IoT Based Smart Led Street Lighting System

SHAURYA GUPTA

GAURI MADAAN

***Abstract*—: Smart led street lighting system aims for designing and executing the advanced development in IOT for energy saving of street light, the best solution for electrical power wastage is automation of street light, the manual operation of the lighting system is completely eliminated. A method for modifying street light illumination by using sensor at minimum electrical energy consumption, when object presence is detected, street lights glow at their brightest mode, else they stay in the dim mode during night time Internet of things (IOT) is used to visualize the real time updates of street processing and notifying the changes occur. This shall reduce heat emissions, power consumption, maintenance and replacement costs and carbon dioxide emissions.**

Keywords— Arduino node mcu (ESP8266),IR Sensor, LDR sensor, bylnk application

I. INTRODUCTION (*HEADING 1*)

Streetlights are an integral part of any developing locality. They are present on all major road-ways and in the suburbs too. Every day, streetlights are powered from sunset to sunrise at full strength, even when there is no one around. On a global scale, millions of dollars are spent each day on these street lights to provide the required electrical energy. This paper gives the best solution for electrical power wastage. Also the manual operation of the lighting system is completely eliminated. The energy consumption in entire world is increasing at the fastest rates due to population growth and economic development and the availability of energy sources remains woefully constrained. We use the word "smart" because the system not only provide power to the street lights but also helps in detecting the direction of movement of the pedestrian and helps him by means of illuminating the path of movement till the near next street light. A simple and effective solution to this would be dimming the lights during off peak hours. Whenever presence is detected, the lights around it will glow at the normal (bright) mode. This would save a lot of energy and also reduce cost of operation of the streetlights. We can check the status of street light on internet using IOT (Internet of things) from anywhere in real time and solve the issues if happen during the processing.

II. EXISTING SYSTEM

The existing systems follow the workings of Street lights in a conserved way to Optimize the service and decrease the operational costs of the infrastructure. Some use lighting with controlled light intensities. A few such papers are:

Intelligent wireless street light control and monitoring system Author: B K. Subramanyaml . K. Bhaskar Reddy, P .Ajay Kumar Reddy.

This paper proposes on intelligent wireless street light control which integrates new technologies, offering ease of maintenance and energy savings. Using solar panel at the lamp post by using LDR it is possible to save some more power and energy, and also we can monitor and control the street lights using GUI application, which shows the status of the lights in street or highway lighting systems.

Design of Wireless Framework for Energy efficient street light Automation Author: P Nithya, K Kayalvizhi

This paper suggested an Intellugent management of the lamp posts by sending data to a central station by ZigBee wireless communication. This streetlight control system helps in energy savings, detection of faulty lights and maintenance time and increase in life span of system.

The project evolution of smart LED street lighting is a cost-effective and sustainable choice for cities today and into the future. Thus we must adapt to our current situation based on the principles' mentioned and promote an effective smart way to coordinate street lights using smart personal devices

III. PROPOSED SYSTEM

In our proposed system, we make use of the property of LDR, which is its resistance varies with respective to the light intensity, In our proposed system the night and day is identified using LDR, Then during the day time the street light will be switched off and then during the night time street light will be switched on automatically, IR sensor is used to detect the presence of vehicle in the Road, If the crowd of the vehicle is low in the street then it will be sensed using IR sensor and light will be switched off, If the vehicle is present in the street then light will be turned on.

A. Functional Description

The present system employs power delivery via a single phase line to the streetlight. The proposed system involves five more components to regulate the power delivery. An Infra-Red Proximity Sensor at the base of the street light detects presence in a small area around the street light. The data from the sensor is sent to the Arduino which forms brain of the circuit. The Arduino then commands to switch between dim and bright modes depending upon the requirement and thus controls the brightness of the street light. A battery eliminator, also powered by the single phase line, is used to supply 5V inputs to the sensors and Arduino.

The design basically includes three working modes:-

- OFF mode : When there is enough natural light in the surrounding i.e. during the daytime, the entire system is switched off and the batteries are charging.
- ACTIVE mode : When the natural light drops below a certain level the system automatically turns on and the motion sensors are powered.
- ON Mode: On the presence of pedestrians, the sensors turns on which in turn switches on the LED lights. These lights turns off after a period of time.

B. Architechture

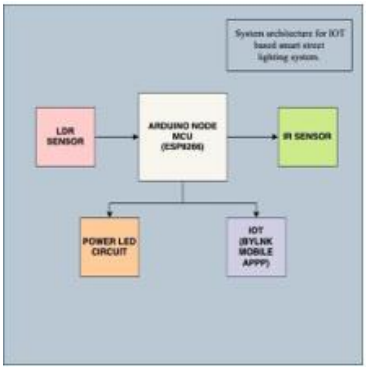

Fig 1.1 system architecture for IOT based smart street lighting system.

This block diagram describes the working of project 'Smart Street light System with IoT'. Through battery we will provide supply to Arduino which is controlling the functioning of LDR and IR sensor as per the presence of vehicle. Then according to the changed occur in IR sensor and LDR the Arduino controls the power LED circuit. The data of Node MCU is now displayed on BLYNK App using IoT. This whole working in details in shown below using flow chart.

C. FLOWCHART

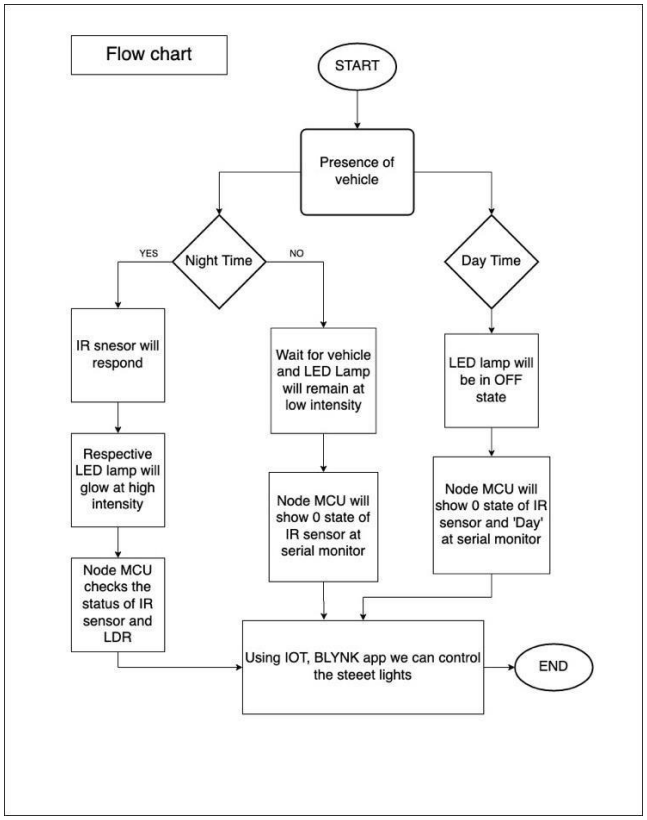

Fig 1.2: Flow chart

D. Hardware Description

a) IR SENSOR

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. It is also capable of measuring heat of an object and detecting motion. Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation is the region having wavelengths longer than visible light wavelengths, but shorter than microwaves. The infrared region is approximately demarcated from 0.75 to 1000µm.

IR (infrared) sensors detect infrared light. The IR light is transformed into an electric current and this is detected by a voltage or amperage detector. A property of light-emitting diodes (LEDs) is that they produce a certain wavelength of light when an electric current is applied but they also produce a current when they are subjected to the same wavelength's light.

b) LIGHT DEPENDENT RESISTOR (LDR)

A LDR or a photo resistor is a device whose resistivity is a function of the incident Electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure below. The arrow indicates light falling on it. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band.

What is light dependent resistor, LDR or photoresistor.

A photoresistor or light dependent resistor is a component that is sensitive to light. When light falls upon it then the resistance changes. Values of the resistance of the LDR may change over many orders of magnitude the value of the resistance falling as the level of light increases.

c) POWER LIGHT EMITTING DIODE (LED)

A high-power LED light source is a single LED power higher than 0.5W. At present, many manufacturers use low power LED, but it need use a lot of LED, and also lower power LED with higher light decay. So its trend to use high power LED source in commercial lighting.

High power LED is a light emitting diode with high rated current. Low LED power is generally 0.1W, operating current is 20mA but high power LED can reach 1W, 2W, or even tens of watts, operating current can be range from tens of mA to several hundred mA.

d) RESISTORS

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor. All other factors being equal, in a direct-current (DC) circuit, the current through a resistor is inversely proportional to its resistance, and directly proportional to the voltage across it. This is the well-known Ohm's Law.

The wire is wound into a coil, the component acts as an inductors as well as exhibiting resistance This does not affect performance in DC circuits, but can have an adverse effect in AC circuits because inductance renders the device sensitive to changes infrequency.

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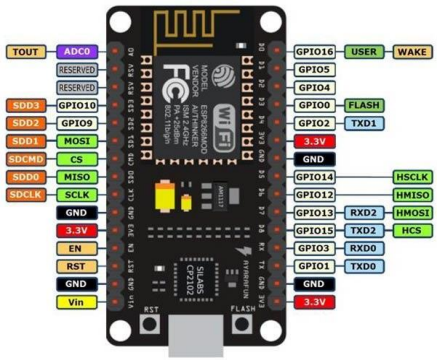
e) CAPACITORS

Capacitor is a passive component used to store charge. The charge (q) stored in a capacitor is the product of its capacitance (C) value and the voltage (V) applied to it. Capacitors offer infinite reactance to zero frequency so they are used for blocking DC components or bypassing the AC signals. The capacitor undergoes through a recursive cycle of charging and discharging in AC circuits where the voltage and current across it depends on the RC time constant.

f) ARDUINO NODE MCU(ESP8266)

Node MCU is an open source IoT platform.It includes firmware which runs on the ESP8266Wi-FiSoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS-SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.



- NodeMCU Development Board Pinout Configuration

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	**EN, RST**	The pin and the button resets the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Programming NodeMCU ESP8266 with Arduino IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this Getting Started Tutorial for NodeMCU to prepare your Arduino IDE for NodeMCU.

D. IoT (Internet of Things)

BLYNK MOBLIE APPLICATION:

Blynk is a Platform with iOS and Android apps to control Arduino Mode MCU(ESP8266) Mode MCU(ESP8266), Raspberry Pi and the likes over the Internet.It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets.

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It’s open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

- Working

  There are three major components in the platform:

Blynk App - allows to you create amazing interfaces for your projects using various widgets we provide.
Blynk Server - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

- Feature
  *Supports majority of development boards like Arduino, RPI, esp8266
  * Easy to use
  *Awesome widgets like LCD, push buttons, labelled value, graphs
  * Not restricted to local Wifi network
  *Direct pin manipulation with no code writing
  *Easy to integrate and add new functionality using virtual pins

IV. IMPLEMENTATION

All the components are to be connected with Arduino board. In this input module of the project, we used 3 IR sensors which are interfaced with Arduino Mode MCU(ESP8266) and work individually with respective to each other. In this we are connecting the output pins of IR sensor to pins D0,D1,D2 of Arduino Mode MCU(ESP8266) to give status of IR sensor.IR sensor senses the presence of a vehicle or a pedestrian on the road and switches the LED street lamps on the road through output module.

All IR sensor works on 5V and Arduino Mode MCU(ESP8266) is working on less than 5V supply (Battery or Laptop USB driver).two virtual switches are connected to arduino mode mcu though blynk application.

V. APPLICATIONS

It can be used in some clocks, alarms, and other electronic devices that are dependent on sunlight.
• We can used it outside of house, corridors or industry area, which helps to save power.
•It can be used as a street light.
•In sea off-shore side we can use it as a dangerous sign.
•Photo resistors have many uses, most of which involve detecting the presence of light. Street lights use photo resistors to detect whether it is day or night and turn the light on or off accordingly.
•Photo resistors are also used in digital cameras to detect how much light camera sees and adjust the picture quality accordingly.
•Smoke detection.
•Automatic lighting control.
•Burglar alarm systems.
•Camera (electronic shutter).
•Strobe (color temperature reading).

VI. ADVANTAGES

Solar street light is independent of grid as a result of this operating cost is much low.

•Maintenance cost is much low compared to conventional street light.
•Intensity of LED can be controlled effectively without changes in its light color.
•Risk of accidents is very low.
•It is environmental friendly, no harmful emissions.
•Longer life compared to conventional street lights.
•Power consumption is much lower.
•LDRs are sensitive, inexpensive and readily available devices. They have good power and voltage handling capabilities, similar to those of a conventional resistor.
•They are small enough to fit into virtually any electronic device and used all around the world as a basis component in many electrical systems.
•Photo resistors convert light into electricity and are not dependent on any other force.
•Photo resistors are simply designed and are made from materials that are widely available, allowing hundreds of thousands of units to be produced each year.
•A LDR may be connected either way round and no special precautions are required when soldering.

VII. LIMITATIONS

Initial investment is very high.
•Rechargeable batteries have to be replaced from time to time.
•Non-availability of sunlight during rainy and winter seasons is a problem.
•Dust accumulation on the surface of panel creates a problem.
•It is sensitive to ambient light and require careful shielding.
•Can be more complicated to align detector pairs.
•Photo resistors are only sensitive to light and no other force can power it without risking damage.
•Also, they are unable to detect low light levels and may take a few seconds to deliver a charge while their electrons build up momentum.

VII. CODE

```
#define BLYNK_PRINT Serial


#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
char auth[] = "RUx84PDPcHq1x-_qPS0wFaEHQJc03ZvY";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "AndroidAP14F2";
char pass[] = "mgez5696";
int ledPin = D3;
int ledPin1 = D4;
int ledPin2 = D5;// choose pin for the LED
int inputPin = D0;
int inputPin1 = D1;
int inputPin2 = D2;
int light1 = D6;
int light2 = D7;
int light3 = D8;
int val = 0;
int val1 = 0;
int val2 =0;
int val3 =0;
int val4 =0;
int val5 =0;
int val6 =0;
int ldr = A0;
```

```
void setup()
{
 // Debug console
  Serial.begin(9600);
  pinMode(ledPin, OUTPUT); // declare LED as output
  pinMode(ledPin1, OUTPUT);
  pinMode(ledPin2, OUTPUT);
  pinMode(inputPin, INPUT);
  pinMode(inputPin1, INPUT);
  pinMode(inputPin2, INPUT);
  pinMode(light1,INPUT);
  pinMode(light2,INPUT);
  pinMode(light3,INPUT);
  pinMode(ldr, INPUT);// declare Infrared sensor as input*/
  delay(10);
 Blynk.begin(auth, ssid, pass);
}
 void loop() {
  Blynk.run();
  val3 = analogRead(ldr);
  Serial.println(val3);
  val = digitalRead(inputPin);
  val1= digitalRead(inputPin1);
  val2= digitalRead(inputPin2);
  val4= digitalRead(light1);
  val5= digitalRead(light2);
  val6= digitalRead(light3);

  if (val3 >500)  {
   if (val == HIGH ) {
     digitalWrite(ledPin, LOW);    }
   else    {
     digitalWrite(ledPin, HIGH);
     delay(500);    }
     if (val4 == HIGH )   {
     digitalWrite(ledPin, HIGH);    }


  if (val1 == HIGH) {
     digitalWrite(ledPin1, LOW);    }
  else    {
     digitalWrite(ledPin1, HIGH);
     delay(500);
  }

  if (val5 == HIGH ) {
     digitalWrite(ledPin1, HIGH);    }

  if (val2 == HIGH) {
     digitalWrite(ledPin2, LOW);    }
  else    {
     digitalWrite(ledPin2, HIGH);
     delay(500);
  }

  if (val6 == HIGH )   {
     digitalWrite(ledPin2, HIGH);    }  }

   if (val3 <500)  {
  digitalWrite(ledPin, LOW);
  digitalWrite(ledPin1, LOW);
  digitalWrite(ledPin2, LOW);

  }}
```

VIII. ESTIMATION

Country	Number of street lights	Energy consumed by conventional street lighting(W/h)	Energy consumed by smart street lighting(W/h)
US	26 million	65 million	39 million
UK	5.5 million	13.75 million	8.25 million
France	6 million	15 million	9 million
Malaysia	2 million	5 million	3 million
European Union	40 million	100 million	60 million

To infer from the table above, take estimates of Malaysia as an example. The estimations show that Malaysia has about 2millions conventional HPS lamps in the streets and each lamp consumes 2.5 W/hr. Hence, the country will be consuming about 5000KW/h, which is 60000KW per day if we take that the lamp lights up for the whole 12hrs duration of the night. Roughly the country would be consuming 21.8MW a year.

On the contrary, if we take the smart street lighting system with LED lamps deployed at the same scale of 2million lamps in the streets. I will consume 1.5w/h, hence the whole country will consume around 3000KW/h which is around 18000KW a day if we take the implemented smart lighting to work for (6-7hrs a day). This would bring down the energy consumption to 6.57MW a year. Hence, the smart street lighting is 70% more energy conservative and energy saving. In addition, the smart street light is utilizing a LEDs street light which consumes small portion of energy as well as last long period almost 50000 hours which is equal to almost 5 years servicing.

IX. RESULT

The project aims were to reduce the side effects of the current lighting system and find a solution to save power. In this project the first thing to do is to prepare the inputs and outputs of the system to control the lights. The project shown in the figure has been implemented and works as expected and will prove to be very useful.

X. CONCLUSION

The use of power electronics is increasing exponentially across various sectors of human life. The components used in the project, like Arduino Mode mcu and sensors are slowly becoming an indispensable part of our daily routines. So, it is only fitting that we use them to improve efficiency in every walk of life. Keeping in mind the urgent need for energy conservation, IoT based smart street lighting system is an excellent and effective solution. It combines safe lighting protocols with consumption of minimal amount of power. The energy savings, as discussed before are phenomenal. The future scope of this project expands into speed detection and customizable area of illumination. The use of LED leads to better functioning of the concept.

Despite their high initial costs, they are a viable option as they drastically reduce the power consumption. They will aid in further saving of energy and reduction in operational costs.

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We thank our parents, family, and friends for bearing with us throughout the course of our project and for the opportunity they provided us in undergoing this course in such a prestigious institution.

REFERENCES

[1] Intelligent wireless street light control and monitoring systemAuthor -B. K. Subramanyaml . K. Bhaskar Reddy, P. Ajay Kumar Reddy.

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[3] Subhas Chandra Mukhopadhyay, Fellow, "Wearable Sensors for Human Activity Monitoring: A Review" IEEE Sensors journal, vol. 15, no. 3, march 2015 1321.

[4] Matthew Kane, Amy kesluk, Edward Teawetal., "A Wireless Health Monitoring System," in Proc. IEEE, 2005.

[5] Takuji Suzuki, Hirokazu Tanaka, Shigenobu Minami etal., "Wearable Wireless Vital Monitoring Technology for Smart Health Care." 7th International Symposium on Medical Information and Communication Technology (2013).

[6] J. Edwards, "Wireless sensors relay medical insight to patients and caregivers [special reports]," IEEE Signal Process. Mag., vol. 29, no. 3, pp. 8–12, May 2012.

[7] K. Malhi, S. C. Mukhopadhyay, J. Schnepper, M. Haefke, and H. Ewald, "A Zigbee-based wearable physiological parameters monitoring system," IEEE Sensors J., vol. 12, no. 3, pp. 423–430, Mar. 2012.

[8] P. A. Shaltis, A. T. Reisner, and H. H. Asada, "Cuffless blood pressure monitoring using hydrostatic pressure changes," IEEETrans. Biomed. Eng., vol. 55, no. 6, pp. 1775–1777, Jun. 2008.

[9] M.-Z. Poh, K. Kim, A. Goessling, N. Swenson, and R. Picard, "Cardiovascular monitoring using earphones and a mobile device," IEEE Pervasive Comput., vol. 11, no. 4, pp. 18–26, Oct./Dec. 2019. [10]