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The Development of Road Lighting Intelligent Control System Based on Wireless Network Control

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ABSTRACT

Energy problem is a social focus nowadays. Energy-saving and environmental protection is the policy of China. According to our national conditions, road lighting system of our country is still emerging technologies. In this paper, to reach the purpose of energy saving, it introduces an information method to deal with the problem of road lighting. The road lighting intelligent control system is based on wireless network control that can implement real-time monitoring for road lighting, intelligent work without manual intervention. It also can save the energy and work efficiently. This paper discusses the design method of road lighting intelligent control system, which was built up by wireless personal network technology, GPRS, microprocessor and host computers, and researched on the system including the structure, key technologies, software design and encryption. At last, future research plans are given.

1. INTRODUCTION

The 4.4 million streetlights in the India Six largest metropolitan statistical areas use an estimated 3 billion kWh of electricity annually, producing the equivalent of 2.3 million metric tons of CO2. If we could achieve a 50 percent reduction in power used, this amounts to a saving of 1.5 billion KWh or 1.1 million metric tons of CO2[1]. Times are changing for municipal lighting management, with greater public scrutiny. The key drivers for change are:

Economic: Against a backdrop of global economic slowdown, funding is becoming limited. Streetlights are among a city's most important and expensive assets, typically accounting for a third of its electricity bill. With energy prices increasing, this is driving the demand for energy-conserving technologies for municipal lighting. Maintenance costs are also increasing, with huge numbers of lamps nearing the end of their serviceable life.

Environmental: The Kyoto Protocol compels signatory states to implement rigorous energy conservation programs. This, in turn, puts pressure on municipal bodies to reduce their CO2 emissions. In addition, ecologically minded governments are responding to the reports of light pollution adversely affecting the nocturnal natural environment.

Recently, there are two ways of road lighting intelligent control system: 1) Control by communication cable. Communication line is set up in the control system which is centralized control buy controlling center. The advantage is accurate and reliable controlling. It can take several control schemes. The disadvantages are high cost, more faults and hard to maintain; 2) Control automatically, including timing control and luminance control. It is low cost, easy installation and simple maintenance. However, timing control is unable to fit the environment change, and luminance control is usually affected by environment, what is more, they are not enough flexible [4]. To improve the road lighting control level, this paper has discussed the design method of road lighting intelligent control system, which was built up by wireless personal network technology, GPRS, microprocessor and host computer, and researched on the system including the structure, key technologies, software design and encryption.

2.INTELLIGENT LIGHTING

An intelligent outdoor lighting system can help local communities do their part in meeting this global challenge. Intelligent lighting systems utilize the latest technologies to optimize the light intensity according to the situation by dimming the lamp[2]. All lamps can be communicated with, so their condition can be assessed remotely and, if necessary, the lamp controlled remotely. The key benefits are:

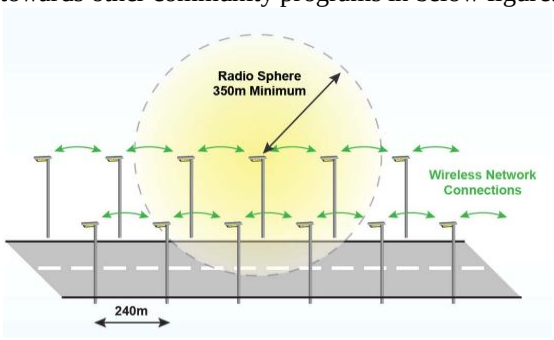
Reduced energy costs: No city can simply switch off its lights at night, so other measures are called for. Not every street and road requires full illumination all the time. Therefore, depending on the site and situation, a frequently feasible option is to dim lights, thereby striking a balance between economical goals and citizens' safety needs. Dimming lights by up to 50

percent is generally imperceptible to the human eye and can show a 40 percent reduction in power use. Typically, lights would be dimmed during non-peak activity times between 11pm and 5am.

Reduced greenhouse gas emissions: With the energy savings there is a corresponding reduction in your community's CO2 footprint. Each saving of 1500 kWh reduces CO2 emissions by approximately 1 ton for mixed power generation.

Reduced maintenance costs: By automatically monitoring the mortality curve of each lamp fixture in a streetlight network, you can accurately predict lamp failures before they occur. This enables you to develop more efficient and cost-effective maintenance scheduling. Also, by intelligent control of the lamp, you can optimize the life-span.

Higher community satisfaction: With an intelligent streetlight system in place, you will be able to significantly improve the performance, efficiency and reliability of the street lighting in your community. No longer do you need to rely on public complaints and visual inspections after sunset to monitor streetlight function and safety. Through its energy and maintenance reduction capabilities, you will also be able to free up a large allocation of public funds that could then contribute towards other community programs in below figure.



Fast payback: Intelligent streetlight systems are very cost-effective, with a typical payback period within five years. By first replacing the oldest lamps that have the most inefficient technology, this period can be shortened still further. **Information:** Information is an increasingly valuable asset. If you can capture data on ambient temperature, moisture, visibility, light intensity, rain and traffic density, you can further lower energy costs and roll out new services for your customers. These innovative applications can add further value to your intelligent lighting system.

3.INTELLIGENT ROAD AND STREET LIGHTING

The traditional implementation and organization of street lighting have no possibilities for improving and development any more. The dynamic changes in economy, energy supplies and ecology on a national, Indian and world like scale require an adequate modernization of street lighting. However, this would be possible only with a quite new functional conception which in fact means adaptability of street lighting. Simultaneous ensuring of the conditions of safe traffic and decreasing the energy consumption and operational costs could be realized in conformity with the constantly changing parameters of the environment.

In conformity with the 24 hours change of daylight, the highly changeable traffic, the variable meteorological conditions and some extreme situations on the roads, the intensity of street lighting should change in a dynamic manner. New technical devices and methods that are offered by technical progress will be necessary obviously for the realization of adaptive lighting[3]. The tender documentation states the goals of the E-street Project and the ways of their implementation. It describes the system structure and the technical requirements towards its subsystems: roadside equipment, power system, local control system, central supervisory system and communication network. The content and project requirements for the implementation of Adaptive street lighting - project management, quality assurance and installation requirements - are given.

3.1 Overall architecture

Figure 1 presents the architecture of an “Adaptive Street Lighting System”. Five subsystems are defined depending on the functions to be performed:

- Roadside equipment
- Power system
- Local control system
- Central supervisory control system
- Communication system/network

The Roadside equipment includes lamps, luminaries, gears, light pools. The Power system consists of transformer stations, power cabinets and power lines. The Local control system can be considered in terms of function as composed of two levels:

I- Level One includes:

- Luminaries with dimmable electronic ballast (DB) with power line modem;
- Controlling high pressure sodium or metal-halide lamps;
- Power line controller (PLC) with power line modem;

- Controlling magnetic ballast and any sensor, such as camera or weather monitor connected to the power grid.

II- Level two includes:

- Substation (Sub Central) with local segment (network) controller LSC;
- Local power line controller PLC (with power line carrier)

The Central supervisory control system (CSCS) system is web–based. The complete monitoring, programming and control are achieved by web–site programs. All the information is collected in a host server. The system and the visible sites or installations are protected by log-in usernames and passwords as well as password level limited actions.

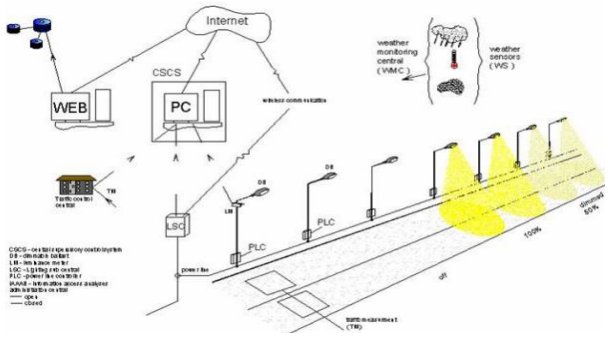


Figure 1: Overall architecture of the Monitoring System for Adaptive Street Lighting

Communication system/network performs information exchange between the different subsystems of E-Street and data collection in the Central Supervisory Control System and in the Lighting Sub Central[4]. The organization of weather condition station depends on the local possibilities, practice and conditions[5]. The street lighting control centre receives information about traffic volume from the traffic centre – TM. The sensor system provides information about precipitation, slipperiness, snow, fog.

4.THE GPRS AND ZIGBEE INTERFACE MODULE OF ROAD LIGHTING INTELLIGENT CONTROL SYSTEM

The hardware design of the GPRS and ZigBee interface module

The main function of the GPRS and ZigBee interface module of road lighting intelligent control system is that information from GPRS network and ZigBee network exchange each other. In this module, it contains a microprocessor module, a GPRS module and the ZigBee module. In this module, free scale's MC9S08DZ60 which is a member of the low-cost, high-performance HCS08 Family of 8-bit microcontroller units, has been adopted as microprocessor[6]. MC9S08DZ60 have 2 serial communications interface (SCI) and 1 Serial Peripheral Interface (SPI)[7]. Therefore, MC9S08DZ60 can meet our communication and process requirements. Concrete block diagram is shown in Figure. 2.

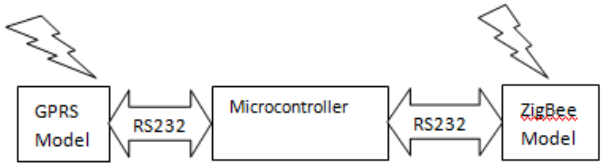


Figure 2:Concrete block diagram

5.ROAD LIGHTING INTELLIGENT CONTROL SYSTEM PRACTICAL APPLICATION EFFECT

Road lighting intelligent control system based on wireless network control, which is designed in this paper, has been tested in small scale for more than two months. The result shows that it has remarkable energy-saving effect, can save energy up to 40%; the system is stable and reliable, and communication data loss rate is lower than 3%; the software has a friendly interface and convenient operation control[9]. The system reaches energy saving, intelligent and practical goal. The actual effect is showed in Figure 3.

6.CONCLUSION

Road lighting intelligent control system based on wireless network control can decrease energy consumption, reduce pollution, improve efficiency for the city and road lighting system. This paper proposed a design method of road lighting intelligent control system, which was built by wireless personal network technology, GPRS, microprocessor and host computers. Also we investigate the structure, key technologies, software design and encryption, and obtained some achievements. In the future, the research work will be

Figure 3: Street light

carried out as follows:

1) Improving system stability further, which ensures that all links of road lighting intelligent control system work stably for a long time;

2) Decreasing communication delay, optimizing algorithm, improving the system communication efficiency;

3) Enhancing the system expansibility. The system must connect to control system of other management departments such as traffic control system, power control system etc. and provide interface of information interaction and communication control for them.

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