be the sensing layer of the Internet of Buildings, responsible for data collection for each building.

### Data Availability

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

The author declares no conflicts of interest.

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