# Zigbee Based Smart Street Lighting System

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**Abstract**— Street light, a source of light that is commonly used along streets when the surrounding turns dark. In recent years various street lighting control systems technology have been developed to control and maintain streets light. However, most of the developed system has some drawbacks. Due to lack of communication capabilities, no system feedback so the system is considered to be outdated. To ensure a higher efficiency and overcome current drawbacks Zigbee communication technology is deployed. The system will be able to detect fault and inform the control room about it.

**Index Terms** — Street light, lack of communication capability, outdated communication, no feedback, Zigbee, higher efficiency, Detect fault.

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## 1 INTRODUCTION

Street lights, a source of light, installed along streets that are used to provide certain amount of brightness when the surrounding turns dark. Street lights are very helpful for public as well as for government in reduction of crime rate and accidents in the areas. However, most of the time the street lights go faulty and not much effort are taken to get it repaired unless a complaint is made or faulty street light comes under observation of higher authorities while supervising the streets light. Even when a complaint is made to the authorities, not much response is given and lots of paper works are involved in getting the street light serviced. People need to wait for days before the streets light can actually function again.

Due to the faulty street light, walking along the streets in the dark environment can be frightening to anyone. This situation can occur in many housing areas, walkways and streets. The street becomes too dark that the walker and other street users are suspected to danger such as theft, kidnapping, accidents and etc. This is due to the use of conventional street light system.

Conventional street lights rely on photoelectric relays to turn ON/OFF the lights and there are no communication capabilities if the street light happens to be faulty. Ignoring faulty street lights being could in turn waste a large amount of power and increase maintenance costs. Besides that, due to faulty street lights there is rise in crime rate and accidents.

Thus, by implementing Zigbee based street lighting system the drawbacks of conventional street lighting system can be overcome. Perhaps the major criterion of the street light development was to reduce night time accident rate as visual performance is poorer at night compared to daytime.

Under the cluster of WPAN comes the technology known as Zigbee. Zigbee is a set of communication protocol defined by IEEE 802.15.4 wireless communication standard.Zigbee consists of low data rate and is widely used for short range wireless networking. Zigbee is majorly used in battery powered applications whereby low data rate, low power and longer battery life are of main priority. The key principle of Zigbee technology is to control and monitor applications.

## 2. CURRENT SYSTEM

The conventional street light may be mounted on wooden or steel pole. Conventional street lights are powered by underground cable line that connects to the nearest distribution line.

At the beginning of the development of the street lighting system, the lights were turned ON manually at night and turned OFF manually at morning. Sooner after that, timer was used to turn ON and OFF the lights based on a pre-set time within the street light. Evolution in street light took place after invention of light detecting sensors such as photodiode, photo resistor and photo relays.

These sensors are mounted smartly on the street light to detect surrounding lighting and turn ON and OFF the light according to how much light intensity are sensed. The structure of the conventional street light consists of a lamp, ballast, capacitor, igniter and a photo resistor. Figure 1 below shows the architecture of a conventional street light.
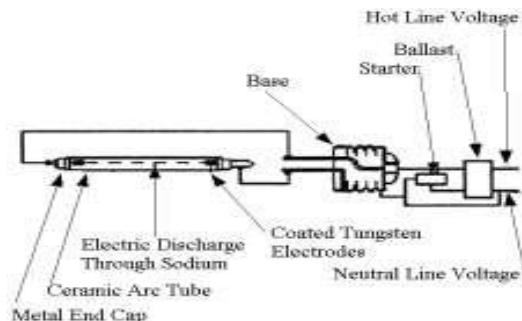
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Fig. 1: Conventional street light architecture.

## 3  PROPOSED ZIGBEE BASED SYSTEM

Zigbee based street lights are mostly battery powered, hence there is no need of laying underground cable line. Zigbee based street light consist of wireless sensor network application that utilizes Zigbee wireless communication protocol to enhance the technology of street lighting system by providing communication capabilities.
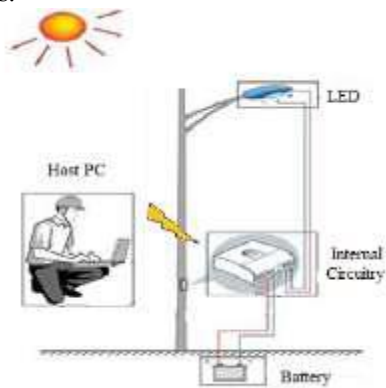


Fig. 2: Zigbee based street light architecture.

Zigbee based street light consist of three types of circuitry i.e. mainly the sensor circuit , Zigbee module, microcontroller and an LED (Light Emitting Diode) circuit. The microcontroller is the brain of the overall system controlling the in and out of the data. When the sensor senses the street light surrounding as dark or bright, it sends a signal to the microcontroller.

The microcontroller immediately sends a high or low to turn ON and OFF the LED lamp. With the help of the Zigbee the microcontroller reports every action and status of the street light to the control panel wirelessly. Then the host at the control station is able to monitor and control the street light all the time.

### 3.1 Results

TABLE 1
STREET LIGHT STATUS CORRESPONDING TO ADC VALUE

| ADC Value | Lamp State | Environment | Status |
|-----------|-----------|-------------|--------|
| 0-199 | ON | Dark | Healthy |
| 200-399 | OFF | Dark | Unhealthy |
| 400-599 | OFF | Dark/Bright | Error |
| 600-899 | ON | Bright | Unhealthy |
| 900-1023 | OFF | Bright | Healthy |



Fig. 3: Graphical user interface for "unhealthy" status



Fig. 4: Graphical user interface for "faulty" status

## 4.  DISCUSSION

A large ADC (Analog to Digital Converter) value is obtained as the surrounding gets darker which results in increase in resistance of the Light Dependent Resistor (LDR). The ADC value can be between 0 to 1023 where 0 is for very brightest environment and 1023 for a darkest environment. The values obtained from ADC are directly proportional to the voltage divider value of both the LDR and the potentiometer in series with each other. The ADC value is sensitive to the change in the resistance of LDR. The microcontroller used in the system is of 10-bit, hence produces as much as 1023 values. The 1MΩ (value used in this Circuit) LDR has a resistance as low as few hundreds of ohms in a bright light while a resistance of Mega ohms in the dark. The resistance of the LDR is inversely proportional to the brightness of surrounding environment. Parameter used to define the light intensity is Lux.
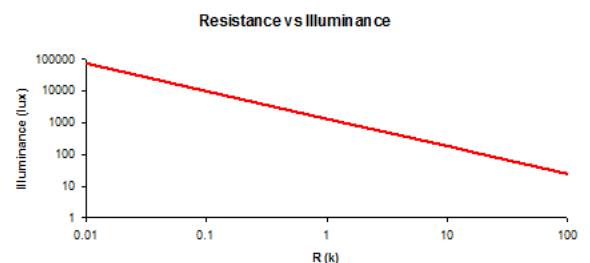


Figure 5: Relationship between resistance and illuminance

The street lighting system in this project can be explained by three different cases which includes healthy, unhealthy and faulty. In a healthy condition, the street light operates normally by turning ON and OFF automatically for night and day light respectively. However, in an unhealthy condition, the street light does not turn ON or OFF automatically and in return sends a feedback message to the control room to notify the host. With the use of GUI (graphical user interface) at the host computer, the host is able to turn ON or OFF the street light which is located a distance away manually and wirelessly as depicted in Figure 3 and Figure 4. In a faulty condition, the street light is considered to have malfunctioned and sends an error message as seen in Fig. 4 to the control room to alert the host regarding the error. The host is notified and further actions are taken to carry out repair works. Compared to the conventional street lighting system, Zigbee based street lighting system provides high reliability and low maintenance with the introduction of feedback system. The feedback system allows the street light to communicate with the control room reporting its daily status and condition. Besides, it involves the use of circuitry that includes wireless monitoring and control with maximum 5V to power up the LED lights.

## 5. FUTURE WORK

Further development can be done to increase the system efficiency by deploying Global System for Mobile Communications (GSM) system to send automatic text message to host at the control station, range of Zigbee communication can be increased by using RF (Radio Frequency) amplifiers.

Capacity of the network can be increased by implementing higher class topologies and to have an internal database (date, time, status and location) to keep track of the street light activity for reference and maintenance purposes. Besides, a motion sensor can be installed so as to turn ON only when there is a sense of movement while the rest of time to be in OFF state in order to reduce power wastage.

## 6. CONCLUSION

Zigbee wireless communication protocol is for the purpose of controlling and monitoring. Zigbee also enable street light to communicate with microcontroller and control station wirelessly without the need of laying down cables. Besides, Zigbee based street lighting is more efficient, power saving and less installation cost than conventional street lighting system. Furthermore, the developed application used embedded programming to control the behaviour of the overall system. The developed application has communication capabilities to provide system feedback which allow for robust communication in different environments.

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