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Application of Smart Lighting in Urban Street Lighting

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Abstract: At present, the number of road engineering projects is increasing, and the corresponding street lighting work is receiving much more attention. In order to improve the lighting, operation, convenience, and energy-saving effect of urban streets, the concept of "smart lighting" needs to be implemented. This includes the planning of an urban street lighting design scheme and the use of appropriate software as well as components to realize significant optimization of the lighting work in urban streets. Therefore, this paper discusses the application measures of smart lighting in urban street lighting to provide reference.

Keywords: Smart lighting; Urban street lighting; Application measures

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1. Introduction

The development of urban streets reflects the level of urbanization, whereas the development of urban street lighting systems reflects the city's overall construction level. The application of the smart lighting concept and it corresponding systems to urban street lighting can promote the overall optimization of the urban street lighting system, which will not only improve the lighting effect of urban streets and the level of urbanization, but also realize the convenience of operation as well as the effect of environmental protection. Therefore, the application effect of smart lighting in urban street lighting is favorable, and this field of research is of great significance.

2. Design scheme of urban street lighting

2.1. Installation design

During the installation design of urban street lighting, if 70 W lamps are used, the distance between lamps and poles should be 1.5 meters and 7 meters from the ground. If 150 W lamps are used, the distance between lamps and poles should also be 1.5 meters, but 10 meters from the ground. At the same time, the distance between two adjacent light poles should be fixed at 10 meters to improve the rationality of urban street lighting and ensure that the environment for driving at night is safer and more comfortable.

2.2. Brightness uniformity

Brightness uniformity refers to the uniform effect of street lamps projected onto the ground within a lighting range. With the help of an instrument, it can test up to 100 points. If the minimum brightness is 10 and the average brightness is 20, the uniformity is 0.5. In assuming uniformity as an important basis for light

distribution, the larger its value, the more scattered the light is, and the better the lighting effect.

3. Smart lighting system in urban street lighting

At present, China's economic level is improving and the process of urbanization is accelerating. The city's development level, as an important environment for people's living and life, has a significant impact on the production as well as the living state and quality of the people. Therefore, the development of "smart cities" and "green cities" has become the main trend in urban development. In terms of urban road traffic, it is very important to fully optimize the lighting system, which requires the application of smart lighting concepts and systems in line with the urban development trend. In fact, the smart lighting system is not a single process, but a scientific system layout. It is necessary to elucidate the significance of urban street lighting in relation to the city's overall development needs in order to ensure people's travel safety and improve the overall road traffic operation effect. Moreover, the thorough implementation of the smart lighting system in urban street lighting will not only effectively meet the aforementioned needs, but also further promote the development of science and technology in China. At present, smart technology, network technology, 4G technology, and 5G technology are all becoming increasingly popular. Applying them to the development of smart cities and effectively implementing smart lighting systems can accelerate the development of corresponding software and optimize the overall layout, so as to improve the application effect of smart lighting system in urban street lighting and promote the development of smart cities [1].

4. Urban smart street lamp design

In line with smart city construction, the faster its development speed, the higher the requirements for smart lighting in urban street lighting. Ensuring the rational application of smart lighting systems is not only conducive to the further development of smart cities, but also provide a guarantee for the safety of people driving at night. Therefore, it is important to pay attention to the design of smart lighting system in urban street lighting.

4.1. Street lamp planning

Street lamp planning is the core component in the smart lighting system. In the process of street lamp planning, it is necessary to first understand the requirements of urban street lighting for street lamps, propose diversified design and planning schemes according to the requirements, establish a planning model with the assistance of building information modeling (BIM), and modify the design and planning contents in line with the actual situation of urban streets. BIM is used to simulate the actual application of the design and planning contents to validify their rationality and avoid the waste of resources.

4.2. Design and implementation

On the basis of ensuring the scientificity and rationality of the design and planning scheme, the smart lighting design can be applied. BIM is used to confirm the contents of the scheme and improve each aspect in detail, optimize the control information to improve the convenience of smart lighting control, as well as provide reasonable conditions for smart operations in accordance to the database, so as to improve the application effect of smart lighting [2].

4.3. Detection technology

The main purpose of using the detection technology in the smart lighting system is to improve the rationality of smart lighting.

(1) It is necessary to inspect the working environment of the smart lighting system to understand the control terminal equipment, host, controller software, and network conditions, so as to avoid adverse conditions in the constituent system.
(2) Detecting the communication interface in the smart lighting system and confirming that the communication state is normal can improve the performance and effect of the smart lighting system. Generally, the application effect of the interface should be mastered through testing.
(3) The test is completed by testing the data processing ability and confirming that the applied software meets the relevant standards [3].

5. System implementation

5.1. Mobile monitoring software

In urban street lighting, the use of mobile phone monitoring software is an important component of the smart lighting system [4]. At present, mobile phones have become an indispensable part of people's daily life and production. They are not only functional, but also important. Some jobs even require that "mobile phones do not leave hands." It can be appreciated that the use of mobile phone monitoring software can improve work efficiency and convenience [5]. In the course of their work, employees, under the smart lighting system of urban street lighting, can control the software by using their mobile phones to carry out smart lighting monitoring. Upon discovering any sort of fault, they must promptly check and tend to the working state of street lamps through the application management center and the remote intelligent network, as well as promptly identify adverse conditions, in order to ensure the lighting effect of urban streets and optimize the maintenance work, so that the application effect of the smart lighting system in urban street lighting can be improved [6].

5.2. Remote smart street lamp communication system

The current technical composition of remote smart street lamp communication system mainly includes 3G technology, 4G technology, and ethernet technology; 5G technology has not been integrated into it. The grid connection association operation of street lamps can be applied using the smart association control and smart node controller to form a scientific and unified smart control layout [7]. On this basis, each street lamp must be equipped with an smart node controller to collect and transmit data. At the same time, it can comprehensively gauge the network situation and timely adjust the communication requirements, so as to improve the stability of data reception and transmission as well as the application effect of remote smart street lamp communication system in smart lighting [8].

5.3. Remote smart data processing center

After completing the construction of the smart lighting system, the remote smart data processing center can be used to carry out data processing, including the monitoring interface of street lamp status, the comprehensive street lamp information prompt interface, and the setting interface of street lamp status. In the work process, information processing can be carried out based on the actual state of street lamps and lighting requirements in the surrounding area. For example, half off, fully off, one-by-one off, and other operations can be implemented, and adjustments can also be made for single light intensity, double light intensity, light color, and other aspects, so that the lighting effect can meet the requirements of street lighting as much as possible in line with the actual situation and traffic status [9]. At the same time, the operation of street lamps in the city can be displayed in real time on screen at the control center. The remote smart data processing center can store and manage relevant data using online technology and cloud technology; these data can then be extracted and analyzed when necessary, so as to provide a basis for the rational application and continuous optimization of urban road smart lighting system from a long-term

perspective [10].

6. Urban road lighting and energy-saving design

6.1. Light source selection

In order to effectively reduce the energy consumption of the urban road smart lighting system, it is crucial to choose a light source wisely in the application process to ensure its rationality and environmental protection effect. In fact, there are many types of lamps that can be used in urban street lighting, and different lamps correspond to different light colors and brightness. At the same time, different lamps have different specifications and parameters. Therefore, the selection of light source should be based on the actual lighting requirements of streets in various urban environments [11]. Based on the current lighting requirements of most urban streets, it is necessary to use LED light sources to achieve a synchronous effect of lighting and environmental protection. This type of light source does not only bring about good lighting effects, but also meet the demand for high efficiency, energy saving, and environmental protection. In general, when using LED lamps as the light source for urban streets and placing them under the same lighting effect, the degree of electric energy savings is around 80%, which significantly reduces the cost amounted in the process of urban street lighting while also reflecting good environmental protection benefits [12].

6.2. Lamp performance

The use of LED lamps as the primary light source for urban street lighting requires careful consideration of its actual use effect while also improving environmental protection benefits. Currently, the effective efficiency of LED lamps that are widely used in China is about 150-160 Im/W, but the effective efficiency of traditional sodium lamps is about 70-75 Im/W over the same period of time. Therefore, it concludes that the use effect of LED lamps is better [13]. At the same time, the bat airfoil light distribution function in LED lamps can realize the light intersection between two adjacent street lamps, thus preventing dark lighting areas and further improving the lighting effect of urban streets. In addition to that, LED lamps also provide a good level of protection. Under normal circumstances, their dust-proof and waterproof densities are relatively high, allowing them to fully meet the requirements of urban street lighting [14].

6.3. Energy-saving ballast

In the process of designing a smart lighting system for urban street lighting, the use of ballasts should be fully considered. Generally, ballasts have several advantages.

(1) Energy saving

A ballast of about 60 Hz should be used as it can improve the lighting effect by about 10% and reduce the power by about 20% [15].

(2) Stability

The use of ballast reduces the possibility of stroboscopic conditions in the lighting system, thus improving the overall stability of urban street lighting. Drivers driving at night can benefit from a better resolution environment and a lower risk of visual fatigue.

(3) Reliable

The operation process of the urban street lighting system is more stable with the use of ballast, and the lamps can also be preheated to improve the lighting efficiency when the system is turned on [16].

(4) Design methods

In the process of designing the smart lighting system in urban street lighting, the design must be optimized in order to improve its energy-saving effect [17]. Designers are required to collect relevant and comprehensive data from every aspect, understand the particularity of urban street lighting based on

professional theories, and use it as the basis to refine the design scheme. At the same time, they should also be able to grasp relevant information about urban street structure and plane conditions, so as to reasonably control the spacing of lamps and improve the utilization rates of various resources while ensuring the lighting effect. When designing the circuit, it is necessary to select the most suitable position for the incoming line and power supply based on the surrounding environment, in order to provide a guarantee for the safety of driving at night [18]. In addition, it is also important for designers to implement energy-saving designs based on the on and off times of street lamps, the amount of sunlight during the day, and seasonal changes, in order to improve the lighting system's energy-saving effect. Other than that, there should be two control modes in the system – automatic control and manual control. The automatic control mode should be applied on a daily basis, whereas the manual control mode should be applied under certain circumstances, so as to fully meet the lighting requirements of urban streets and control the energy consumption.

7. Urban street lighting maintenance

In order to ensure the lighting effect of urban streets, it is necessary to pay attention to the maintenance of lamps. If a lamp fails to function and is not repaired in time, the light intensity will reduce, thus affecting the lighting effect in the surrounding area [19]. As a result, not only is it difficult to ensure the safety of driving at night, but there is also a waste of electric energy. Therefore, relevant staffs must pay close attention to the maintenance of lamps, regularly carry out urban street lighting system maintenance in a comprehensive manner, as well as timely identify and address the errors [20]. In addition, UV resistant lampshade or impact resistant materials should be used to reduce the probability of failures and prolong the service life of lamps, which can help with energy conservation, environmental protection, and cost reduction.

8. Conclusion

Road traffic plays an important role in the process of urban construction and development, and urban street lighting has been receiving much more attention. Under the background of sustainable social development, the use of smart lighting in urban street lighting has emerged as the main development trend. Therefore, in the construction of urban street lighting systems, the application of the smart lighting concept and system is conducive to optimizing the development of urban streets. At the same time, it serves as an impetus for promoting the development of smart city systems.

Disclosure statement

The author declares no conflict of interest.

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