IOT based Smart Street Light System

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Abstract: *The aim of IoT Based Smart Street Light System is the conservation of energy by reducing electricity wastage as well as to reduce the manpower. The Saved energy can be utilized in various purposes like residential, commercial etc. This is done by using the LDR sensor. Here the LDR sensor is used ON-OFF the street light based on the ambient intensity level. It is an uncomplicated light/dark activated switch and contains a relay at its output. This switching can be done by a low-cost Wi-Fi module ESP8266 after reading the LDR value. The real time information of the street light (ON/OFF Status) can be accessed from anytime, anywhere through internet. It ensures high reliability and excellent long-term stability. This work is implemented using a programmed NodeMcu board for providing the required intensity of light at various times. The proposed work has achieved a better performance compared to the existing system.*

Keywords: IoT, LDR Sensor, Relay, Wi-Fi module ESP8266, NodeMcu

1. Introduction

This street lighting is one of the largest energy expanses of a city. A street lighting system can cut municipal street lighting cost is 50% to 70%. The smart street lighting system is a system that adjusts light output based on the usage and occupancy, i.e., automatic classification of pedestrian versus cyclist, versus automotive. The project is mainly implemented to track the intensity of the light using sensors and it is done using the wireless system to control the energy consumption and uses reduction measures through power conditioning and control.

The street light (ON/OFF Status) will be accessed from anytime, anywhere through internet based on the real time system. The street controller should be installed on the pole light which consists of NodeMcu ESP8266. The data from the street light controller can be transfer to base station by using wireless technology to monitor the system. The operation of the system can be conducted using auto mode and manual mode the control system will switch on-off the lights are required timings and can also vary the intensity of the street light according to requirement.

2. Literature Survey

The project is usually a multi-functional prototype that has a aptitude to get rid of the manual operation of the old street lightning system by strategy of the self-automation [1]. It aims at designing and executing the advanced development in embedded systems for energy saving of street lights and their maintenance at reduced cost with modern development. Street Lightning system has a feature as two sensors are used which are Light Dependent Resistor (LDR) to point a day/night time and therefore the passive infrared sensor (PIR) to detect the movement on the road [2].

In this IoT context, among the all integrated wi-fi chips, ESP8266 is one of the best and it is a low-cost of wi-fi module. A 32bit TensilicaXtensa L106 micro-controller is integrated into it. Within less PCB area RF balun, low noise receive amplifier, power amplifier, filters and power management modules with minimal external circuitry are included in front end module [3].

In [4] Automatic Street Light Control System is not only easy but also the powerful technique. Relay uses a automatic switch in this system. It releases the manual work almostup to 100%. As soon as the sunlight goes under the visible region of our eyes this system automatically switches ON lights. Light Dependent Resistor (LDR) is a type of sensor which actually does this work and senses the light as our eyes does. As soon as the sunlight comes, visible to our eyes it automatically switches OFF lights. Such type of system is also useful for reducing energy consumption.

In [5] this project is designed to detect the vehicle movement on the highways to switch ON only a block of the street light ahead of it and switch OFF the trailing light to save energy. During the night all the lights on the highways remain ON for the vehicle, but loT of energy is wasted when there is no vehicle movement on the highways.

The Wi-Fi ESP8266 MODULE is employed to upload to the important time information on the cloud through IOT panel [6].Providing a street lightning is one in every of the foremost important and expensive responsibilities of a city. Lightning can account for 10-38% of the overall energy bill in typical cities world-wide [7].

3. Implementation

The idea of this project is to give information about the IOT SMART STREET LIGHT SYSTEM. So, we have chosen the THING SPEAK technology to get more control over the street lighting. In this project we are interfacing NODEMCU ESP8266, RELAY &LDR SENSOR.

India facing one of the major Problem is maintenance of street lights. In India street lights are maintained manually, it is found that there is wastage of power by operating the street lights due to manual operations like switch on the light

at day time. To reduce the manual errors by controlling, implementation is done using Thingspeak for effective communication.
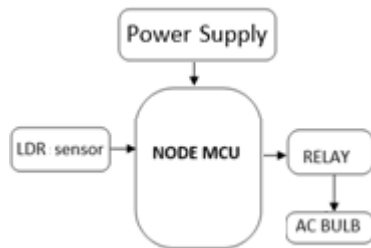
3.1 Block Diagram

Figure 1: Block Diagram

3.2 Equipment used

- Power supply
- LDR sensor
- NODEMCUESP8266
- Relay
- Bulb

3.3 Power Supply

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others. This power supply section is required to convert AC signal to DC signal and also to reduce the amplitude of the signal. The available voltage signal from the main is 230V/50Hz which is an AC voltage, but the required is DC voltage with the amplitude of +5V and +12V for varies applications.

3.4 NODEMCUESP8266

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. And, you have to program it in low-level machine instructions that can be interpreted by the chip hardware.

The ESP-8266 may be a low-cost Wi-Fi microchip with full TCP/IP Transfer control protocol/ Internet protocol). It makes the web connectivity possible for the IOT panel. ESP8266 offers a whole and self-contained W-Fi.
- 2.4 GHz Wi-Fi (802.11 b/g/n, supporting WPA/WPA2).
- General-purpose input/output (16 GPIO).
- Inter-Integrated Circuit (I²C) serial communication protocol.
- Analog-to-digital conversion (10-bit ADC).
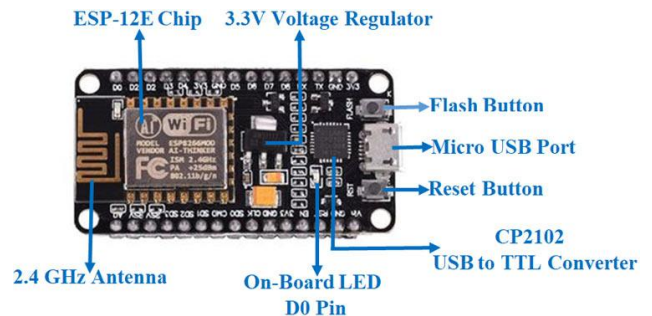- Serial Peripheral Interface (SPI) serial communication protocol.

Figure 2: WiFi module ESP8266

3.5 LDR sensor

Photo resistors, also known as light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity. The sensor that can be used to detect light is an LDR. Since the LDR gives out an analog voltage, it is connected to the analog input pin on the Arduino. The Arduino, with its built-in ADC (analog-to-digital converter), then converts the analog voltage (from 0-5V) into a digital value in the range of (0-1023).

Figure 3: Light Dependent Resistor (LDR) sensor

3.6 Relay Board

Relay boards are computer boards with an array of relays and switches. They have input and output terminals and are designed to control the voltage supply. Relay boards provide independently programmable, real-time control for each of several onboard relay channels.

A relay is an electrically operated switch that can be turned ON or OFF, letting the current go through or not, and can be controlled with low voltages, like the 5V provided by the NodeMcu pins. Controlling a relay module with the NodeMcu is as simple as controlling any other output.

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical, or vice versa. Relays are mainly made up for two basic operations. One is low voltage application and the other is high voltage. For low voltage applications, more preference will be given to reduce the noise of the whole circuit. For high voltage applications, they are mainly designed to reduce a phenomenon called arcing.

Figure 4: Relay Board

3.7 Bulb

LEDs use much less energy than incandescent bulbs because diode light is much more efficient, power-wise, than filament light. LED bulbs use more than 75% less energy than incandescent lighting. Another advantage of LEDs is the "hassle factor." LEDs last a lot longer than a regular bulb.

Figure 5: Bulb

4. Software Required

4.1 Arduino IDE

The Arduino Software (IDE) is an open-source software and it makes easy to the code and upload it to the board. I t runs on the different plant from Windows, MAC OS, Linux. The environment is written in Java and before running the IDE Java software to be installed on the machine this software can be used with any Arduino board.

4.2 Thingspeak

ESP8266 Thingspeak is an analytic IoT platform service that allows you to aggregate, visualize and analyse live data streams in the cloud.

ThingSpeak is an open wellspring of web of things (IoT) utility and API to purchase and recover records from issues abuse the hypertext move convention and MQTT convention over internet or through a near to space organize.

ThingSpeak licenses the presentation of detecting component work programs, area following bundles, and an informal community of things with standing updates.

5. Advantages

- Maintenance cost reduction
- Reduction of light pollution
- Energy saving
- Lightning system also reduces crime say murder, theft and plenty of more to a great- extend.
- Reduction of man power
- Major advantages of street lightning include prevention of the accidents and increase in the safety

6. Working

Internet of Things is a term of opening new possibilities of interacting with electronic devices by digitally interfacing them possibly providing information in a very simple user-friendly format to a smart device and connected to the same network as the rest of the system. In this system, every device is required to be operate in the basis of IoT, are connected to each other on the same network.

The system architecture is adaptive system and it consists LDR sensors, NODEMCU ESP8266, relay, Bulb. In this system NODEMCU microcontroller acts as the brain of the entire system. All the sensors used in this system are connected to micro controller. LDR is light dependent resistor. When the day time sunlight falls on it, its resistance decreases and makes the light to switch off. When the night time, light do not fall on the sensor, so its resistance increases and triggers the light to switch On.

Relay acts an automatic switch and electromagnetic switch it is connected to the micro controller by relay driver. It is highly reliable and automatically switches ON and OFF the lights.
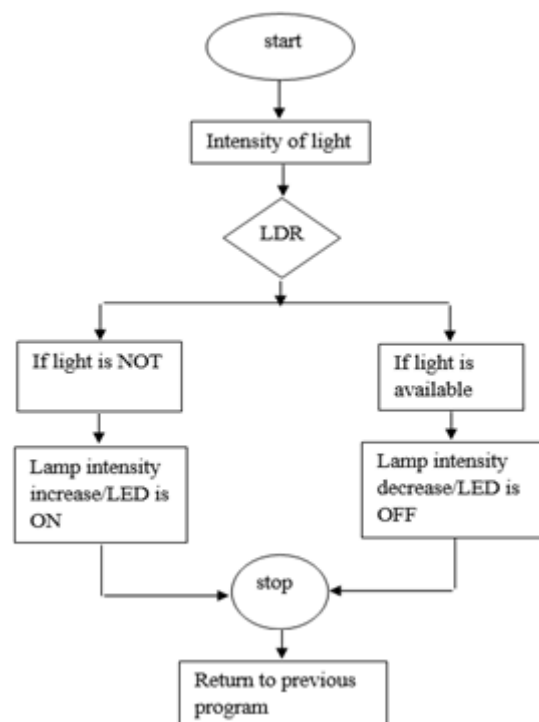
6.1 Flowchart of working system

Figure 6: Flowchart of working system

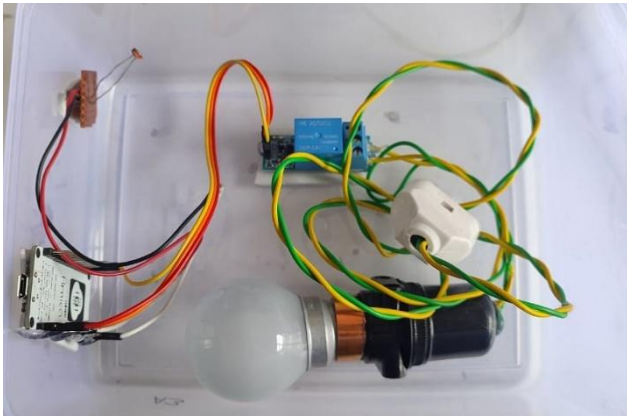## 7. Results and Analysis

Figure 7: Prototype of the IoT based smart street light system

7.1 Scenario during Day under Full Brightness

At daytime due to full environmental brightness, no LEDs are ON and the value of LDR remains almost constant. The intensity varies depending on brightness.

7.2 Scenario during Night under Full Darkness

At night due to zero environmental brightness, all LEDs are ON at their full intensity and the value of LDR here too remains almost constant as the LDR would not sense any light all night. Table1 shows the value of LDR which is referred as external brightness and on the other hand the value of intensity. With the help of Table1 we got a graph as shown in Figure7By looking at the graph we could say that as the external brightness increases the intensity of the LEDs decreases and as the external brightness decreases the value of LEDs increases. When it is totally dark outside the Intensity reaches to the peak.

Table 1: External Brightness vs Led intensity

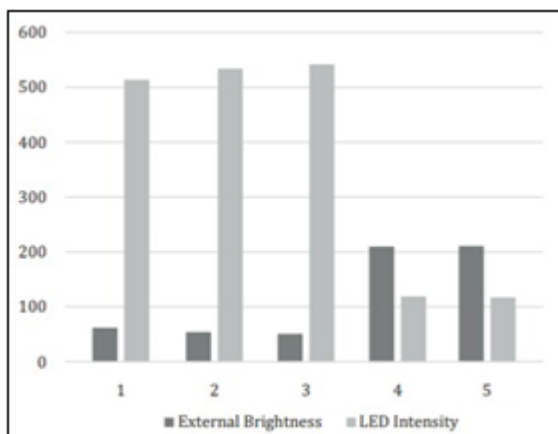| External Brightness	LED Intensity
62	514
54	534
51	542
210	119
211	117

Figure 8: Brightness Vs Intensity

8. Conclusion

The proposed system is easy to setup and implement and it doesn't require extra maintenance compared to the already existing system. This system can be further enhanced by writing logic into the code and that can be able to retrieve information of the time of sunset and sunrise from a reliable weather reporting source and automate the process completely by turn ON the street light at the time of sunset and turn it OFF by sunrise. This further eliminates human intervention and a manual visit to the location of the street lights will be required only in case of a malfunction. The efficiency of automated systems is more than the manual systems. We can also reprogram these devices with respect to our needs. By using the API key, the generated data is stored in Thingspeak database which we can use for future references.

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