Advance Street Light System using IoT

Lalit Makar*#, Vrushali Patil*#, Khusboo Patel*#, Priti Rumao*
# = Equal Contribution

** Atharva College of Engineering*
lalitmakar71@gmail.com, vrushalipatil095@gmail.com, kkp5601@gmail.com, pritirumao@gmail.com

Abstract

The main objective of the system is to reduce energy consumption. This is achieved by minimizing the unwanted use of energy consumed by street lights. This project incorporates LED lights, ultrasonic sensors and Wi-Fi based microcontroller NodeMCU. It is an automated system which detects presence of sunlight and acts accordingly. When the ultrasonic sensor detects movement on the road during the night, the lights glow up to their maximum intensity. Moreover as the object moves forward the trailing lights will reduce to 25-30% of their intensity i.e they go in the power saving mode. Unlike the traditional system which turns OFF the lights completely. Also, this system uses built-in Wi-Fi module which notifies the authorities about faulty lights.

Keywords: *IoT, Street Light, Power saving, micro-controller, LDR, LED, NodeMCU, movement detection.*

1. Introduction

Street lights are an important factor in modern cities. It is a major part of a city's infrastructure. They consume enormous electric energy. Street Lights are necessary for security reasons of pedestrians, vehicles, animals, etc. during the night. Street lights are often classified based on the lamps used such as mercury vapor, incandescent, metal halide, low sodium, high sodium fluorescent light and LED light. Led lights show a promising solution for modern street lights, the advantages of these are likely to replace the traditional street lamps in near future. Current street lights are controlled only by means of embedded brightness sensors. They are automatically activated when it becomes dark and automatically turned off when it becomes bright. Due to this, there is a huge wastage of energy and this should be changed. In this paper we proposed a system that consists of ultrasonic sensors, LDRs and low-cost micro-controller to automatically switch off lights during the day. During the night if vehicles, animals, or pedestrians are detected by the sensor, lights will glow at maximum intensity else they will glow at low intensity. This reduces power wastage. Also, this system has a fault detection mechanism by which it will automatically notify the authority about the faulty street lights thereby making maintenance easier. Thus, making it efficient than the current system which does not have any such mechanism of fault detection.

2. Literature Review

Kavita A. Bajaj, Tushar S. Mote [1] proposes a highly efficient centralized street light system which concentrates on three main areas. Firstly, they use light emitting diode (LED) instead of sodium vapor lamps and compact fluorescent lamp (CFL) for long life and power saving features. Secondly, point-to-point information transfer is done using ZigBee transmitters and receivers. This information is sent to the control terminal to check the status of the street lights and take necessary actions in case of any failure. Thirdly, renewable energy sources such as solar energy to achieve maximum efficiency. Lights are switched ON/OFF automatically with the help of LDR status and the value of the PIR sensor. The status information of the street lights is stored in the PIC controller.

Kunjal Nanavati et.al [2] developed a system with four modules namely: 1. Solar Tracking System: It consists of a solar plate with a servo motor which rotates the solar panels as per the position of the sun and stores the power into the battery. 2. Auto Dimming: This feature enables the led to glow with low power when the light intensity is high and glow with high power when the light intensity is low i.e the LEDs glow with high intensity during the night and with low intensity during the day. This was done using opt coupler.3.Fault Detection: Dual-band GSM/GPRS module was used which communicated with the controllers via AT commands. When there was a break down in the system the GSM was used to send an SMS to the control system regarding the same. 4. Auto Switching: It consisted of Relay, MAX 232 IC. During low power level of the battery the power automatically switches to grid power. The LDR was used to decide whether it is day time or night time by the intensity of the LDR. Due to this there is no manual operation.

Aman Singhal [3] explains a system to save maximum energy possible by avoiding inefficient lighting which wastes significant financial resources each year. This is done by dimming of lights when there is no vehicle present on the road i.e. lights are at minimum intensity. When PIR sensor detects any movements the intensity of the lights is maximized and once the vehicle moves ahead of that region the lights automatically go back to the dim mode i.e. low intensity. This helps is saving 80% of the energy per day.

Surabhi Gurav et.al [4] proposes a smart street light system which aims at reducing power consumption by varying the light intensity as the object is detected. The line-in-sight IR sensors detect the object and micro-controller changes intensity of lights. This system also incorporates a Solar power module which powers the street lights. This system doesn't have any fault detection system.

Snehal Bhosale et.al [5] developed a system to improve the efficiency by automating the process of switching the street lights. It consists of a control system, internet, electrical devices and a client server mechanism. With the help of this the user can directly interact with the Web based application to control the street lights. When user switches on the street light the server sends a notification to the controller to which decodes and finds the street light which has to be turned ON/OFF. The java application keeps a record of the entire street light of the city.

Vismita Kolvekar et.al [6] proposed an intelligent street light control system which uses two sensors namely LDR and the IR sensor and Raspberry Pi will act as brain to control this system. Street lights will be turned on when the object is detected at night otherwise it will be completely turned off, LDR will detect day/night and IR sensor will detect the object. Lights will be completely turned off when there is no vehicles detected.

3. Proposed System

3.1. Proposed System

The proposed system is an automated system designed to increase efficiency as well as accuracy by automatically timed controlled switching of street lights. This project represents an upgraded cost effective solution for conventional street light system. The system architecture of advanced street light system is as explained in Fig. 1. It consists of micro-controller module i.e. NodeMCU which forms the crux of this circuit. This proposed system also consists of different sensors for sensing various parameters.

- NodeMCU: NodeMCU is a low-cost as well as open source lua based IoT platform. It includes software which runs on WiFi module. It is implemented in C language.
- Light sensor (LDR): This senses the presence of natural light in the surrounding and helps in automatic switching of LED's that is the street light when it gets dark. Also it is used to check the intensity of the street lights.
- Ultrasonic sensors: Ultrasonic sensor triggers ultrasonic waves. These waves triggered by the sensor head reflects back from the target to the sensor head and gives the time taken between emission and reception. This helps in calculating the distance and programming the system according to the required needs. It is used to detect movement on the road.

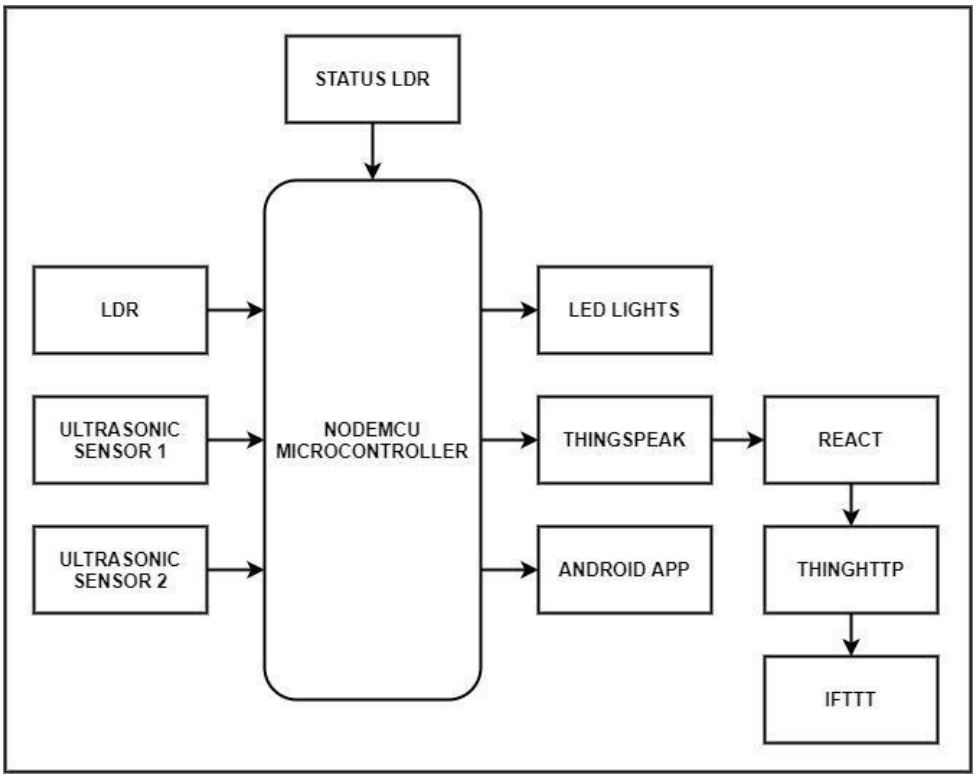

Fig. 1: Block Diagram

Features to be fulfilled by our proposed system are:

- Automatic switching of street lights according to the requirements.
- Automatic fault recognition using sensors.
- Intensity control of LED lights on detection of human or vehicle or in idle state.
- Monitoring via wireless communication using built-in Wi-Fi module.

4. Implementation

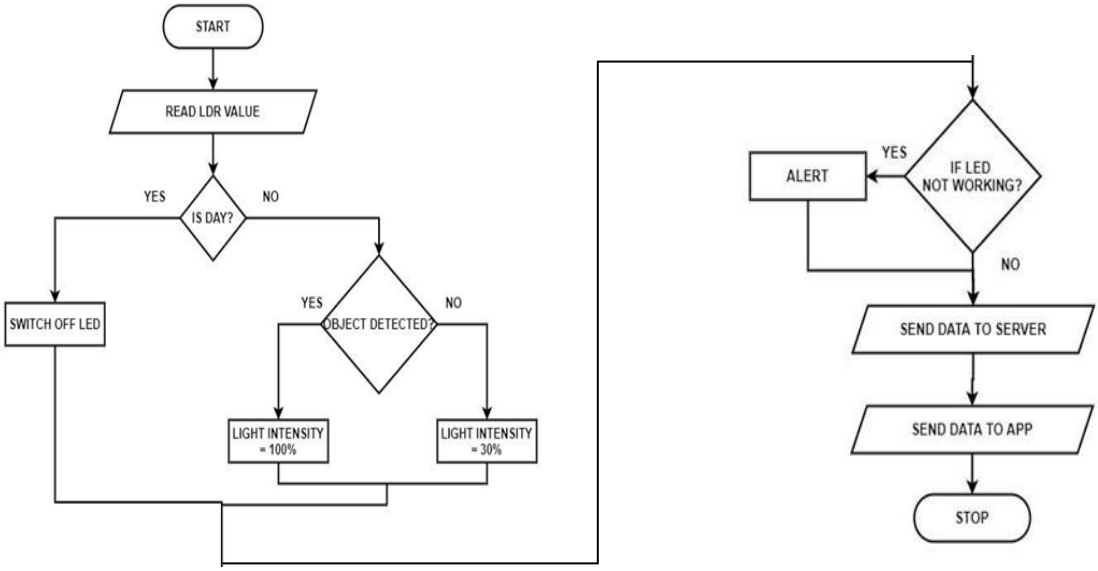

Fig. 2: Flowchart

The proposed system uses low cost micro-controller NodeMCU to design an automatic street light control system. This micro-controller checks the value of the LDR and detects if it is day time or night time and accordingly switches the lights ON/OFF. If it is day time then all the street lights are automatically switched off by the microcontroller. If it is night time then there are two cases of operation depending upon the status of ultrasonic sensor value which detects movement on the road.

Case 1 BUSY ROAD: In this case there is necessity of light on the road so the lights will be operated at 100% intensity using PWM value 1023.

Case 2 Empty ROAD: In this case there is less requirement of light hence the lights will be operated at 30% intensity using PWM value 300.This is the power saving mode.

Fault detection system: In this the status of the light is checked using an LDR. If the light was supposed to be on but it is found to be off then there is a failure in the system and requires an alert message to be sent to the authority. For this purpose this system uses THINGSPEAK, an IoT application and API to store, retrieve data from things using HTTP and MQTT protocol over Internet. All the data will be stored on Thing Speak cloud server. An alert will be given using ThingHTTP call by React to call an IFTTT Applet. Two channels will be created on ThingSpeak, first channel will show the device status while second channel will show the Light Intensity Status of the device. MIT APP INVENTOR 2 is used which is a web application integrated development environment to create application software (apps) for two operating systems (OS): Android, and iOS. The system can be monitored using the app that is created using MIT App Inventor 2 which makes maintenance easier and more efficient.

5. Results

Given below are the screenshots of the implementation of the proposed system described in the paper.

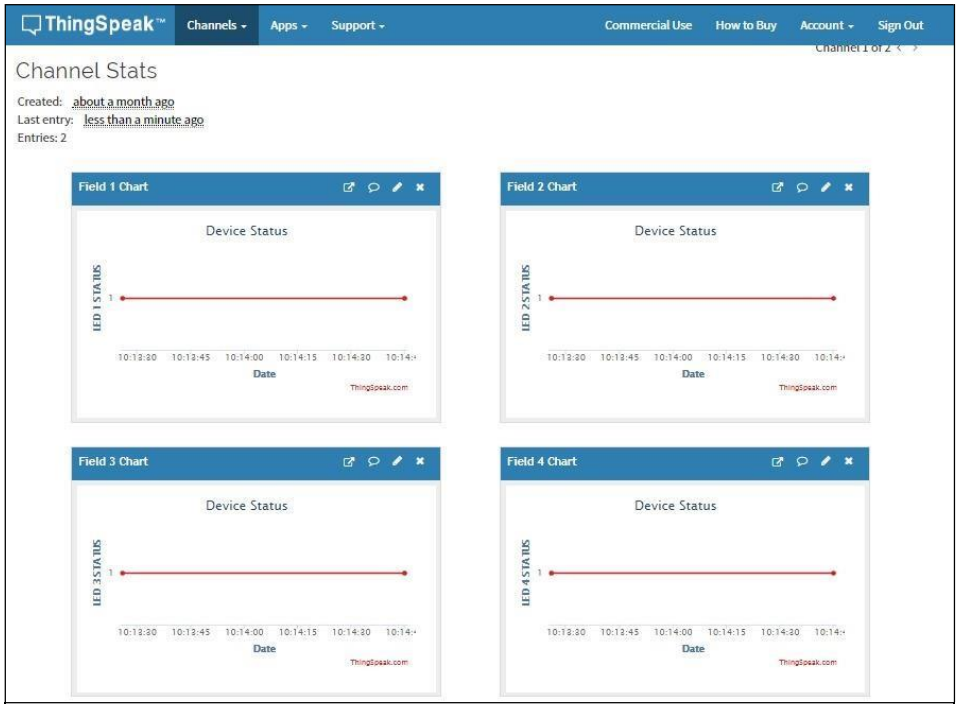

Fig. 3: Device Status Graph

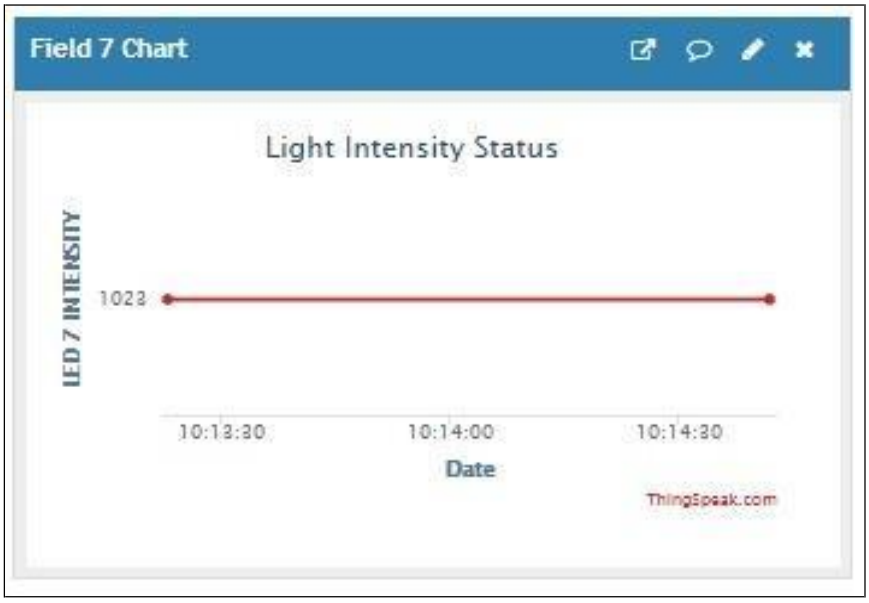

Fig. 4: Light intensity Graph of LED 7

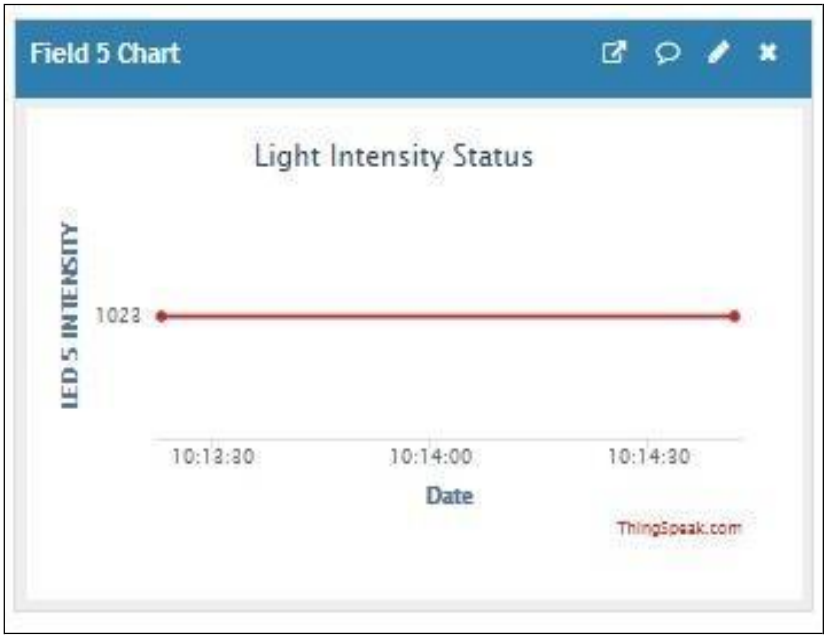

Fig. 5: Light intensity Graph of LED 5

Fig. 6: Screen 1 of App

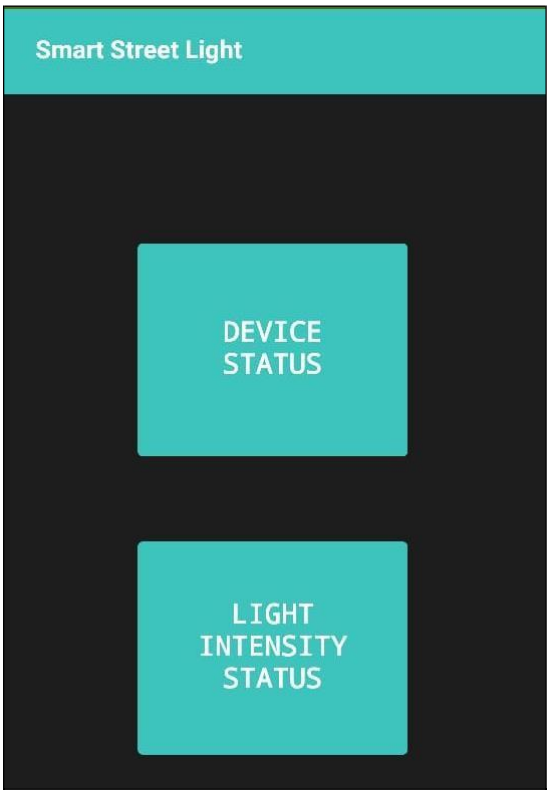

Fig. 7: Screen 2 of App

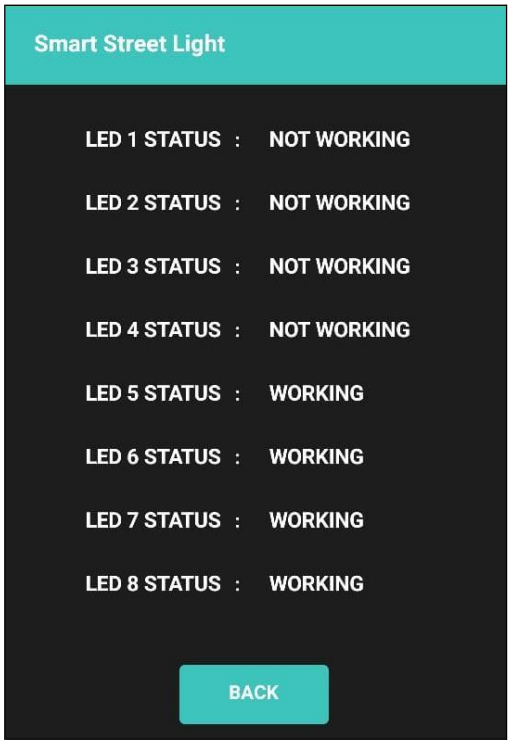

Fig. 8: Screen 3 shows device status of led

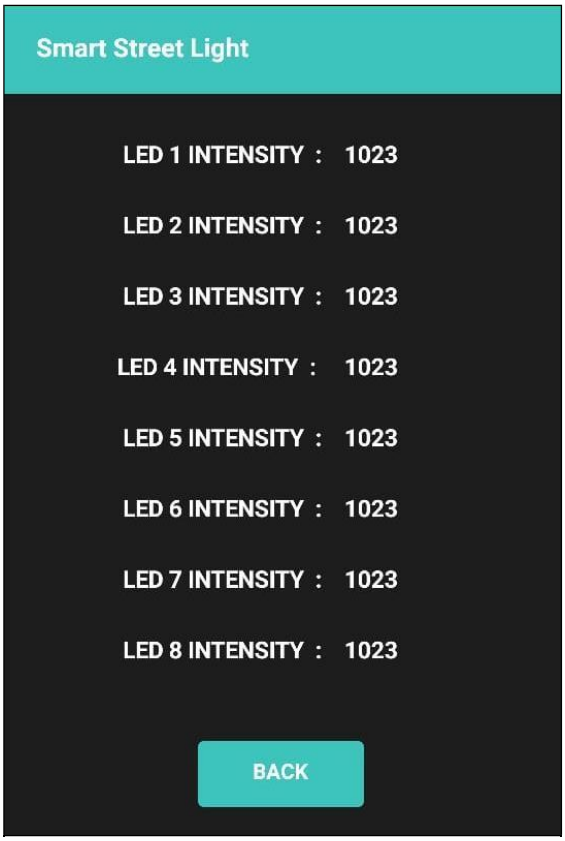

Fig. 9: Screen 4 shows light intensity of the led

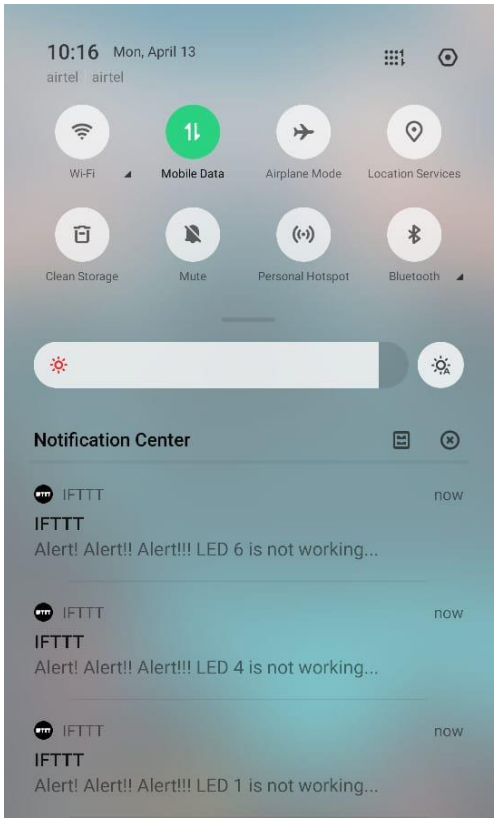

Fig. 10: Alert Notification

Advantages

1. Maintenance cost is low as compared to conventional street light.
2. Intensity of street light can be controlled
3. Lowers the risk of accidents.
4. Environmental friendly as there is no harmful emission.
5. LEDs have longer life compared to conventional HID lamps.
6. Less power consumption.

Future Scope

1. We can make use of GSM Module along with Internet enabled micro-controller to provide alerts even when there is no internet connection.
2. The app can be upgraded to cover a larger location.

Conclusion

The main benefit of this system is power saving. This will save tremendous amount of economy in the coming years. The system is studied and designed using NodeMCU with built-in Wi-Fi module. This initiative will help us save energy, money and meet various other needs of our nation. In addition to this, another advantage is that, it provides less maintenance cost. This proposed system is cost effective, pragmatic, practical and safe to travel at night time. The initial installation cost may be a disadvantage but with the bulk production of the module the overall cost can be reduced further. Due to the automatic message sent to the authorities, maintenance becomes easier. The proposed system is especially appropriate for street lighting in rural areas and specifically areas with low footfall count. The system is versatile, extendable and adjustable according to the needs of the user.

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