

IoT based Street Lights for Smart City

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Abstract— Streetlights are among a city's strategic assets, providing safe roads, inviting public areas, and enhanced security in homes, businesses, and city centers. However they're usually very costly to operate, and they use in average 40% of a city's electricity spending. As the cost of electricity continues to rise and as wasting energy is a growing concern for public and authorities, it's becoming crucial that municipalities, highway companies and other streetlight owners deploy control systems to dim the lights at the right light level at the right time, to automatically identify lamp and electrical failures and enable real time control. Street Light Monitoring & control is an automated system designed to increase the efficiency and accuracy of an industry by automatically timed controlled switching of street lights. This project describes a new economical solution of street light control systems. The control system consists of a GSM Modem, and control circuitry and the electrical devices. Base server can control the whole city's street lights by just sending an SMS to GSM network. The main motive behind implementing this project to save energy. Also we can automate daily required electrical switching using this project.

Key words: IoT, Smart City, Street Light Monitoring, Raspberry-Pi, Wireless Communication

I. INTRODUCTION

Automate street lights are necessary while we are trying to survive in the era of smart world. As automation provides perfection and efficiency. In this paper we are focusing on automated street lighting, as current system is facing many problems. Here we are considering the problems which are done manually. A user has to deal with numerous problem like maintenance problem, timer problem, connectivity problem, display problem.

The solution to this problems is IoT Based Street Lights, which allows This template, modified in MS Word 2007 and saved as a "Word 97-2003 Document" for the PC, provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

II. MOTIVATION

Street lights are one of the main city's assets which provides safe roads, inviting public areas, and enhanced security in homes, businesses, and city centers. As they use in average 40% of a city's electricity spending which leads to power consumption. Following are the issues of existing electric system.

Connectivity issue-In existing system, connections of street light are done manually. As each connection requires different contractors and if any one of them is not available then it will leads to functionality problem of street lights.

Timer Problem-Contractors needs to manage timer settings manually. As timer requires twelve hour of continuous electricity supply, and if in case it is not available, it will delay further timer settings.

Maintenance problem-If any of the street light gets failed or any problem occurs, it's not resolved immediately.

Incorrect Readings-Sometimes exact readings are not shown on to the display. So we cannot conclude how much energy is being consumed which give rise in high billing.

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Street Light Monitoring & control is an automated system designed to increase the efficiency and accuracy of an industry by automatically timed controlled switching of street lights. This project describes a new economical solution of street light control systems. The control system consists of wireless technology. Base server can control the whole city's street lights by just sending a notification using network. The main motive behind implementing this project to save energy.

III. LITERATURE SURVEY AND CURRENT ISSUES

P.M.Modi had announced his vision to set up 100 smart cities across the country soon after his government was sworn into power mid last year. Since then a race has been on among cities to land on the list that the ministry of urban development is compiling. The 100 smart cities mission intends to promote adoption of smart solutions for efficient use of available assets, resources and infrastructure.

A city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions. It assures water and electricity supply, sanitation and solid waste management in urban mobility.

The availability of electricity is an important determinant of the quality of life in human settlements. As electricity factor in a growing concern, it needs to be managed tactfully. In urban areas, as we see that there is wastage of electricity and its increasing day-by-day. On other hand, in case of rural areas there are few areas which are without electricity supply. It is necessary to make a proper management in order to reduce wastage of electricity in urban areas so that it would be helpful in supplying in rural areas. This motivates us to choose electricity as an important factor as wherein we can improve our existing system through the help of IoT based street lights.

In order to get detailed information about the existing system of street lights and its working, we visited Pune Municipal corporations Tilak road branch. We met Mr. Medhekar who is head in-charge of electricity department. They told us working of existing system of street lights. If we take in to consideration a particular area, for example Sinhgad road, it requires almost 115 feeders. Each feeder has separate connection and its done manually. They make use of automated timers through which they set timings onto it and accordingly street light gets ON and OFF. But after every four months they needs to go feeder point and makes the changes manually.

Timer is connected with the digital meter. At each feeder point this connection must be done manually. As timer requires 12 hour of continuous power supply in order to light the street lamps. In case if there is load sharing and 12 hour power supply is not sufficient to light the street light then whole system comes to halt which leads to delay in timings.

A. Energy Efficiency using SSL

SSL is nothing but the smart street light system. The SSL system, a framework for fast, reliable, and power efficient street lamp switching based on pedestrians' location and personal desires of safety.

In the developed prototype user location, detection as well as safety zone definition and announcement of other configuration information is accomplished using standard Smartphone capabilities. An application on the phone is periodically sending location and other information to the SSL server. For street lamp control, each and every lamppost is extended with a ZigBee-based radio device, receiving

control information from the SSL server via multi-hop routing.

B. Embedded Platform for IoT applications

For embedded platforms, CoAP (Constraint Application protocol) is used for IOT applications. The main idea of this protocol is to provide a lightweight protocol for resource-oriented applications run on constrained networks. For reducing the burdens of manufacturers, we have designed our software framework for embedded system nodes to allow IoT service development with minimal efforts. As this framework supports application-layer API, which do not affect the existing codes and hides network-layer functions, product manufacturers only need to append a simple CoAP service definition, network driver, and physical network adapter to start IoT services on nodes.

C. Electrical power saving using VANET

The huge amount of electrical power of many countries is consumed in lighting the streets. However, vehicles pass with very low rate in specific periods of time and parts of the streets are not occupied by vehicles over time. an efficient autonomous street lighting control and monitoring system based on the innovative technology named as Vehicular Ad-Hoc Networks (VANET) is proposed. The system can be integrated with VANET to reduce the cost and use the rich services and communication features of VANET. Huge energy can be saved without affecting the visibility and the safety of the drivers. It can extend the lifetime of the lamps. It can automatically monitor the street lighting equipment's and warn the maintenance traffic authority upon failure detection in any place of the streets

D. Fully controlled street lights using Raspberry-pi and Zigbee

The Raspberry-Pi has been chosen for its low costs and for the possibility to drive also a WiMAX modem/router which allows to make the data system visible by a web site accessible by Internet also for areas very far from the city and not reached neither by the ADSL line nor by 3G signals. Intelligent lighting of the lamp, the storage of the functioning data, and their sharing by a local communication wireless mesh realized by ZigBee devices that send information to the coordinator lamp equipped with a Raspberry-Pi card.

Paper Name	Theme	Issues
"An energy efficient pedestrian aware Smart Street Lighting system"	Energy efficiency using SSL	Requires more powerful antennas or signal amplifiers for wireless Communication More Cost.
"An Internet of Things (IoT) Architecture for Embedded Appliances"	Embedded Platform for IoT applications	Provides limited Resources.
"Smart Street Lighting Control and Monitoring System for Electrical Power Saving by Using VANET"	Electrical power saving using VANET	Require more cost for installation of VANET
"A Smart City Application: A Fully Controlled Street Lighting Based on Raspberry-Pi Card, a ZigBee Sensor Network and WiMAX,"	Fully controlled street lights using Raspberry-pi and Zigbee	Complex design because of hierarchical Layers

Table 1: Literature Survey and Current Issues

IV. PROPOSED SYSTEM AND RECOMMENDATIONS

We are using Raspberry-Pi to provide interface between user and system. It is connected to wireless network and relay

circuit which will pass the operational admin's message to the system. Then relay circuit operate the commands like ON Lights, OFF Lights, Alter ON, Alter OFF onto the connected array of street light.

Our system includes two admins: System admin and Operational admin. System admin handles log messages and operational admin. System admin can add, delete and view operational admin. Once the operational admin added to the system by the system admin then operational admin can log in to the system.

For example, operational admin choose the city and area from database to ON or OFF the street lights. And if any fault occurs in the functioning of street lights then relay circuit will send the faulty street light's IP address to the operational admin then operation admin will resolve the problem.

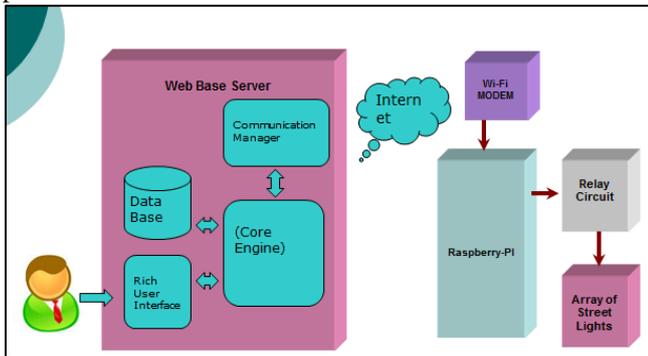


Fig. 1: System architecture of system

V. FEASIBILITY STUDY

A. IOT Based Street Lights

Given a failure case viz. Q, poor network connectivity or damage of street light, we devise an algorithm for this problem as follows:

For a Problem P1 to be NP-Hard, Satisfiability problem (SAT) must be reducible to P1;

$SAT \leq P$;

Let the propositional formula be: $G = X1 \wedge X2$

Where

X1: True if Network Connectivity is very poor

X2: True if Street Lamp is damage.

Algo sati ()

```
{
For i: 1 to 2
 $x_i = \text{Choice}(\text{True}, \text{False});$ 
if  $G(x_1, x_2)$  then
Success();
else
failure();
```

Therefore, since the problem becomes a decision problem, it is NP.

VI. SATISFIABILITY AND REDUCIBILITY

3 SAT problem is NP Complete. The system can be reduced to 3SAT problem. A 3SAT problem takes a Boolean formula S that is in CNF in which each clause has exactly three literals. 3SAT is a restricted form of CNF-SAT problem.

- x1 – System Admin Operation
- x2 - Message Building and Encoding
- x3 – Client-Server communication.

$$S = (x1 \wedge x2 \wedge x3)$$

Algo sat()

```
{
For i= 1 to 3
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$X_i = \text{Choice}(\text{true}, \text{false})$

If $(S(x_1, x_2, x_3) = \text{true})$

Success()

Else

Failure()

}

As it is polynomial time. It is NP-Complete.

VII. CONCLUSION

The application of new technologies to a system, historically not the subject of much innovation, can transform it into an extremely efficient system allowing energy and money savings if compared with classical systems, as the Smart City paradigm teaches.

We have presented a detailed description of our IoT Based Street Lights for Smart City System. It helps overcoming the shortcomings of the current lighting systems. The biggest challenge that one faces in a system is the high cost involved in building new mechanical infrastructures. In this system, we have provided an automated lighting system without introducing any mechanical system in the existing infrastructure

This architecture that uses local sensors for intelligent lighting of the lamp, the storage of the functioning data, and their sharing by a local communication wireless mesh realized by ZigBee devices that send information to the coordinator lamp equipped with a RaspBerry-Pi card.

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