



Article Title: **Smart Street Light Monitoring System in Cloud Computing**

Smart Street Light Monitoring System in Cloud Computing

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ABSTRACT

Multifunctional and unique cloud-based Smart Street lighting control system with central management system (CMS) software. It is a perfect solution to manage large-scale outdoor lighting networks in order to control and monitor street lighting infrastructure while saving energy and reducing maintenance costs. Street Lighting CMS is just the first step of more sophisticated Smart City platform development process. Smart street lighting control system allows a city to schedule lights on or off easily and set dimming levels of lights so a city can provide the right level of lighting intelligently. Smart and intelligent street lighting control systems are designed primarily for energy efficiency. Cities using Smart Street lighting control system reduces their street lighting energy. Smart street lighting control systems accurately detect light failure and other maintenance problems in real time so malfunctions can be fixed quickly. This intelligent system provides the operator with web access for automatic or manual monitoring and control over illumination performance. Cities, public organizations, and industries around the world are joining the Smart City Initiative. One of the important components of Smart City is "Connected LIGHTING". Cities, municipal corporations around the world are adopting the connected lighting solution by replacing their old street light infrastructure with the Internet of Things based lighting which brings more efficiency in energy consumption and operational issues. Smart Street Lighting solution gives cities and municipalities the capability to remotely monitor & control the street lights in a much effective way. Our Smart Street Lighting Solution CCMS (Centralized Control and Monitoring System). CCMS is the product, designed indigenously by us for Street Lighting Projects in India to control lighting schedule, monitor energy consumption and faults. With CCMS, the street lights can be scheduled according to the time of the day or as per predefined lighting requirements. Our smart street lighting solution can be used for highways, urban/rural streets, sports arenas, buildings, parks, and industries to monitor and control the lighting system from anywhere.

1 Introduction

Both safety and energy conservation are very important advantages of smart cities. Namely, the city street lamp is correlated with both safety and energy conservation. Therefore, street lamp is an indispensable part of the smart cities. However, current street lamps have lack of smart characteristics, which increases both danger and energy consumption. In order to address these problems, a smart street lamp (SSL) based on fog computing for smarter cities is proposed in this paper. The advantages of the proposed SSL are:

1. Fine management, because every street lamp can be operated independently.



Article Title: Smart Street Light Monitoring System in Cloud Computing

2. Dynamic brightness adjustment, all street lamps can be adjusted dynamically.
3. Autonomous alarm on abnormal states, each street lamp can report the abnormal status independently, such as broken, stolen, and so on.

The experimental results showed that proposed SSL can improve energy efficiency and reduce danger. Energy conservation and better performance is a must in smart street lamps assembled in smart cities. The existing street lights are not suitable for smart cities where the maintenance and security is quite complicated. In order to address these problems, a smart street lamp (SSL) is proposed in our concept. Every smart lamp can be operated independently which results in a fine management. In all smart street lamps brightness can be adjusted dynamically. Each street lamp can report the abnormal status independently with an automatic alarm. The experimental results showed that proposed SSL can improve energy efficiency and reduce danger. Intelligent street lamps have been proposed based on many communication technologies, such as ZigBee, LPWA, GSM, and so on. Moreover, there are many other communication technologies, such as Bluetooth, UMTS/LTE, Wi-Fi, and so on. Each of these communication technologies has its own characteristic. The street lamp is equipped with some sensors, such as location sensor, infrared sensor, and light sensor, to form an intelligent sensing street lamp. Consequently, brightness of street lamps can be adjusted. As already mentioned, safety is one of the most important characteristics of the smart cities, and periodic maintenance of street lamps is a key parameter for safety. The shorter the maintenance is, the better the safety will be.

2 Recent works

Kamen Georgiev, Konstantin Hristov (2019) in this street lighting, an option for remote control of rehabilitated street systems is shown. With the tunnel lighting system implemented, the two gates are not connected to each other and are monitored directly via the global network. The same system, with minor modifications, is also used to control the lighting of industrial halls on the luminance of the windows. In this process, the control is tailored to the specificities of modern LED lighting - the relationship between power and radiated luminous flux during dimming reducing the efficiency of the driver of the luminaire by increasing dimming and achieving energy savings in the implementation of CLO main groups of luminaires and the implementation of manual mode of lighting control by groups. The photometric system is similar to that seen in tunnel lighting, but here it provides information on the luminance of the glazed part of the hall on the left and right.

Angel Pachamanov, Kiril Kassev (2019) examines the possibilities for rehabilitation of public lighting in the municipalities of the Republic of Bulgaria, the technologies for the construction of the transmission environment and the devices that monitor and manage the public lighting by regions. This article is proposed to the development of information and communication technologies (ICT) has brought new challenges to the diverse systems operating in a modern city LPWA (Low Power Wide Area) technology. These networks are referred to as LPWAN (Low Power Wide Area Networks). Popular varieties are LoRaWAN (Long Range Wide Area



Article Title: Smart Street Light Monitoring System in Cloud Computing

Network) and Sigfox. Server establishing a connection with a cloud-based data-base service for data acquisition and storage from multiple central stations /SCADA controllers.

Akhmad Wahyu Dani, Andi Adriansyah (2019) proposed “Automation Control and Monitoring of Public Street Lighting System based on Internet of Things”. The Main objective of this paper is several sensors, microprocessor system, actuators and a software graphical user interface are utilized in this research. Based on several experiments it can be said that the proposed system able to maintain Street Lighting System more satisfaction, low maintenance system and accurate. In this paper, the design of hardware and software required will be explained in this section by showing the block diagram of the street light automation system that will be created and the flow chart program of the system. IoT is studied from various perspectives, thus there exist manifold definitions. The reason for seeming fuzziness of the definition stems from the fact that it is syntactically composed of two terms - Internet and things. The first one drives towards a network focused on a vision of IoT.

Filipe Gabriel Carloto, Nelson da Silva Spode (2019) proposed “The Role of a Smart Street Lighting into a Smart Grid Environment”. The proposed system is presented as well as a developed prototype. The results of the prototype are demonstrated, such as the hardware architecture, performing the energy measurement, control, and dimerization of the street lights, as well as the results achieved with the communication system. This project has the intention to become a pilot project inside UFSM’s (Federal University of Santa Maria) campus, in Santa Maria / Brazil. A LoRaWAN network is presented in the campus which includes Gateways and a Network Server. Firstly, the proposed hardware to control and to monitor the lamp is presented, already aiming its use in a smart grid environment. This includes sampling the grid voltage and current, measuring the power consumption, and sending this information from time to time along the day. Another implemented function is voltage sag and swell information: When this event occurs, the device sends a notification automatically. The energy monitor has a Digital Signal Processor (DSP) dedicated to calculating the electrical variables, like RMS voltage and current, active, reactive and apparent power and energy consumption.

Nguyen Van Doai, Tran Phuong Nam (2019) proposed “Application of Intelligent Lighting Control for Street Lighting System”. The paper focuses on products and innovative components for street lighting, proposing a consumption reducing solution based on an intelligent system for remote measurements and control with GPS/GPRS/4G technologies for public lighting system. The architecture was successfully tested and validated and continues to be in development. The paper is proposed to monitor the network parameters a network analyzer type Module Sim900 can be used which can provide GSM/GPRS/4G, settable signal, taken by the communication modem and transmitted to the dispatcher. To monitor the traffic, current and voltage sensors can be used, which by electronically counting systems give information about current and voltage. The experimental system contains light source network with 250W high pressure lamps and LEDs lamps, connected by various automation equipment’s.



Article Title: Smart Street Light Monitoring System in Cloud Computing

Disadvantages of existing system

Presently, the street lamps mainly adopt manual management or light perception control, which both have certain disadvantages: long maintenance period. Both manual management and light perception control adopt manual patrol to check broken street lamps. Therefore, the maintenance period is too long, especially for the suburban street lamps, it can be even longer than few months. However, the danger increases just after the street lamps are broken, thus there could happen more traffic accidents, more robbery and stealing. Hard fine grain control. It is obvious the manual management is not smart enough, and it can be difficulty controlled in real time. Moreover, in order to simplify manual management, one switch is used to control many street lamps simultaneously. For the light perception control, the flexibility is almost limited. Remote and real time controls are not part of current management systems. High energy consumption. Current street lamps have only two states, off and on. Moreover, they cannot adjust their brightness. Therefore, they consume unnecessary energy. Sometimes, the street lamps can be dim to reduce energy consumption. Easy stolen. There is no effective method to prevent stealing of street lamps. There are a large number of street lamps so it is particularly impossible to control all of them all the time. In order to avoid stealing, the effective way is to make street lamps have self-supervise ability.

3 Proposed work

We propose a smart street lamp (SSL) based on fog computing for smarter cities to meet the above four abilities. The proposed SSL consists of three main parts: an intelligent sensing street lamp, which can adjust lamp brightness, an autonomous alarm which reports about abnormal behaviour; an efficient network, which is used for real-time communication between managers and massive street lamps; and lastly, a flexible management platform, which is easy and highly automated. The average maintenance period, which denotes the time period from the moment the street lamp is broken to the moment that is noticed by the server, is less than 20 minutes. Moreover, the proposed SSL can reduce human resources avoiding an inefficient manual patrol. The main contributions of the proposed SSL are: The hybrid network is adopted, the Narrow Band Internet of Things (NB-IoT) is used for real-time communication between server and massive street lamps, and the Internet is used for real-time communication between managers and server; A flexible management platform is implemented, and it notifies the managers about broken street lamps at real time and automatically dispatches the maintenance staff to repair broken street lamps. The states of all street lamps can be traced and adjusted in real time.



Article Title: Smart Street Light Monitoring System in Cloud Computing

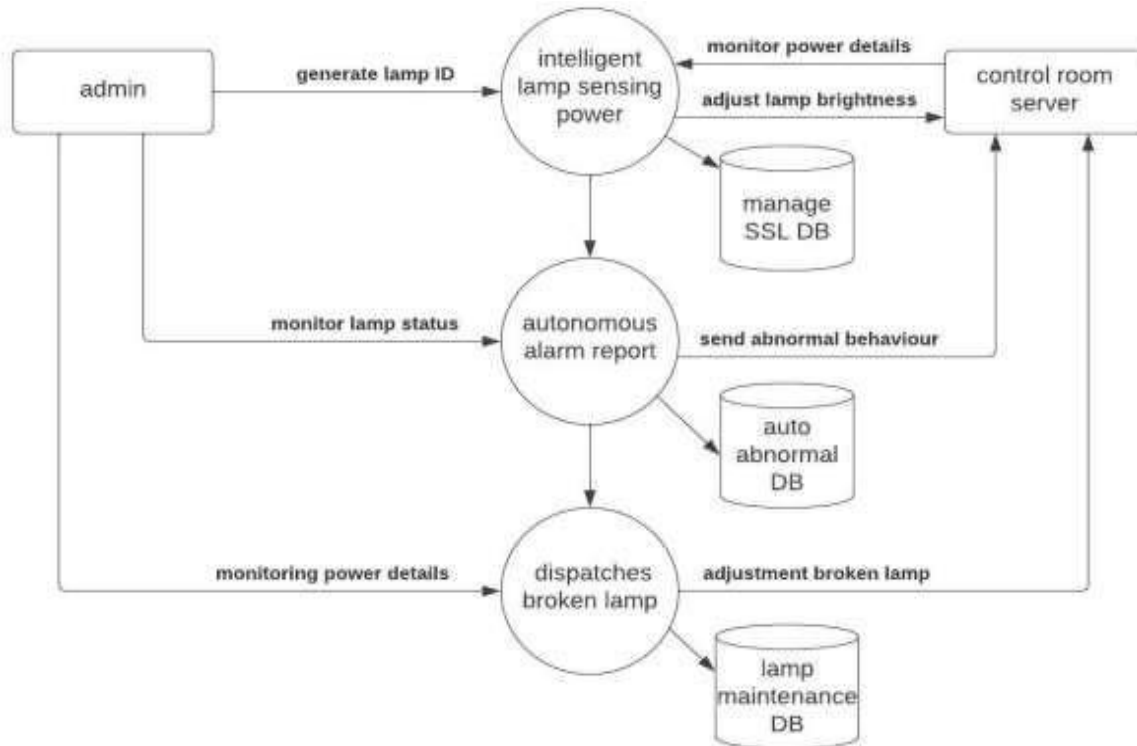


Figure 1: Proposed block diagram

Proposed system comprises 10 modules:

- Admin
- Unique ID Generation
- Monitoring Chart
- Control Room Surveillance
- Street Light Information
- Receiving Street Light Status
- Monitoring Power Details
- Smart Lamp Module
- Manage Power Adjustment
- Auto Abnormal Alert

Admin

The admin controls the entire system through online in which the whole smart street lights has been covered. The admin has the proper authentication to operate the total number of street lights that has been involved in the system.

Unique ID Generation

After the process has been undertaken by the admin each smart street light has been provided



Article Title: Smart Street Light Monitoring System in Cloud Computing

with a unique ID from which the admin can easily identify the exact smart street lamp for further operations like ON/OFF, maintenance, stolen, broken etc. By assuming the unique ID every smart lamp can be handled under the control of the admin.

Monitoring Chart

We evaluate the effectiveness of the proposed SSL by simulation of abnormal states of street lamps based on fog computing server which implements flexible management platform. We analyse the periodic maintenance of abnormal states of street lamps. The results of SSL reliability; and finally, the energy conservation has been solved.

Control Room Surveillance

The server will check the abnormal states, the server will automatically send the information on abnormal lamp state consisting of street lamp ID, lamp location, and abnormal state description to the managers and nearest serviceman. Therefore, the maintenance period can be decreased seriously. The managers can send commands using mobile application or Web browser. Therefore, the serviceman can receive the tasks through mobile application or SMS.

Street Light Information

The Smart Street Light SSL consists of three main parts: an intelligent sensing street lamp, which can adjust lamp brightness, an autonomous alarm which reports about abnormal behaviour; an efficient network, which is used for real-time communication between managers and massive street lamps; and lastly, a flexible management platform, which is easy and highly automated.

Receiving Street Light Status

Using both the intelligent sensing street lamps and efficient network, the server gets the information of all street lamps, consisting of lamps states, locations, external environment brightness, and so on. Therefore, the management platform is a key factor of the street lamp management system. Here, we implement a flexible management platform based on fog computing, which simplifies the management system. Moreover, the fog computing-based server offers better real time response, while cloud computing delivers the elastic computing power and storage at a lower cost. As already mentioned, all street lamps periodically send information of their states to the server, and the server stores received information in the database. In order to find the abnormal states of street lamps, the server periodically checks.

Monitoring Power Details

The check cycle can be set by managers. The longer the check cycle is, the longer the maintenance cycle of a broken street lamp is, and the lower the system cost is. Contrary, the shorter the check cycle is, the shorter the maintenance cycle of a broken street lamp is, and the higher the system cost is. 20 minutes can be tolerable for both maintenance cycle and system cost. Therefore, to balance these two sides, we set the check cycle to 20 minutes, i.e., server



Article Title: Smart Street Light Monitoring System in Cloud Computing

checks states in database every 20 minutes.

Smart Lamp Module

The states of all street lamps can be traced and adjusted in real time. The street lamp periodically sends reports on its current and voltage values. Based on the current and voltage values of the street lamp, the server can determine the street lamp state. If the current of the street lamp is zero, but the voltage is not zero, then the server can conclude that the light bulb may be broken. By the location sensors in the street lamp, the server can be informed whether the street lamp is stolen. Moreover, the street lamp can be found when the street lamp is lost. Further, when the server finds the light bulbs of street lamps are broken, the server can send the detail location to the serviceman for repairing, so the serviceman can locate the broken street lamp accurately which improves efficiency.

Manage Power Adjustment

In intelligent sensing street lamp, the brightness of street lamp can be adjusted with flexible management platform, the management platform can optimize resource scheduling for easy and highly automated management. The street lamp is equipped with some sensors, such as location sensor, infrared sensor, and light sensor, to form an intelligent sensing street lamp. Consequently, brightness of street lamps can be adjusted. The infrared sensor in street lamp makes the street lamp more intelligence. The street lamps can distinguish the demands for brightness. Namely, for street lamps in the unmanned area, the brightness should be turned down, and for the street lamps in the crowded area, the brightness needs to be turned up. Therefore, safety in the crowded areas can be guaranteed, and turning down of unmanned street lamps meets energy conservation requirement.

Auto Abnormal Alert

Autonomous alarm is to avoid stealing. Every street lamp needs to have a self-protection ability. When it is stolen, it should autonomously send the alarm. In this way, the street lamp stealing can be avoided. A flexible management platform is implemented, and it notifies the managers about broken street lamps at real time and automatically dispatches the maintenance staff to repair broken street lamps.

4 Results

Control Room Server will monitor the street light by analysing the Street light information.



Article Title: Smart Street Light Monitoring System in Cloud Computing

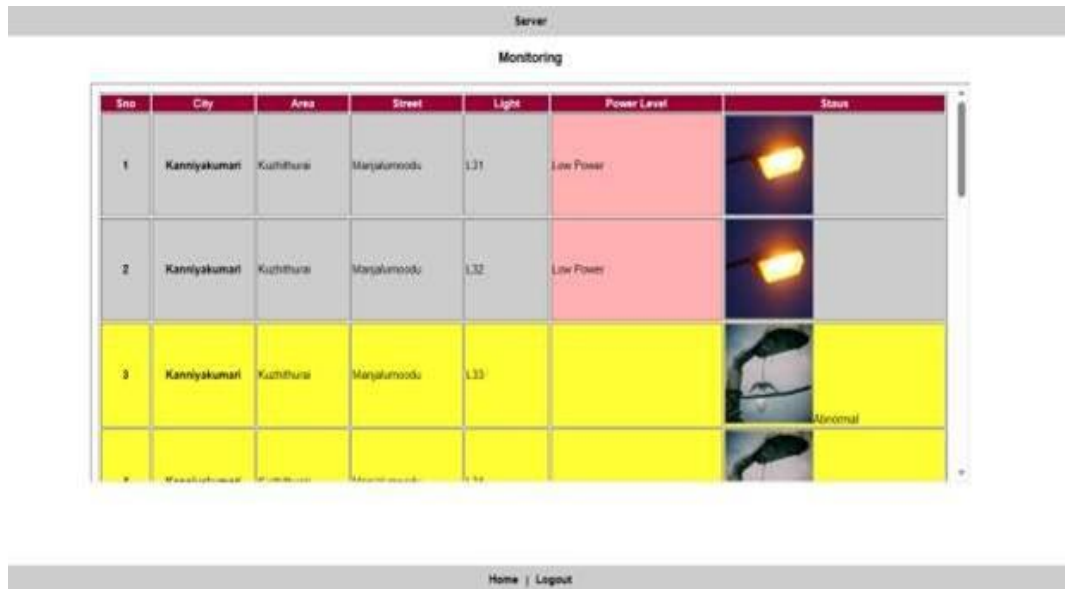


Figure 2: Control Room Server Monitoring

In the above figure 2. Server Predicts that the two Street Lights having Low Power and Another two Street Lights are in Abnormal so it sends Abnormal alert to the Manager with an Abnormal Autonomous Alarm

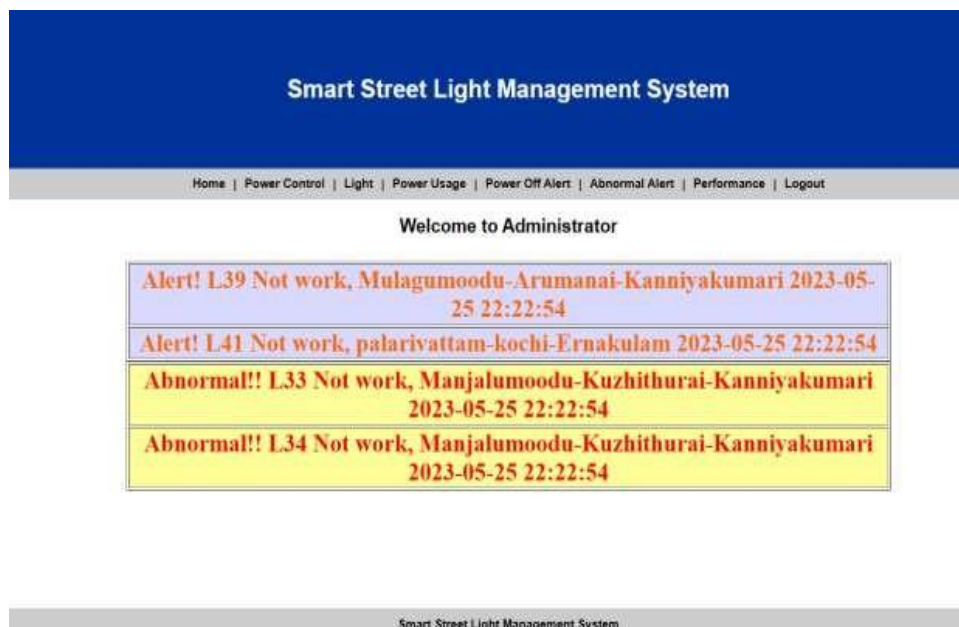


Figure 3: Alerts

In the above fig 3. Manager Notices these Alerts about broken or abnormal street lights at realtime and automatically dispatches the maintenance staff to repair abnormal street lights.



Article Title: Smart Street Light Monitoring System in Cloud Computing



Figure 4: *Street Light Working Properly*

In the above Fig 4. The Server Predicts all the Street Light Working Properly and this monitoring System helps to monitor street lights individually.

5 Conclusion

In order to satisfy the requirements of smart cities, this paper proposes a smart street lamp (SSL) based on fog computing. The SSL mainly consists of three parts: intelligent sensing street lamp street lamp brightness can be adjusted and autonomous alarm notifies about lamp abnormal state); efficient network (real-time communication is achieved, the NB IoT is adopted for communication between server and massive street lamps, and the Internet communication technology, such as Wi-Fi and 4G, is adopted for communication between server and managers); and flexible management platform (management platform can optimize resource scheduling for easy and highly automated management of street lamp system). The average maintenance period, which denoted the time between the abnormal lamp state appeared and the server checked it, was about 20 minutes. Moreover, the proposed SSL can reduce human resources by eliminating unnecessary periodic inspections.

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