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Smart Street Light Management System Using LoRa Technology

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Abstract: ***Increase in population and the corresponding increase of roadshas increased the number of street light, for the roads and people's safety, which rises investment and energy. Lighting consumes adequate amount of energy in both outdoor and indoor. However different approaches are being proposed for making systems energy efficient and upgraded with latest technology. This research gives precise and the best control over energy efficient street lighting system. It gives practical implementation using Long Range (LoRa) and Arduino micro-controller using sensors to gather information.***

Keywords: Street-light, Street Lighting System, LoRa, Arduino, Sensors

1. Introduction

Travelling is part of human livesas peoplehave to movearound every now and then, either going to office, attending school or attending to other daily needs. Every time, important time and energy are used to plight roads, without light this is not possible. So, street light is installed on roads to help vehicles as well as pedestrian in the road. Smart lighting adds intelligence and control to street lights to help reduce the largest energy expense of a typical City. Smart lighting provides remote lighting control that can better adjust the amount of time the lights are turned-on to minimize energy costs without sacrificing public safety. Intelligent Street-light may be referred to as any public street light system that adjust to the needs pedestrians, cars and other road users. It can also be termed as adaptive street lighting which dims when not need or any movement is detected. Street lights can be made smart or intelligent by incorporating actuators,sensors and cameras into the design, these enables automatic motion detection, image capturing or comparison and triggers when needed. Nowadays, networksallow different street lights to communicate with each other. Several blue-chip companies have coined approaches to the idea of smart-street light system. Light Emitting Diode(LED)has been considered the future illumination, with corresponding increase in public demand for efficiency. LEDs have advanced in technology to become one of the best solutions for indoor lighting because of its best feature with respect to efficiency and longer life span,for other illumination purposes, other technologies with high intensity discharge lamps and electrodes fluorescent are still used because of durability, efficiency, and cost.The key idea of this research is to develop an automated and controlled street light according to requirement the road and vehicles and the traveler.

2. Literature Survey

In retrospect, different work have been proposed on street light using both wire as well as wireless technologies. In wired technology power line communication (PLC) is the preferable and feasible for the energy efficient as well as user satisfaction with fault monitoring and detection [1].Deploying intelligent wired or wireless technology for Automatic Street light management system has always been a difficult experience. In the wireless one, itdictatesthat each street light must be equipped with different types of sensors that are connected to a microcontroller to monitor its environment with regards to its working needs like lightintensity, current capacity, voltage load and temperature which are collected and transferred by the means of radio frequency. Two forms of communication were executed, one for short range communication data exchange between street lights and the second one for long range exchange data from street light and the data center[6].

2.1 Street Light

Street Light provision is one of the most expensive but important responsibilities of city lighting which accounts for about 10-38% of the total energy bill in typical cities worldwide. Public authorities consider it a matter of critical importanceto invest in Street lighting in developing nations because it help stimulate economic and social stability. On the other hand, inefficient lighting creates wastage of financial resources and brings aboutsocial insecurity.An energy efficient design and implementation of viable technology would cut costessentially; such savings eliminate or reduce theneed for new generating plants and creates avenue for expanding such initiatives to remoteareas, increasing accessto lighting in low-income populace and other areas of interest.In addition, improved lighting quality and expansion coverage services can improve safety conditions for both vehicle traffic and pedestrians. A well-designed, energy-efficient street lighting system should permit users to travel at night with good visibility, safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighborhood. In the same vein, poorly designed lighting systems can lead to poor visibility and creates light pollution. In most cases, design of street lights are poorly done and not frequently maintained when need or in some cases, obsolete technologies are deployed thereby consuming huge amounts of energy and also create highfinancialconsequences and in the process failing to provide high quality lighting. In India, based on Central Electricity Authority statistics, it was revealed bythe Bureau of Energy Efficiency thatan estimated gross energy consumption for public lighting wasabout 6,131 million kWh for the years 2007-2008.

2.2 Energy-efficient Street Lighting

In the last few years, technology advancement have led to the development of energy-efficient lighting systems that consist of one or more components like low loss ballasts, constant wattage high intensity electronic ballasts, energy-efficient luminaries & Better monitoring and control mechanisms.

Energy Efficient street lighting projects have several stages as shown in figure 1.

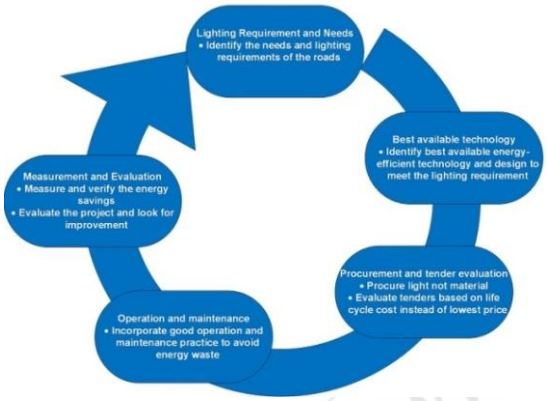

Figure 1: Street Lighting Project Cycle

2.3 Requirements for Streets Lighting

Designing or modifying an existing design in street lighting has some key requirements, it is important to first understand the light requirements of the roads. In Indian standard, lighting is according to the traffic density of the road and accordingly, based on classification in the installation code, concerned engineer matches the category of road then designs and provides installation specifications for the particular street lighting system.

2.4 Choice between retrofitting and new installation

Based on the lighting requirements and purpose of installation, considering the age of the existing infrastructure, broad decisions have to be taken on whether new design and installation is required or justretrofitting the existing system accomplishesthe job. To have a retrofit done, it can be in two forms, either completely dig-up from ground including cables or using the existing poles and then change the cabling and other accessories.

a) Retrofitting

Retrofitting is considered for energy and maintenance savings. Retrofitting or replacement issometimes necessary in cases where light is not distributed correctly, or where a pole has been damaged. There are great opportunities for significant improvements in efficiency since pole locations do not change.

b) Complete or new installation

This option entails completely removing the existing system and replace with new equipment. While another fromof this installation is to design and install a completely new system where street lighting had not previously existed. This provides great flexibility in the design with regard to quantity and pole locations. When a main street improvement project is planned, entirely new poles and lighting fixtures may be the best option for the most effective energy-efficient design of the street lighting system.

2.5 Surveying the technicalities of Street Lighting

Components used for lighting can be grouped according to their on their functions, which can generally described as electrical,structural and optical. These components include:

a) Structural/civil
- Steel or any metallic Poles
- Concrete pole Bases (foundations)

b) Optical components
- Complete luminaires

c) Electrical
- Electric Lamps
- Current Ballasts
- Fuse box for service

Efficient systems are designed to minimize life-cycle cost while achieving lighting requirements (e.g., minimum illuminance requirements to ensure proper functioning and safety of users). To achieve an effective energy-efficient design, it is essential to a combination of the proper lamp/ ballast that produces high lumens per watt together with fixtures that meet design requirements which minimizes glare, light trespass, and light pollution.

2.6 Proper Usage & Routine Maintenance

High energy consumption in street lights can be reduced by inculcating good maintenance routines as such;
- Defective lampsshould be replaced along with accessories and wires
- Faulty cables should be rectified early.
- Cable installation should be done properly.
- Fuse box requires regular checking to avoid loose contacts
- Keeping luminaire cover free of dust or dirt increases light output

A substantial amount of energy savings can also be achieved by installing mechanical/electronic timers and/or daylight sensors for turning street lights on and off.

2.7 Metering & Monitoring

Metering is an important aspect in street lighting system, it helps to correctly monitor the energy usage and performance of the system, it also measure and verify the savings in case the system needs to be updated. Defective meters should be replaced immediately to avoid average billing by electricity boards. Advanced technologies like remote monitoring of switching points in street lights can be utilized to record information such as:
- Instant energy consumption
- Trend analysis
- Patterns of energy consumption

These can then be used to identify and analyze reasons for increases or decreases in energy consumption.

2.8 Measurement & Verification (M&V)

Measurement and verification is used to provide a credible, transparent, and replicable process which can be used to quantify and assess the impacts and sustainability of implemented energy-efficiency projects. The basic principle in M&V is comparing the measured electricity consumption and demand before and after implementation to determine the electricity savings.

2.9 LoRa Technology

LoRa means Long Range,this technology enables connectivity, real-time analytics, reporting, and additional functions such as geo-location. It penetrates in dense urban and deep indoor environments, connecting to sensors which are about 15-30 miles away in rural areas, enables multi-year battery lifetime of up to 20 years or more, supports millions of message per base station, helps tracking application without the use of GPS or additional cause for power consumption, LoRaWAN specification ensures interoperability between different applications, Internet of Things (IoT) solution providers and telecom operators, embedded end to end AES-128 encryption of data ensuring optimal privacy and protection & reduces upfront infrastructure investments, as well as operating and end-node costs.

3. Problem Statement

Proper guide for lighting of public streets, roads, andhighwaysis provided in the Indian Standard (BIS,1981), but because no regulatory authority enforces theseguidelines, it isvery common forlocalities to be unaware of such standards,and may tend not to comply.The most common reasons for inefficient street lightingsystems among people are:

- Inefficient luminariesselection.
- Unprofessional design and installation.
- Low power quality.
- Lack ofguided operation and routine maintenance practices.

4. Methodology

To achieve success in this research work, a hardware setup will be setup. Different sensor types were included, the most common are; Light dependent resistor (LDR) for day light saving, passive infraredresistor(PIR)for motion detection. LM35 for near to accurate sensing temperature, MQ-7 for checking the pollution created by carbon monoxide and hydrogen, Arduino as microcontroller and ESP8266 are used for data transfer as shown in figure 2.

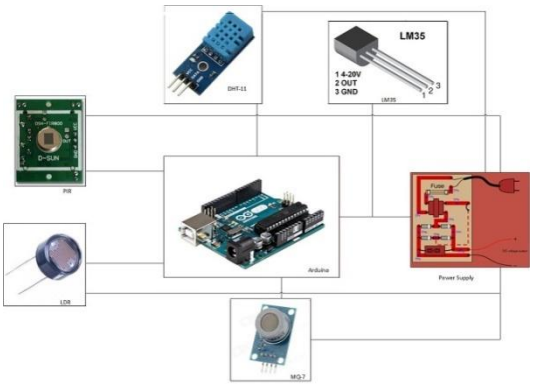

Figure 2: Sensorsconnection schematic

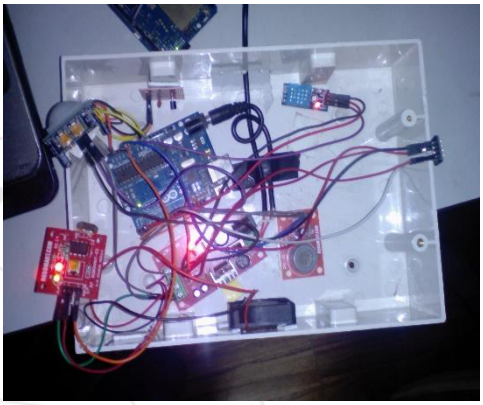

Figure 3: Model smart management system

The main model of this project is shown in figure 4below which explains working modality of the system.

Figure 4: Proposed System Model

Steps involved in this model

- Sensors embedded in each street light have the ability to control light functions
- LoRa Technology in the sensor connects the street light to a LoRa-based Gateway
- The LoRa gateway aggregates data from all nearby street lights
- Sensors for other smart city application connect to the same gateway.

- The gateway sends information to the cloud where the data is analyzed by an application server
- Application server controls lighting
- Server sends maintenance alerts for burnt out bulbs and other issues.

5. Results

The project has been started with the assembling of the sensors as shown in the fig 3 from which the temperature, humidity and the state of light through LDR has been received for more results will be able to show are complete installation of street light in suitable premises where the demonstration can be done.

6. Conclusion

In this research, minimizing energy which is wasted in street light was ensured. It automatesfunctionalities according to requirements of road and vehicle with valuable information being presented in the led screen present in the poles at certain places. The paper also describes how manual surveillance is reduced on the poles; faulty ones are detected and easily repaired or replaced.Conclusively, it was found out that deploying smart streetlight management system with the help of LoRa technology saves energy, cost and also help saves the environment.

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