Module Design of Wisdom LED Street Light Based on Internet of Things

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Abstract

The hot degree of artificial intelligence, cloud computing, and Internet of Things technologies can be said to be household names in recent years. Based on the respective advantages of these technologies and the background of mutual penetration and integration, the emerging concept of smart cities has been derived. The areas covered include: smart medical care, intelligent transportation, smart grid, smart home, smart environment, smart city management and many other aspects. With the support of Internet of Things technology, the realization of intelligent urban lighting systems, such as intelligent LED street lights, is crucial for the construction of intelligent transportation. How to build a complete and effective smart LED street light for us to use is also the direction that should continue to be researched and developed.

Keywords

Smart city, Internet of Things,lighting system,smart street light.

1. Introduction

Road lighting is an important part of urban lighting system. In the past, street lamps often used 360-degree illumination of high-pressure sodium lamps, and the disadvantage of large loss of light source caused huge waste of energy. Along with the rapid development of China's economy, the contradiction between supply and demand in energy is becoming increasingly prominent. There are sometimes serious shortages in power supply, and energy conservation is an urgent problem to be solved. LED street lamps have a series of advantages such as energy saving, environmental protection, high efficiency, long life and wide color range, which are of great significance to the city's lighting system.

Smart street lights are based on LED street lights and are combined with core technologies in the Internet of Things. In addition to the mainstream technology, namely power line carrier communication technology (wired control technology), there are ZigBee-based wireless control technology, NB-IoT IoT technology, Bluetooth MESH new protocol control technology and super Wi-Fi control technology. In addition to the advantages of LED street lights, it also needs to implement a series of functions such as intelligent management, remote control, and fault alarm to achieve the goal of “autonomy” of street lamps. This article takes the NB-IoT technology in the Internet of Things as the bearer, tries to design and develop the module for the smart street lamp, enhances the management level of the street lamp lighting system, and also promotes the purpose of energy saving, emission reduction, high efficiency and easy maintenance.

2. Status quo at home and abroad

2.1 Overview of domestic development status

Domestically, in 2016, the overall market penetration rate of China's LED road lighting products has exceeded 48%, and it is expected to continue to work hard in 2019. It is understood that enterprises in the field of smart street lamps are currently divided into two types in the industry. One is the strong R&D capability and the wide resource channels. These enterprises have set up the banner to complete the project from R&D to overall deployment, such as Shanghai Asia. Ming, Sansi Electronics, Zhou Ming Technology. The other is to have autonomous product production capacity, but the lack of product and IoT integration capabilities, which makes these companies usually seek cooperation with third parties. For example, the smart streetlight project that NVC Lighting and the Chinese Academy of Sciences are working together. The Chinese Academy of Sciences' smart streetlight project has been piloted in Guangzhou and Foshan. The Smart Street Light Pilot Project, which will be hand-picked by the Chinese Academy of Sciences, Guzhen Town Government, Guangdong Base Lighting Co., Ltd., China Dengdu International Street Light City, will also open two demonstration sites in Dengdu Ancient Town. Among them, the one-kilometer "test light road" at the entrance of China's Dengdu International Street Light City has been completed, and in 2017, it will be a pilot of smart streetlights. At the same time, it will also be a main road in the vicinity of the ancient town government, which will be used as a pilot road for smart street lamps in the ancient town. The new NB-IoT street light controller is also used in the Xiong'an New District streetlight pilot project, which can realize independent on-demand switching, dimming and energy-saving control for each street lamp, and can realize comprehensive sensing and intelligent control. The interaction and deep integration, reducing excessive lighting, can achieve 30% to 60% power saving rate, and truly achieve energy saving and emission reduction. At the same time, it can realize the refined management of urban road lighting facilities.

2.2 Overview of foreign development

In 2016, Los Angeles decided to change the street lights from the original high-pressure sodium lamps to LED lights. All of these LED street lights are intelligently connected. In the future, smart street lights can also work in response to surrounding conditions, such as flashing in an emergency, reminding passing pedestrians and guiding ambulances, police cars, etc. In addition, the electricity saved by the LED streetlights will be used to run 100 electric vehicle charging stations. The MK Stadium in Milton Keynes, UK, uses Schrader's smart, integrated Shuffle luminaires, which use LED lighting technology combined with wireless networking, surveillance video, public address, and electric vehicle charging. The Shuffle at the ticket office and store has 360-degree lighting modules (16 LEDs), CCTV at the surveillance entrance, public broadcasts for the event, and Wi-Fi. CCTV and public broadcasting access to the main control room of MK Stadium to realize remote control for easy connection in time. The modular design makes Shuffle a more forward-looking concept that can replace any component, such as a charging device, with more advanced technology at any time, or with innovative features such as advertising signs.

3. Intelligent street light module design based on NB-IoT Internet of Things technology

3.1 NB-IoT structure analysis

NB-IoT, the narrowband Internet of Things, is built on the carrier's cellular network. NB-IoT technology can be widely used in computer room, station power, environmental monitoring system, low-voltage power distribution monitoring system, power data monitoring system, factory machinery and equipment, production line operation status monitoring system, production information collection system and other wireless monitoring and early warning. Also used in oil fields, oil wells, gas fields,

steam pipes, heating pipes, pump houses, refrigeration, storage, agricultural greenhouses, aquaculture and other environmental data real-time monitoring and early warning.Its main features are as follows:

(1) Wide coverage; one base station can provide 10 times area coverage compared to traditional GSM. Its transmission distance can reach 10 kilometers and can cover a small county. The gain of 20db can be increased under the existing LTE and GPRS base station networks, and the coverage area can be expanded by 100 times.

(2) Massive connection; a base station can drive more than 200,000 terminals, which means that it is easy to manage each street lamp, and the more connections provided, the fewer base stations are built, thus reducing construction costs. At the same time, it can cover areas such as underground parking lots, underground pipes, and basements that are difficult to reach. There is generally no signal in the ground, but NB-IoT can still communicate.

(3) Low power consumption; the core of NB-IoT lies in small-rate applications and small data volume, so its power consumption is very small, and the standby duration of terminal modules can reach 10 years. NB-IoT introduces eDRX power-saving technology and PSM power-saving mode, which further reduces power consumption and extends battery life. In PSM mode, the terminal is still registered in the network, but the signaling is unreachable, so that the terminal stays in deep sleep for a longer period of time to save power. The eDRX power-saving technology further extends the sleep cycle of the terminal in the idle mode, reduces the unnecessary start of the receiving unit, and greatly improves the downlink reachability relative to the PSM.

(4) Low cost; low power consumption and low bandwidth make it cost-effective, and a single connection module can be as low as $1, which plays a crucial role in reducing the cost of smart lighting.

Of course, NB-IoT also has its shortcomings. Its deployment frequency is authorized. This means that it must be deployed by operators. Privately wanting to build such a platform seems to be infeasible at present. Secondly, compared with mature GPRS. Module, WiFi module, NB-IoT module cost is still high, but this problem will gradually decrease as its usage increases.

The three-layer structure of the smart LED street light under NB-IoT technology is shown in Fig 1.

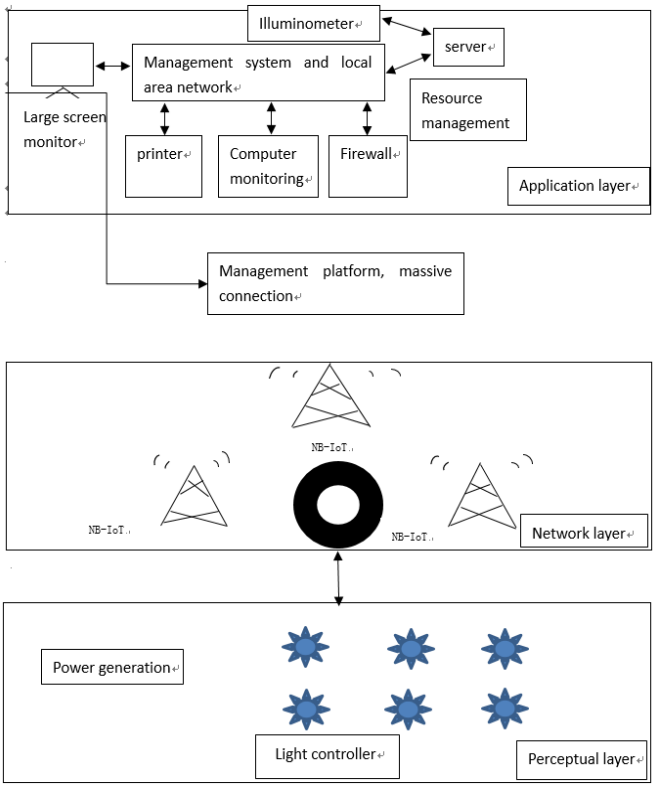

Fig 1 NB-IoT structure diagram

Perceptual layer: It consists of various sensors, including temperature and humidity sensors, QR code tags, RFID tags and readers, cameras, infrared, GPS and other sensing terminals. The perception layer is the source of the Internet of Things to identify objects and collect information.

Network layer: It consists of various networks, including the Internet, the broadcasting network, the network management system, and the cloud computing platform. It is the backbone of the entire Internet of Things, responsible for transmitting and processing the information acquired by the sensing layer. The narrow-band IoT network layer is equivalent to the human nervous system and transmits various signals.

Application layer: It is the interface between the Internet of Things and the user. It combines with the needs of the industry to realize the intelligent application of the Internet of Things. The application layer of the Internet of Things is equivalent to the human brain and is responsible for analyzing and processing various data.

3.2 Design of the function module under NB-IoT

Smart LED street light function module is shown in Fig 2.

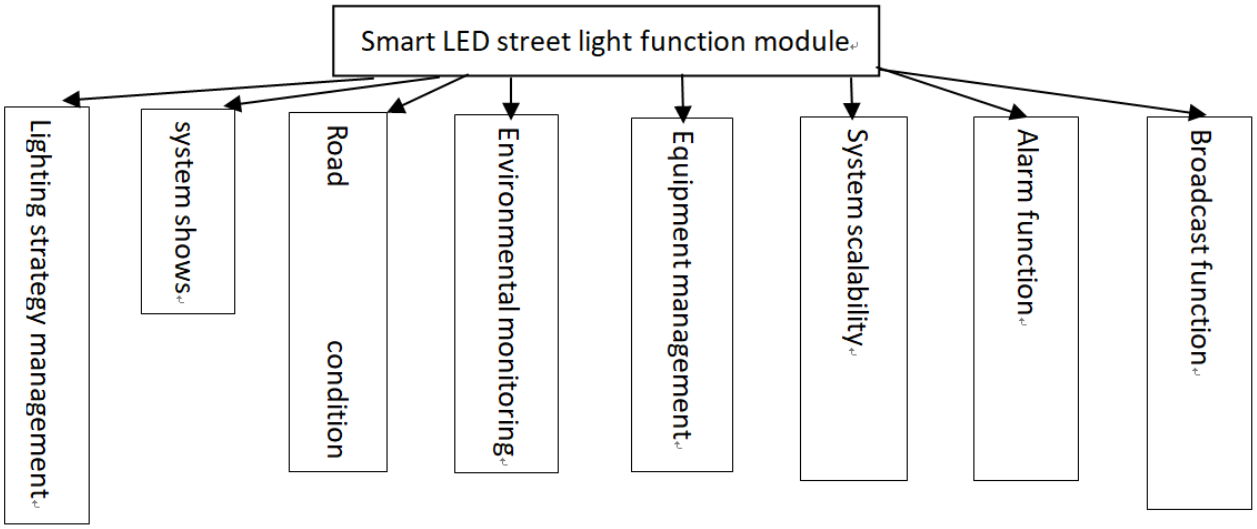

Fig2 function module

Smart LED street lights not only need to be the basic function of lighting, but also the monitoring of road conditions, the uploading of data and other functions that are not available in existing ordinary street lamps.

(1) Reasonably adjust the street light and its brightness. Aside from the automatic switch at normal time, when there is an abnormal time environment such as rain and snow, cloudy weather, etc., the management system should control the street light in time to provide timely illumination; when a certain section is detected at a certain time When the internal vehicle flow rate is reduced, the brightness of the street lamp can be appropriately reduced or the interval switch can be adjusted for the street lamp to achieve the purpose of energy saving.

(2) Display road traffic conditions in real time. The display screen is installed on a specific street lamp, and the road condition information is reflected on the display screen through the detection of the sensor and the processing and analysis of the data, so that pedestrians, vehicles and the like can be informed in time, and the information can be uploaded to the management platform in time. Remind the supervisors to pay attention to the situation, especially for the supervision of the current congested road sections. This may become a frequent road section of traffic accidents. According to the situation, the smart street lamps can find a way to clear the traffic. The supervisors send relevant staff to solve the traffic jams and traffic. The accident is handled to decompress urban traffic and be effective and timely.

(3) Environmental monitoring around smart street lamps. On the basis of long-term data collection and uploading, through the processing and analysis of the data, we can find out the roads with large

traffic volume. The large traffic volume means that the vehicle exhaust emissions are large and threaten the surrounding environment. In such roads, it can be increased. Greening area, increasing the amount of water sprinkling, reducing dust particles in the air, improving the regional environment, thereby improving the environmental quality of the city. In the roads with large traffic volume, the roads are seriously damaged. The intelligent street lamp management system will periodically remind the supervisors to overhaul the roads.

(4) Equipment management. When the intelligent LED street light equipment fails, the fault can be uploaded to the management system in time, and the supervisors can repair the smart street lights in time through the uploaded data.

(5) System scalability. With the popularization of new energy vehicles, in addition to the charging of electric vehicles for conventional electric vehicles, rechargeable batteries can be installed for smart street lamps. In order to cope with the sudden emergency, the battery can be charged in time to ensure that the car can run normally. The charging post is fully charged.

(6) Ask the police or emergency center for emergency situations through the rescue button on the smart street light. Passers-by do not need to know the location of the emergency situation, the intelligent street lights will be automatically located and uploaded to the personnel who come to the rescue, so that the emergency can be resolved quickly and effectively.

(7) Broadcasting within a certain range of emergency situations, so that doctors, emergency personnel, and people who can help nearby can come to the rescue.

4. Conclusion

This paper introduces the use and popularization of smart LED street lamps at home and abroad for the intelligent LED street lighting system, and analyzes the demand for the design of intelligent LED street lamp function modules under the IoT lamp technology, so as to save energy and intelligence for traditional street lighting systems. Through the installation of various sensors, controllers and communication modules on the street lamps, it is convenient and effective to control the area where the smart LED street lamps are located. This also adapts to the current development trend of the Internet of Things and the development trend of urban informationization and modernization.

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