Smart Street Lamp Management System based on OneNET Cloud Platform

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***Abstract*—At present, many of our road lighting system lack of intelligent management, is still the traditional manual control or timing control, the lack of unified planning or planning is lagging behind. Based on this, this paper designed the intelligent streetlight management system, the ZigBee networking technology applied to the street lamp management and air pollutant monitoring system design, the entire system of the equipment for efficient integrated networking, to achieve efficient adaptive road lighting and real-time monitoring of air pollutants. Intelligent street lights in the system can not only on-demand lighting, but also real-time collection of lighting data and air pollutants; not only the brightness of each street can be independently adjusted and can collect particulate matter data through mobile networks and Wi-Fi upload to OneNET cloud platform. Finally, based on OneNET cloud platform development online monitoring platform for the terminal to collect data for unified management and analysis, to build a complete online monitoring and management platform.**

***Index Terms*—ZigBee networking; data acquisition; OneNET cloud platform; Wisdom street light**

I. INTRODUCTION

As an important part of urban public infrastructure, road lighting system continues to promote urbanization. As a result, the number of street lights installed in road lighting systems continues to increase, and energy consumption is also increasing. And most systems still use traditional manual control or timing control, there is a need to illuminate the local lights are not bright, needless to illuminate the local light is very bright, so that the design of the operation caused by the same, poor maintenance real-time, control the high cost of the line [1], a waste of energy.

The intelligent street lamp management system of this article uses sensing technology, network technology, cloud storage and cloud computing technology to achieve adaptive road lighting, as well as real-time collection and monitoring of lighting data and environmental data. Cloud platform will use IOT technology in the smart street lamp management system, through the mobile platform or computer platform for efficient supervision of street lamps, so that accurate perception, precision operation, fine management [2]. A street lamp as the city's capillaries, is an excellent city information data acquisition, transmission node. Adopt IOT technology and smart street lamp technology to carry out lighting on demand and collect lighting data and environmental data in real time. Not only the brightness of each street lamp can be adjusted independently, but also the index data of collected particles can be transmitted through mobile network, NB-IOT or Wi-Fi upload to OneNET cloud platform.

More significant, the future can rely on intelligent street light to establish a smart city IOT system, all kinds of municipal applications within the scope of light poles access Internet of Things, so that smart street lights in the future smart city information Internet "city blood vessel ". For example, street lamps can communicate with municipal utility equipment such as vehicles, manhole covers, parking spaces and traffic lights in the vicinity to provide vehicle inspection, manhole cover monitoring, parking space monitoring and traffic light monitoring. The OneNET cloud platform can push user-needed information to. For example, when a user needs a parking space, the user only needs to send the requirement information to the cloud platform, and the cloud platform will call the sensor near the user to quickly find the free parking space nearest to the user and push the location information of the vacant parking space to the user. Which can provide strong support for the realization of the smart city in the future and accelerate the construction of a smart city.

II. SYSTEM OVERALL PROGRAM

As shown in Figure 1, the system is divided into equipment layer, OneNET cloud platform layer and wisdom street lamp management layer. The equipment layer can be divided into single lamp controller, ZigBee wireless communication module, centralized controller, advertisement machine, remote monitoring center, mobile terminal Etc., as well as the construction of micro base stations and various hardware circuits and preparation of programs; OneNET cloud platform layer includes the development of mobile APPs and PC-side Webs and the establishment of cloud platforms; the intelligent street lamp management layer includes information management, user management, equipment management, Parameter setting, real-time data view, equipment overrun alarm, data report and so on. The single-lamp controller communicates with the centralized controller through the ZigBee network, and the

centralized controller communicates with the OneNET IoT cloud platform via Wi-Fi or GPRS to monitor the working status and air quality of the street light. The centralized controller uploads and stores the working status and environmental data of the street light on the OneNET Internet of Things cloud platform. The user can obtain the current environmental indicators and historical data from the OneNET Internet of Things cloud platform at any time through the Web or mobile APP on the PC side, View and control the working status of Streetlights anytime, anywhere.

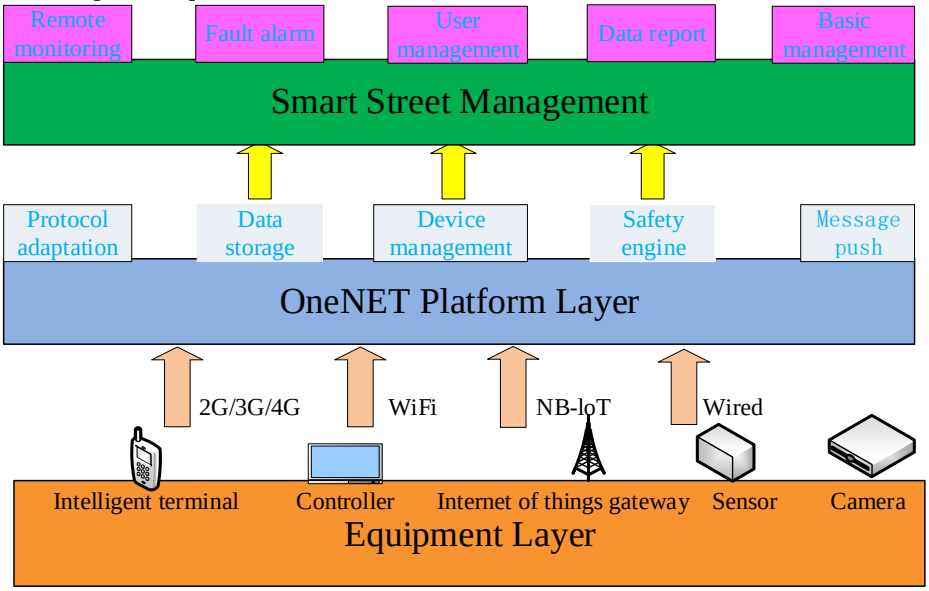

Figure. 1 The overall structure of the program map

Remote monitoring center as the control of the heart, responsible for lighting system automatic control and management tasks from the monitoring workstation, total control server and the big screen and so on. At the same time, the system has access to the OneNET Internet of Things cloud platform, which can realize lighting monitoring data and image information sharing through the network. Alarm analysis, display module and the switch light management module is the core of street lamp monitoring and management software. The supervisory software adopts the super-intuitive and intuitive graphic structure to analyze, judge, locate and mark faults in real time. The purpose of monitoring is to monitor the operation status of field equipment, input / output lines and intermediate electrical appliances so as to achieve the purpose of ensuring the lighting when the precursor is faulty. Mobile Terminal Control Based on the API interface provided by the OneNET IoT cloud platform, the current information is displayed on the mobile terminal APP in a timely manner, and the interaction between the device, the computer and the mobile phone APP is promptly realized.

The terminal node is connected with the sensor and the street lamp driving power switch for data acquisition and street lamp adaptive control. By analyzing the information collected by the sensor, and according to the program pre-set conditions to control the lights on or off automatically; and under different light intensity to adjust the brightness of light to achieve adaptive control of street lights and energy-saving management. The street lamp is the main control object, and the sensor-based technology, network communication technology, automatic control technology and software technology [3] and ZigBee intelligent self-organizing and self-recovery technology are used to integrate the road-related facilities efficiently and efficiently. Road lighting system to enhance the intelligent, safe, convenient, comfortable street lighting system management system control platform. When a car or a person near the street passes, the street light can automatically turn on and adjust the appropriate brightness; and can determine the number of street lights to be turned on according to the detected car speed so as to fully cover the driver's line of sight, to meet the lighting needs of drivers and pedestrians. When the cars and the pedestrians through the rear lights can automatically turn off the corresponding street lights to reduce unnecessary energy consumption.

III. SYSTEM COMPOSITION AND FUNCTION

A. ZigBee network

ZigBee network is a kind of self-organizing network. The internal network communicates through 16-bit short address or 64-bit IEEE address and can not directly communicate with other networks [4]. It has self-organizing and self-healing capability and is robust and suitable for applications in industrial control and testing, a wide range of distributed environments [5]. It is established by the coordinator, the building process includes the initialization of the network and the node joins the network. When other nodes apply to join the network, the coordinator or an existing parent node needs to be connected to the network. When a node detects a nearby network, it can automatically join the network to the nearest coordinator or parent. After a node joins the network, it will obtain its own network address information and send it to the coordinator. When

applying for a network, routing nodes and terminal nodes require doing configured accordingly.

As the core part of the whole ZigBee network, the coordinator, the main function is to set up the network, transmit the network beacon and manage all the nodes in the whole network, and store the information of each node in the network, and also provide the network between the associated nodes Routing information he coordinator is placed in the center of the entire management system to connect with the PC communication, the entire road lighting system information can be displayed on the PC, to facilitate management and monitoring personnel management.

The main function of the router node is to assist other devices to apply for network access, perform data jumps, and assist the sub-end nodes to communicate. According to the actual design requirements can be allocated in the ZigBee network multiple routers to connect a sufficient number of terminals to meet the lighting system networking needs. In wireless sensor networks, reducing the transmission energy of the nodes and delaying the whole network usage period is one of the key issues. By using the neighbor nodes to find the destination node routing algorithm, the number of transmission hops from the source node to the destination node can be reduced, transmit energy [6], which can reduce the energy consumption of the entire network.

The terminal module mainly accepts the command sent by the central controller through the Zig Bee module, parses the command and performs the corresponding operation [7]. It is the specific implementation of data acquisition and control of street lighting equipment, according to the needs of the terminal node can be connected sensors or street light drive power switch for environmental information collection and street lamp adaptive control. The terminal is set to low-power sleep mode most of the time.

B. OneNET cloud platform

OneNET cloud platform adopts distributed cluster mechanism to support large amount of concurrent access of massive devices, adopts distributed architecture, provides complete data interface and the multiple guarantee mechanisms, and provides efficient and convenient access to devices to realize the monitoring and management of devices, online debugging, real-time control functions. Can quickly create front-end equipment management page, data mapping and reporting, and to achieve remote control of the device. Based on Hadoop and other data management and analysis capabilities to provide a unified and rapid evolution of products and services; convergence of multimedia services, location services, video services, public cloud and other core capabilities to provide an open API interface to shorten the terminal and application development cycle[8]; cloud support time trigger engine, custom trigger conditions to help users quickly implement business logic[9]; the collected data through message forwarding, short message push, APP information push way to quickly inform the business platform, mobile phones, AAP client to establish effective channel for two-way communication.

OneNET Internet of Things cloud platform with remote control, scene mode, data storage, big data analysis, user rights management and other functions. OneNET Internet of Things cloud platform will be uploaded to the terminal environment data for big data analysis, through the WeChat public number to send a user, can also be pushed to the street advertising on the display. OneNET cloud platform can have a variety of access protocols, such as: EDP, MQTT, HTTP, etc., smart pole using EDP protocol access cloud platform. Centralized controller integrates Wi-Fi and GSM modules, can adapt to a variety of environmental devices and cloud platform connection. In the vicinity of the Wi-Fi environment and good signal priority Wi-Fi access network access cloud platform; in the absence of Wi-Fi environment, but also through the GSM network access cloud platform.

As shown in Figure 2, access to cloud intelligent street lights can be remote control and sensor data acquisition and analysis. Cloud platform to remotely control the opening and closing of a single smart street light and adjust the brightness, to achieve automatic control program and manual control a combination of control methods and functional debugging means. The cloud platform supports a time-triggered engine, which can customize the triggering conditions and processing mechanisms. Real-time processing can be implemented when conditions occur, helping to quickly implement business logic. Sensors integrated on each intelligent street lamp transmit the collected real-time data to the cloud platform through a centralized controller. The cloud platform encodes the collected environmental data and encodes it through various communication methods (GPRS mobile communication, ZigBee and NB-IOT Etc.) and OneNET cloud platform communication, data transmission to the information center computer back-end database, the central station software will receive the data into the computer for processing, forecasting, storage. Data flow management interface in the cloud platform can see the data collected line chart, the data analysis to make the appropriate response feedback to the device, the formation of two-way communication of information. Automatic adjustment of the brightness of the light pole brightness is based on the acquisition of real-time light intensity to control. Sensor data acquisition and analysis can realize real-time monitoring of local environmental pollution, detection of air pollution index, and upload to the cloud platform to push advertising machine display, can also view the real-time environmental data on the phone APP.

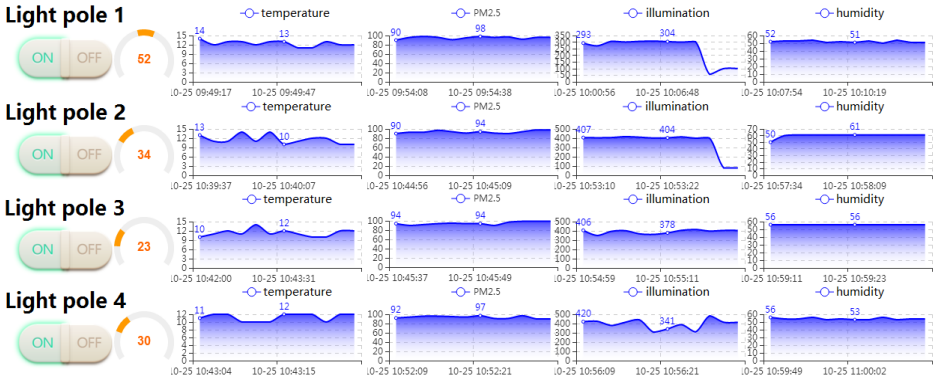

Figure. 2 Data flow supervision chart

C. Terminal control strategy

According to the data collected by the light intensity sensor, the terminal controller can divide the illumination modes of the system into three lighting modes: A-turn off, B-turnable lighting and C-full power. As shown in Figure 3, when the system is in a mode, the controller will turn off the other sensors and turn off all the street lights to save energy, except the light intensity keeps working. When the system is in B mode, the controller turns on the vehicle detector and the human infrared sensor at each intersection, and the same type of sensors in other positions are set to sleep. When the corresponding junction sensor detects the vehicle coming or pedestrians will open the front of the sensor, and according to the detected speed to determine the need to open the number of street lights and ambient light intensity to adjust their brightness; car ahead of the street lights Will be opened one after another, to maintain the car in front of the street lighting range to fully cover the driver's safety line of sight. When cars and pedestrians pass, if the rear sensor does not detect a car or pedestrian, the rear lights will automatically turn off. The control strategy is as follows: when the speed is lower than 10 km / h, turn on the 3 street lamps in front of the car; when the speed is higher than 10 km / h and lower than 30 km / h, turn on the 5 street lamps in front of the car; km / h, 8 lights in front of the car are turned on; 3 lights near the pedestrian are turned on when only pedestrians are detected; when there are both cars and pedestrians in the same time, a control strategy is implemented when there is a car; when the system is in C mode , The same control mode and B mode, but not for PWM dimming, but to maximize the power of street lamps, so that the maximum brightness of street lamps.

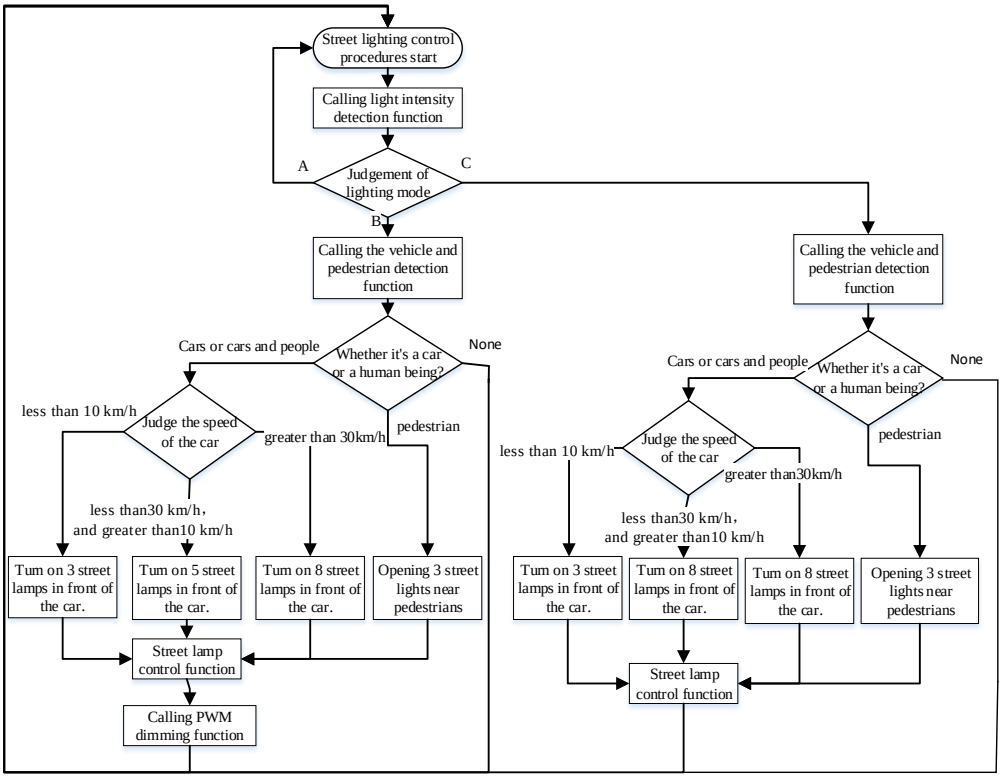

Figure. 3 Flow chart of control program of street lamp

PWM dimming PWM pulse control signal is used to control the turn-on and turn-off time ratio of the street lamp driver's power switch to change the effective value of the output current to control the luminous intensity of the street light. PWM dimming belongs to digital dimming, control, with a dimming range, high precision features [10-11]. Based on this, this paper uses PWM dimming technology to adjust the brightness of street lights. When the street lamp needs to be turned on, the controller calculates and outputs the intensity of the PWM wave of the corresponding intensity according to the detected light intensity so as to meet the standard lighting requirements.

IV. CONCLUSION

At present, the system has been able to achieve the basic adaptive lighting function, but when the control of street lights through the cloud platform, there will be a response delay phenomenon; data acquisition capabilities are basically able to achieve the same through the cloud platform will gather the data stream to the advertising display it is also a delay phenomenon, is now looking for ways to solve. By comparing the electricity consumption, it is proved that the smart street lamp with the adaptive lighting function can save about 20% of the electric energy than the ordinary street lamp.

In the future, after the charging pile is added, the electric vehicle can be wired or wirelessly charged, and the charging data can be uploaded to the cloud platform. The user can check the charging status at any time through the mobile phone APP, pay in real time and make advance reservation service, select the nearest free charging pile from the user. It is also possible to install a wireless charging post above the street light for future logistics UAV charging. When the logistics unmanned aircraft for long distance delivery power shortage, you can tell the cloud platform its location and battery life, cloud platform for its most appropriate push the street for charging. It also plans to realize the communication between car and street lamp, build intelligent traffic, and upload the car traffic and human traffic information collected by street lamp to the cloud platform. After big data analysis, the cloud platform predicts traffic dynamics and sends the most suitable driving route to the driver, allow drivers to avoid congestion routes, thereby relieving traffic pressure and avoid traffic jams.

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