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Based on the Internet of Street Lamp Illumination by Automatic Control System

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Abstract

With the continuous development of information technology, the application level of city information is increasing. A model based on Internet of street lamp illumination by automatic control system is designed in this paper. Based on intensity of illumination, and traffic noise, the information such as temperature and humidity automatic data collection and information processing, the system sets the corresponding weights of each measurement parameter, through the corresponding algorithm to judge the different road and weather conditions, make the corresponding instruction, realize adjustment function of intelligent street lamp illumination in different road and weather conditions. Through the light body GPS technology, fast fault detection and location, the complexity and cost of the artificial maintenance is greatly reduced.

Keywords*: Wisdom city, iot, intensity of illumination*

1. Introduction

As internet of things is put forward, the concept of smarter planet, smart city, and smart home has also been proposed. IBM CEO Sam Palmisano put forward the 'smarter planet' concept in January 2009, in which internet of things is an integral part. The sixth China Internet conference is on May 21, 2015 held in Shanghai, 'the Road of Internet of things industry convergence practice' discusses about car networking and intelligent transportation, wearable and health management, deep integration of informationization and industrialization and industrial 4.0, smart city and networking technology applications, smart home, and so on. From smart city and intelligent transportation point of view, the research on ZigBee technology is relatively mature at home and abroad, but applying ZigBee technology to street smart lighting systems is very few. More economical, more intelligent, more green environmental protection Has become an urgent issue in the development of city street lamp. Aiming to energy saving and intelligent control, a automatic measuring control system of street lamp illumination based on ZigBee technology is proposed, this design could realize automatic collecting, measuring and controlling of the street illumination, with the characteristic of energy saving, intelligent, informatization, high reliability, and low cost.

2. The System Design

2.1 The Overall Design Diagram

This automatic measurement control system of illumination intensity mainly contains: the monitoring center, software management system, 3G base stations, ZigBee coordinator, terminal controller, data acquisition module[1]. Each area of ZigBee coordinator has a data collection site to install data acquisition module. The data information is sent to ZigBee coordinator node by ZigBee terminal nodes, then be sent to

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monitoring center by 3G base stations, finally be processed by monitoring center and displayed on computer[2]. According to some important factors, such as illumination intensity, flow, temperature, humidity, noise, and so on, the monitoring center estimate the road and weather conditions, and send instructions to the terminal controller, which will control the brightness of the lamp by adjusting the duty ratio of the output PWM. At the same time, the monitoring center determines whether a street lamp fault occurs, if occurs, display and alarm. The specific work diagram is shown in Fig.1.

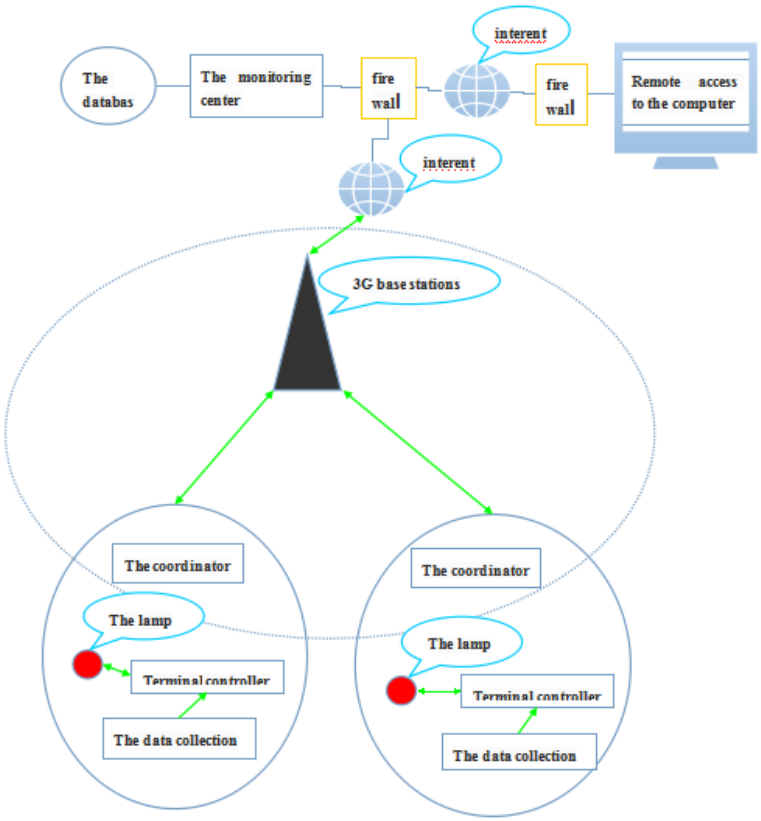

Figure 1. The Schematic Diagram of Automatic Control System of Street Lamp Illumination

2.2 Data Collection Scheme Design

Through a variety of special sensors, the street lamp information acquisition system detects a variety of street lamp information, such as: illumination, traffic, temperature, humidity, noise, etc. These information were collected automatic by ZigBee terminal node, be sent to ZigBee coordinator node through the ZigBee terminal nodes, and be sent to monitoring center by 3G base stations, finally be processed by monitoring center[3], which will make a decision on its control method and the fault alarm. The overall flow chart is shown in Fig.2[4].

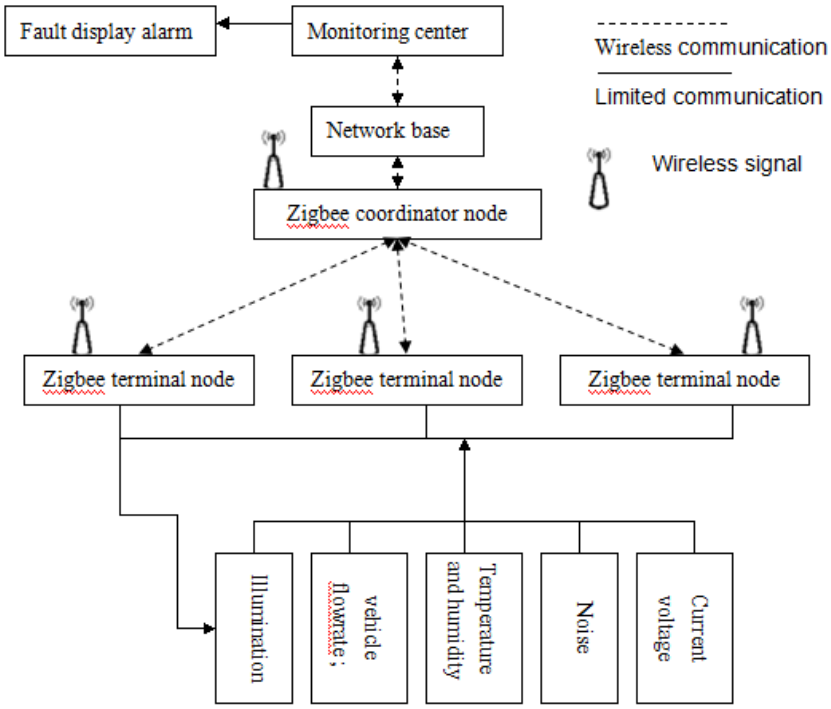

Figure 2. The Flowchart of Collection and Measurement System of Street Lamp Information

2.2.1 Voltage/current collection of lamps: Using the current/voltage sensor, the voltage and current value of single lamp is collected, measured and processed, to realize intelligent diagnosis of street lamp working condition. The fault code, is uploaded to the monitoring center through the 3G network[5], in order to realize fault location, and improve the efficiency of maintenance.

2.2.2 Illumination measuring: According to different applications, the lamp place has four main mode: unilateral configuration, bilateral symmetric configuration, bilateral asymmetric configuration, more lateral configuration. In order to satisfy test requirement of different layout methods and different road surface illuminance, the street lamp is set to lift, thus greatly improve the test efficiency and reduce the installation work. According to the street lamp distribution, the test point location has four modes: unilateral, bilateral symmetry, bilateral crisscross, and center symmetry[6].

In the two lamps area of test site some fixed test points are assigned. Each test point put a illumination sensor, which is fixed in the center of the grid intersection point. At the same time setting a test terminal, decorating cable in the ground, sending illuminance data of each test point to the terminal through the network transmission cable, and synchronous calculation and displaying the average illuminance and uniform Performance. This can guarantee the repeatability and reproducibility of the experiment[7], and greatly improve the working efficiency. In order to ensure the accuracy of the data, the number of sensors and the density of points is increased, which could enhance the precise of measured data. The height of lights can be adjusted, which is suitable for different paths, such a testing method for the intensity of illumination acquisition has very vital significance[8].

According to the test data, calculating average illumination, and then choosing one point or some points, which equivalent to average illumination, as illumination collection point. In this way, the average illumination on the road could be reflected by illumination

acquisition of these points. This system has some advantages and characteristics: 1) eliminating the manual test uncertainty and higher accuracy. 2) saving the installation time and manpower, greatly improve the efficiency. 3) the detection information is stored in the archive server, which could be easily accessed, or network connected, displayed intuitive, applying to all kinds of road lighting optical test.

2.2.3 Traffic acquisition: Traffic information, whose accuracy is very important for street lamp control system, is used to control the brightness level of street lamp. At present, the most commonly methods of traffic information detection has buried induction coil detection, ultrasonic and infrared sensors, video detection, etc. Buried induction coil detection method with high precision, but has weakness of installation inconvenient and maintenance difficulties. Ultrasonic testing precision is not high, whose performance is easily affected by environment's temperature and air flow. Infrared detecting vulnerable to the influence of body heat source, the accuracy is not high. Video detection method, with the development of computer and image processing technology, is more and more widely used in traffic detection. Its advantage is easy to install, debug and maintain. With monitoring range, could extracting high quality traffic scene and traffic flow information, and detecting multiple lanes[9].

This design, using the video detection method and own image processing technology, improve the detection precision and computing speed of the traffic information, at the same time reduce the storage space. When RGB component, with weights of 0.299, 0.587, 0.114, the gray value is closer to human vision transformation formula:

$$I_g(i,j) = 0.299\ R(i,j) + 0.587\ G(i,j) + 0.114\ B(i,j) \tag{1}$$

Where, *R(i, j), G(i, j), B(i, j)* is respectively *R*, *G*, *B* channel component of the input color image *f (i, j)*, $I_g(i, j)$ is a gray image after conversion[10].

Binary image is an index image with only two colors (black and white), also known as special gray image, black with '0', white with '1'. The image binarization processing can extract the light target, in addition to the front lights, it may be also including some interference signals, such as pavement reflection and car body reflective. The headlights is very bright, its center pixel brightness can reach or close to a maximum of 255, at the same time the brightness of pavement reflection and car body reflective in some special cases may also be close to 255. The brightness area of pavement reflection is larger and the pixel gray value is uniform, but the brightness is not higher than car lamp, so setting the appropriate threshold to do image binarization processing, can extract the car headlights, eliminate some interference signals, its binarization formula is:

$$f'(i,j) = \begin{cases} 255 & f(i,j) > g1 \\ 0 & f(i,j) \le g1 \end{cases} \tag{2}$$

Where, *f'(i,j)* is the pixel values of binarization image *f(i, j)*, *g1* is *the* gray level for that point, the size of threshold determines the extracted headlights area, binarization processing with a threshold, comparing with no threshold binarization processing, can eliminate the jamming of non-headlights target. In a word, take the binarization image, calculate the number of cars, determine whether the road is in the busy time, for the control of street lamp illumination.

2.2.4 Temperature and humidity acquisition: The temperature and humidity sensor LTM8901 is used to collected the temperature and humidity information. Its technical indexes are: the temperature range is from -25℃ to +60℃, the humidity range is 1%~99% RH, the precision of temperature and humidity is ±5℃ and ±3% RH respectively. Due to the weather won't vary too big in one region, so the testing grid of temperature and humidity don't need too densely populated, just need set one grid in an area, upload the

data to the monitoring center, and carry on the corresponding processing, make reasonable instructions[11].

2.2.5 Noise acquisition: In this paper, the noise collection is mainly divided into road traffic and noise-sensitive structures. In the monitoring process of road noise, each road select a monitoring point at a distance from intersection, in order to eliminate other noise interference. From monitoring point to center line of the first driveway, the distance is 7.5m, the high is 1.2m, which could real-time collect noise intensity of important road.

The noise monitoring for noise-sensitive structures is to understand outdoor environmental noise levels of the noise-sensitive structures, and to evaluate whether meet the requirement of environment function areas. This article selects 20 noise-sensitive structures monitoring objects, which are mainly affected by traffic noise sources. Each monitoring object selects two noise monitoring points, which respectively is close to the road end point and away from the road end point. Monitoring location, based in outdoor buildings, from the building outer wall or the window is 1m distance, from the ground is 1.2m high, day and night monitoring respectively, as shown in Fig.3.

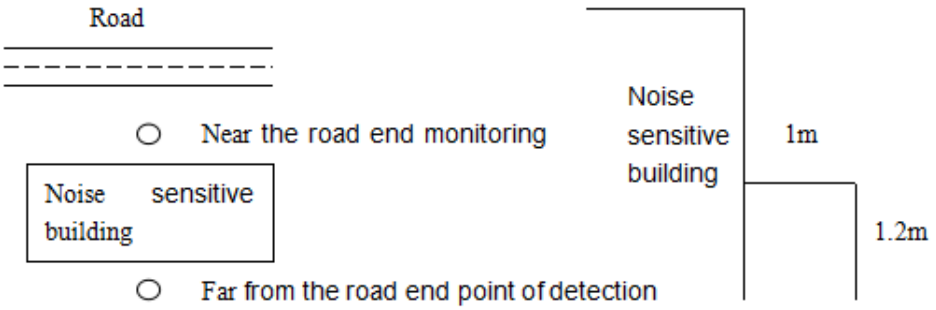

Figure 3. The Monitoring Diagram of Noise-sensitive Structures

For noise-sensitive structures, if beside the road, the side of buildings near the road is affected by the strong noise, while the other side away from the road is weak. For the comprehensive evaluation of the noise level of noise-sensitive structures acoustic environment, both sides of building set up respectively a monitoring stations, so as to calculating the average equivalent sound level. In the monitoring process, the noise data is gathered per second by psophometer, and be calculated variance to obtain the volatility of noise, and then determine the noise strength of road, judge whether the road is in the busy stage, adjust appropriately the brightness of the lamp, convenient people's life.

2.3 Hardware Design

2.3.1 The terminal controller design: The terminal controller TYCON is used to control the brightness and monitoring the working state of the LED lamps, according to the command of control center, which controls the brightness of the LED lamps, and detects whether the lighting equipment is working properly. if the abnormal situation occur, the alarm information will be send to the control center, be real-time displayed on the control center and client software.

The wireless sensor TYSEN belongs to the matching equipment, which can collcet the scene illuminance, traffic flow, temperature, humidity, and noise, send the collected information to the control center, provide a reference parameter for intelligent controlling of the control center.

2.3.2 Coordinator design: The main function of coordinator TYREP is to coordinate and build up a network, used for the ZigBee network management, data transmission between road site and control center.

The using flow chart of the software management system is shown in Fig.4.

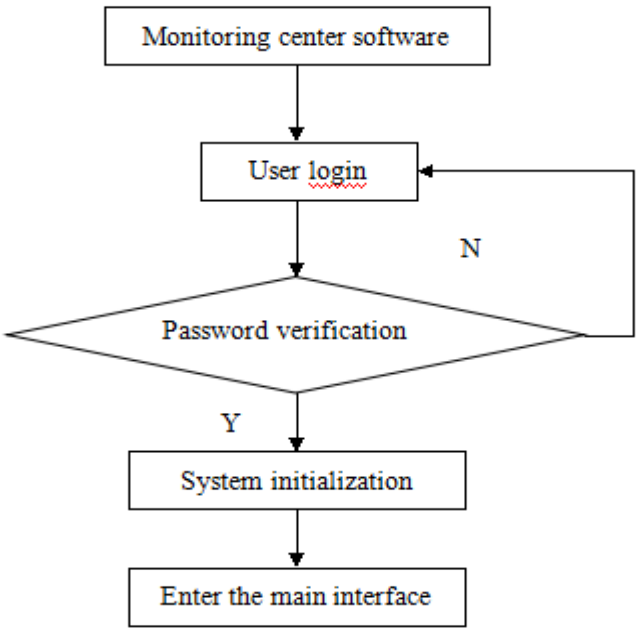

Figure 4. The Using Flow Chart of the Software Management System

The software management system can realize the following functions: (1) the display and control function of electronic map. (2) real-time status display. (3) prestore three sets system working mode. (4) the telemetry and telecontrol function for terminal controller. (5) through the control center to receive, display, storage the working state of each terminal controller. (6) display working state of control object. (7) historical data report. (8) secondary development according to actual demand.

The software management system can real-time view various management state when street lamp running, which mainly contains lamp-post management, coordination management, controller management, street lamp management, the coordinator operation monitoring, controller monitoring, street lamp running monitoring, fault alarm information. The function operational interface diagram is shown in Fig.5, the center interface has user name, date, time, weather conditions, plan list. The left side is management module, which mainly contains parameters setting, equipment management, operation monitoring, dimming management, statistical analysis.

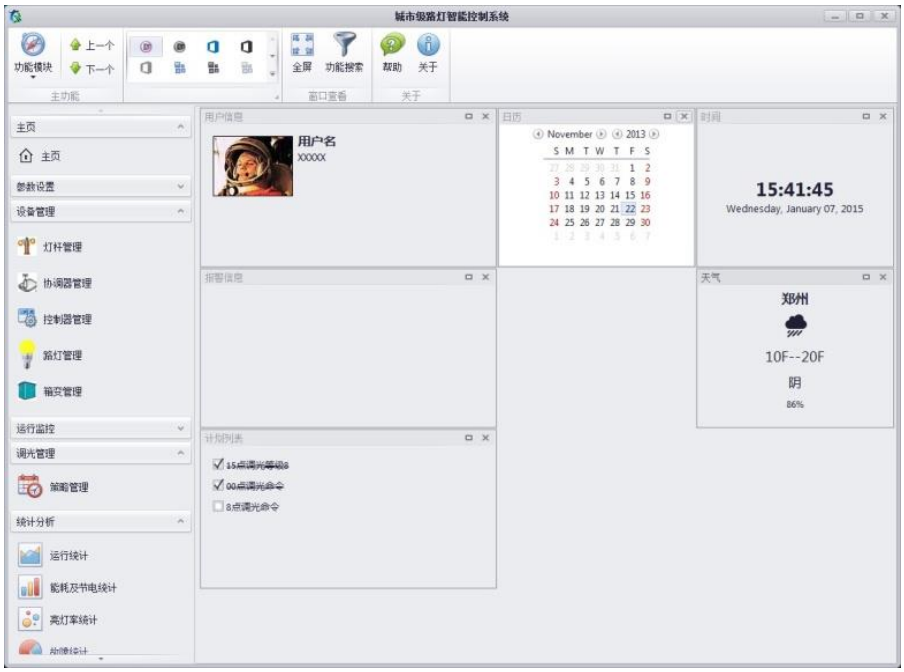

Figure 5. Software Management System Function Operation Interface Diagram

3. The Display and Analysis of Experimental Result

The laboratory testing model is below in Fig.6.

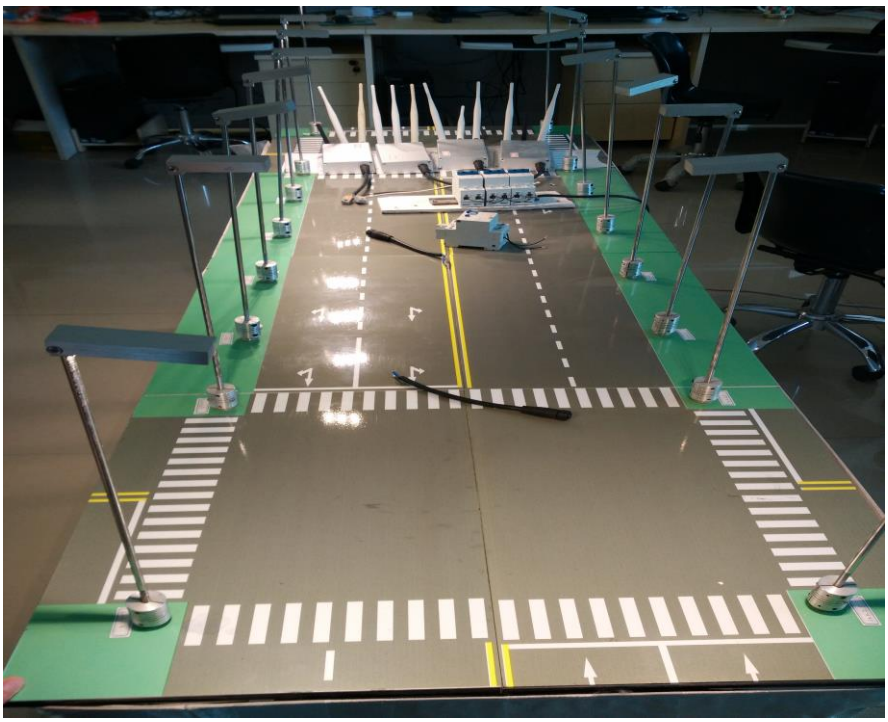

Figure 6. The Testing Model of Laboratory

4. Conclusion

Design in this paper, based on the Internet of street lamp illumination by automatic control system, realized the street light illumination in real time by measuring and can adjust the street lamp according to the collected information in real time measurement, fault intelligent alarm, system integration management, energy conservation, is suitable for various kinds of road lighting. In short, intelligent street lamp automatic gas measuring control system has made great progress in recent years, and is widely used in the relevant road lighting, and based on Internet of street lamp automatic control system has been in the illumination intensity of illumination by test automatic measuring and monitoring integration control technology and application has made great progress.

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