ISSN 2616-5775 Vol. 4, Issue 6: 82-85, DOI: 10.25236/AJCIS.2021.040614

Research on Smart Street Lamp Planning Based on Information Utility

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Abstract: *Compared with traditional street lamps, LED smart street lamps have strong functions and high cost. In the reconstruction of existing urban road lighting, it is not necessary to realize intelligent reconstruction of all street lamps. Therefore, how to realize the optimal layout of LED smart street lamps will be particularly important. In this paper, by analyzing the influence of traffic incident rate, traffic flow rate, information availability and information acquisition rate on road lighting, a relatively general model of urban intelligent lighting with the maximum information utility as the objective function under the same construction cost is constructed.*

Keywords: *smart transportation, street lamp location, urban planning.*

1. Introduction

In recent years, China has vigorously promoted the construction of smart cities. Among them, the key construction areas are flexible energy management, infrastructure, data-driven public safety governance and intelligent transportation. The construction of the three will exceed half of the overall proportion of smart cities. Smart street lamps are an important infrastructure in cities. In China, the government street lamp management department has taken how to optimize the lamp management system, effectively control energy consumption and reduce maintenance and management costs as an important part of the construction. [1]

2. Smart Street Lamp Application scenario

Multi-function smart street lamp has controllable lighting, security monitoring, environmental detection, advertising display, epidemic prevention, one-click alarm, convenient charging and other functions, which can provide a good carrier for 5G micro base stations. However, compared with the traditional street lamp, its construction cost is high while its function is powerful, and it is difficult to achieve large-scale construction. At the same time, as different regions have different demands for smart street lamps, and some functions of smart street lamps are only applicable to specific scenes, the road lighting renovation should follow the principle of adapting measures to local conditions and putting people first. Smart street lamps should be installed accurately under the premise of ensuring economy, efficiency, systematic and practicability to avoid repetitive construction and resource waste.

According to the above analysis, three typical application scenarios of smart street lamps are given below: [2]

·Arterial street.

There is a large demand for lighting on urban arterial roads, so the installation of smart street lamps should be based on lighting requirements and equipped with other corresponding functions. Due to the large traffic flow on the main road, supervision is difficult and accidents are easy to occur, so security monitoring function should be equipped to catch illegal vehicles and detect vehicle information at any time. Due to the large flow of the main road, smart street lamps equipped with LED screens will play a good publicity role and generate a large market value. This will facilitate traffic guidance, information dissemination, advertising, etc. Finally, the main road highlights the image of a city, and the installation of beautiful and efficient smart street lights can beautify the city.

·Smart community.

In the process of community construction and transformation, smart street lamps have great advantages. The smart lighting system can adjust the brightness of street lamps in real time according to

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the actual demand. This minimizes light pollution while saving energy. In addition, the security monitoring system can track suspicious people in the community all day to ensure community safety. Finally, electric cars are becoming more and more popular. Smart street lamps with the function of charging piles further meet the demand for new electric vehicles and meet the national environmental protection policy.

Smart campus.

Smart street lamps will play an important role in the construction of smart campus. High-definition camera monitoring, smart lighting, LED screens, public broadcasting and other functions will effectively promote smooth information transmission and data sharing. At the same time, it will improve the efficiency of campus management, and effectively solve the hidden dangers of campus security.

3. Smart Street Lamp Accessories Planning

3.1. LED electronic screen location model.

The LED information screen can display many information contents, including traffic information, weather conditions, air quality, advertisements, etc. The construction goal of the information screen subsystem of smart street lamp is to maximize the information utility generated by its information release. When considering information utility in practice, it is necessary to classify different information, consider its corresponding information utility respectively and quantify it. Taking the LED screen for releasing traffic information as an example, when planning the layout of the LED information release screen, the influencing factors should be considered:

Traffic flow.

LED display is mainly used for information release and advertising. The larger the traffic flow, the more drivers and pedestrians can see the information on the screen, and the better the publicity effect will be. At the same time, the larger the traffic flow, the more likely the congestion, LED display can display the road condition in time, for traffic guidance.

Incidence of road traffic incidents.

In places prone to traffic accidents, smart street lamps equipped with LED screens should be installed on this road section. On the one hand, it warns drivers to drive safely and reduces the incidence of accidents. On the other hand, when there is a traffic accident in this section, the driver should be informed of relevant information in time so as to choose other routes.

Information redundancy.

If the LED display is close to each other and the information displayed is roughly the same or does not change much, information redundancy will be caused. Therefore, in order to avoid information repetition, intelligent traffic street lamps should be reasonably distributed and not too dense.

Information acquisition rate.

More information on the smart street lamp LED display is not always better. During fast driving, the driver has a limited time to observe screen information. Generally speaking, the more information, the lower the information acquisition rate of the driver.

Safety degree.

In accident-prone areas such as intersections or curves, LED screens may affect the driver's line of sight, distract the driver's attention and cause danger. So such places should avoid installing too conspicuous, informative LED display.

From a qualitative point of view, it should be installed at a road section with a large traffic flow, which is close to the next intersection, but not too close. The displayed road section is close to the installed road section and is a road section with frequent traffic accidents. At the same time, it should not display too much information on the road section, and the distribution of information screens should not be too dense. Therefore, the hierarchical classification strategy is adopted, the information utility location model is established, and the installation section of the smart street lamp and the specific installation position in the section are determined, so that the location scheme of the information screen subsystem is obtained. Different LED information screens have different impacts on traffic. An effective information screen location model can shorten the average travel time, reduce the congestion rate and improve urban traffic

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conditions. At the same time, the information screen is combined with the lamppost as much as possible, which reduces the space occupation and construction cost, beautifies the city image, and contributes to the development of smart transportation and the construction of smart city.

3.2. Subsystem 5G Micro Base Station Location Model.

From the infrastructure construction of 5G micro base station, its single-load fan power is 1,000 W, single station is 3000 W, and the total power consumption of single station is nearly 3700 W, while the power consumption of 4G typical configuration is about 1,200 W, which is 3-4 times that of 4 G. The power supply demand for equipment has been greatly improved, and the power supply requires uninterrupted power supply to ensure the stability and security of the network. 5G mobile communication adopts extremely high frequency band, which can transmit more information. However, the transmission distance is greatly shortened, and the coverage capacity is weakened. The signal coverage radius of 5G micro base station is less than 200 m. Considering the coverage capability, the layout of 5G base stations will adopt the mode of Macro base station + micro base stations. [3]

Among them, 5G micro-base stations will be used for coverage of hot spots and blind coverage of urban networks due to their flexible deployment and small interference on the same frequency. Therefore, the number of 5G base stations is at least 2 ~ 3 times that of 4G, and the demand for station sites is greatly increased, and the TCO of 5G base stations will be higher, which mainly comes from station site acquisition cost, infrastructure construction cost, station site rent, operation and maintenance labor cost, station electricity fee, etc. The cost problem will also become the focus of consideration for operators to build 5G base stations. From the perspective of multifunctional lamppost system, street lamps are evenly distributed in cities, with an average distance within 100 meters, and their positions are fixed and recognizable. This natural resource advantage can meet the demand of the number and density of 5G micro base stations, and is conducive to improving the coverage rate of areas with poor signals such as roads and railways. The stable power supply system for street lamps can meet the needs of 5G base stations, and it is no longer necessary to deploy a separate power supply system. If the multifunctional lamppost system is equipped with 5G micro base stations, the space waste caused by the independent arrangement of 5G base stations can be avoided, the acquisition cost and construction cost of the station site can be reduced, and the beautification degree of the city can be improved. Through the unified intelligent street lamp management platform for information collection and interaction, the effective utilization of big data can be realized. The sensor device mounted on the intelligent lamppost system can also detect the temperature and state of the 5G micro base station, and the intelligent street lamp management platform can transmit information in the cloud, thus reducing the monitoring cost and facilitating the maintenance and management of the micro base station. Therefore, the multifunctional lamppost system is the natural platform for the 5G micro base station. The reasonable site selection scheme should follow the following basic principles:

1) Basic demand principle: according to the coverage range of 5G micro base station (related to the hanging height and frequency band, the approximate range is less than 200 m), cooperate with Macro base station, realize full coverage, and meet the coverage intensity requirements of hot spots.

2) Principle of minimum number of construction: As the total cost of 5G base stations is relatively high, the total number of 5G micro base stations required to be built is at least.

3) Principle of preferential pole combination: On the premise of the least number of base stations, priority should be given to installing 5G micro base stations on street lamp posts in site selection planning, which can save space, beautify the city, reduce the cost of re-pole, and achieve the effect of "multi-pole integration and multi-purpose".

4) Principle of best coverage effect: When the above principles are met, choose the scheme with the best overall coverage effect by measuring the repeated coverage rate and repeated coverage area.

4. Conclusion

By analyzing the influence of various factors on road lighting, this paper constructs a relatively general model of urban intelligent lighting with the maximum information utility as the objective function under the same construction cost, and preliminarily determines the location range of intelligent street lamps, which provides reference for the decision-making of relevant departments in intelligent transportation construction.

ISSN 2616-5775 Vol. 4, Issue 6: 82-85, DOI: 10.25236/AJCIS.2021.040614

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