NATIONAL HIGHWAY STREET LIGHT FAULTY DETECTION & MONITORING SYSTEM

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Abstract

Street Light Faulty Detection and Monitoring System is a simple yet powerful energy efficient concept. By using this system manual on-site works are 100% removed and can be controlled from anywhere through internet(IoT) and it can be operated using 2 modes. In one mode, it automatically switches ON power supply given to lights when the sunlight goes in-visible to our eyes. This is done by a sensor called Light Dependent Resistor (LDR) which senses the light actually like our eyes. It automatically switches OFF power supply given to lights whenever the sunlight comes visible to our eyes. In another mode, it automatically switch ON the lights, only when the motion is detected. If there is no motion, lights automatically switches OFF. This is done by using IR sensors. We can monitor the working of lights from anywhere through internet (IoT). If there is any fault in lights, we can take necessary action fastly and easily.

Keywords: Light Dependent Resistor (LDR), IR sensors, IoT.

1. INTRODUCTION

Due to the increase of environmental concern, Street lighting control systems will play an important role in the reduction of energy consumption of the street lighting without impeding comfort goals. As mentioned the energy is the single most important parameter to consider when assessing the impacts of technical systems on the environment. Energy related emissions are responsible for approximately 80% of air emissions and central to the most serious global environmental impacts and hazards, including climate change, acid deposition, smog and particulates. Street lighting is often the largest electrical load in offices, but the cost of energy consumption is low when compared to the personnel costs. Thus, its energy saving potential is often neglected. According to study global grid-based electricity consumption for street lighting was about 2650 TW in 2017, which was an equivalent of 19% of total global electricity consumption. European office buildings dedicate about 50% of their electricity for street lighting, whereas the share of electricity for street lighting is around 20-30% in hospitals, 15% in factories, 10-15% in schools and 10% in residential buildings. Intelligent street lighting control and energy management system is a perfect solution for energy saving, especially in public street lighting management. It realizes remote on/off and dimming of lights, which can save energy by 40%, save lights maintenance costs by 50%, and prolong lamp life by 25%. The system application in streetlight control for each lamp will reduce in streetlight electricity and maintenance cost and increase availabilityof street light.

The system compromises of cloud server, cloud GUI App to display and nodes which are micro controlled and processed with embedded sensors measuring different parameters. Each node in the network is linked to the main server via Wi-Fi protocols. The analog data sensed by the sensor is converted in digital form, processed by microcontroller and then sent to the server. This scenario increases life of streetlights, reduces power consumption, ease of monitoring and controlling and less installation cost are the various advantages achieved.

Due to light emitting diode (LED) with better performances, the demand for developing LED street lighting is growing continuously. Nowadays, a topic of interest in this context is the search for electronic driver in order to take advantage of LED performances. This work focuses in saving potential pitfalls during intelligent driver design procedure.

In this system, we have applied Wi-Fi to intelligent street lighting system. As a result of such a combination one obtains a system designed to increase functionality of light installations for a wide range of applications and introduce a platform for new additional services, which meets current and future user needs. The system is composed of Wi-Fi nodes integrated with light sources based on high power LED diodes.

2. LITERATURE REVIEW

An important component of power consumption worldwide is street lighting. India is no different. Global trends in street lighting show that 18-38% of the total energy bill goes towards street lighting and therefore this is one domain that needs major attention if we look at improving efficiency of power consumption with an objective of saving energy.

As on 31 Dec 2014, as per CEA, Ministry of Power, India has a total installed capacity of generating 255681.46 MW. Of this,

TABLE 1

Coal based units generate	154170.89 MW
Gas based units generate	22971.25 MW
Diesel	1199.75 MW
Nuclear	4780 MW
Hydro	40867.43 MW
Renewable energy	31692.14 MW

The sector-wise share of installed capacity is: State owned units – 37%, Private units -36% and Central units – 27%.[11]

Poor Condition of Street Lighting

In most cities, the street lights are installed and maintained by municipalities. Most urban and semi-urban cities and towns are still using a combination of fluorescent, CFL, high pressure sodium lamps or metal halide bulbs, which are not designed to meet area-wise lighting needs. Very little study or planning has gone into the illuminance required in different areas of streets, to address the needs of pedestrians and vehicular traffic alike. For instance, the lighting needs of vehicular traffic in high speed zones are different from low-speed high traffic zones. Likewise, lighting needs in road crossings are different from secondary roads. Then again, the lighting requirements of an area with vehicular traffic will vary from that of an area with high pedestrian traffic.

A one-size-fits-all approach to street lighting results in inefficient deployment of power resources and ends up in wasteful use of electricity that could have been better utilized elsewhere. Street light planning is not just about luminosity but also the 'height' of the lighting mast, which in turn varies based on the requirements of that particular area. Due to a lack of 'area-wise' study, standard tenders are issued on a 'city-wise' basis, leading to high operational cost incurred on street lighting. Very often, one notices that the street lights stay on well past sunrise. This is because the lights are switched off based on a predecided time rather than lighting needs, which vary based on season and location of the city. There is a need for devising a well thought out way to prevent wastage of electricity. Perhaps, the government can think of implementing Automatic Street Light Control System using LDR (Light Dependent Resistor), which automatically switches off lights when sunlight fall on it.

Poor maintenance of street lights is another problem faced by most citizens, leaving large areas without adequate lighting. The municipalities are hard pressed for funds and it is the citizens who have to face the brunt..[11]

3. METHODOLOGY

In the development of this project proto type, IR sensors used for detection of presence of vehicles on the highway. IR sensed data is sent to NodeMCU, where decision is taken based on program uploaded in flash memory. If presence is detected then street lights for up to hundred meters will get switched on and then will be kept one for few seconds. Now as the second IR sensor detects the presence of vehicles then street lights for another 100 meters gets on and previous hundred-meter lights will get off.

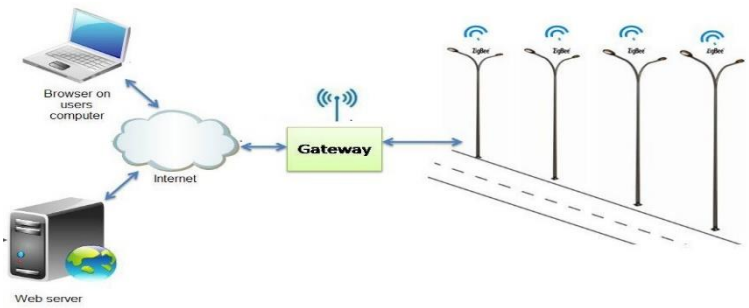

Figure 1. Project Methodology

The important feature that has been added in this project is Internet of Things technology. Here Blynk Cloud and

Blynk android app has been used for monitoring and storage of data on cloud for analysis purpose. Status of street light will be store to cloud data base through Wi-Fi and same data will be appear on Blynk app. It is very helpful for supervisors and technician for getting status of faulty street light and attending it immediately.

LDR sensors are attached to each street light for knowing its functioning status. If any street light is not functioning then its corresponding LDR sends the LOW signal to local NodeMCU controller and it send this information to cloud and the cloud send this information to peered smart phone through authentication key.

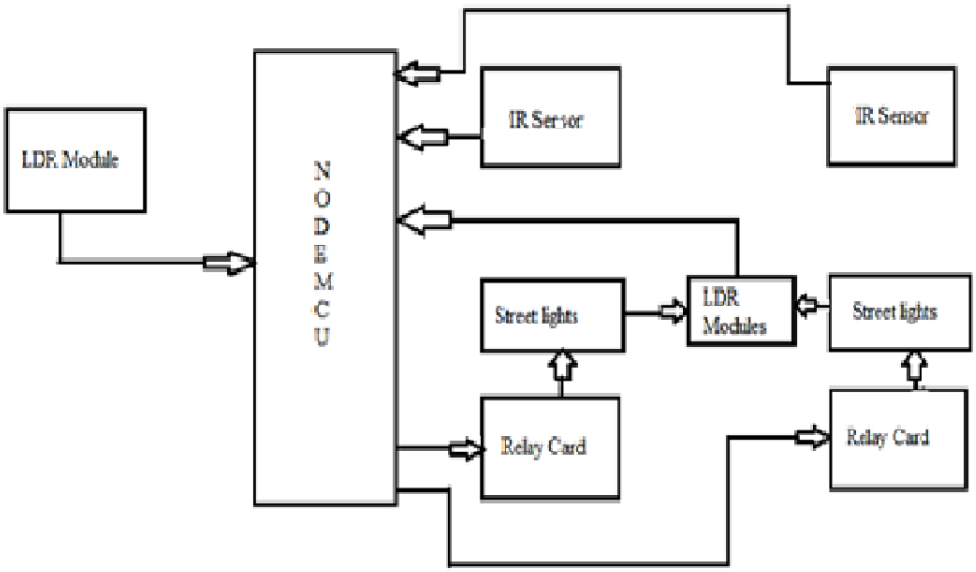

Figure 2. Block Diagram of Implementation

4. WORKING PRINCIPLE

In this Design, Master LDR sensor is used to sense the environment light status if environment light is low then LDR generates the high pulse to NodeMCU and Street light system become active and it will enter into the sensing of presence of vehicle on the road. If vehicle is detected then NodeMCU trigger the relay and it will switch on the AC supply to street lights and street lights gets on. When vehicle comes under detection of another IR sensor then second relay gets triggered by the NodeMCU further lights gets on.

In this project, a status checking LDR sensor is embedded in each street light if any particular street light is not working then corresponding status sensor will send the faulty Light status information to centralized monitoring system and App through cloud server. Faulty sensor sends status information to Wi-Fi node that is connected to local Wi-Fi network and this network takes the information to cloud network. The cloud network sends the information to peered device that are being used for monitoring purpose and it could be Computer or Smartphone.

Another feature of this implemented system is controlling through cloud and Wi-Fi. This feature is provided by cloud developer means in some situation master environmental light status sensor does not work then technician or supervisor can off the environment light measuring sensor through Blynk app that is installed either android or iOS based smart phone.

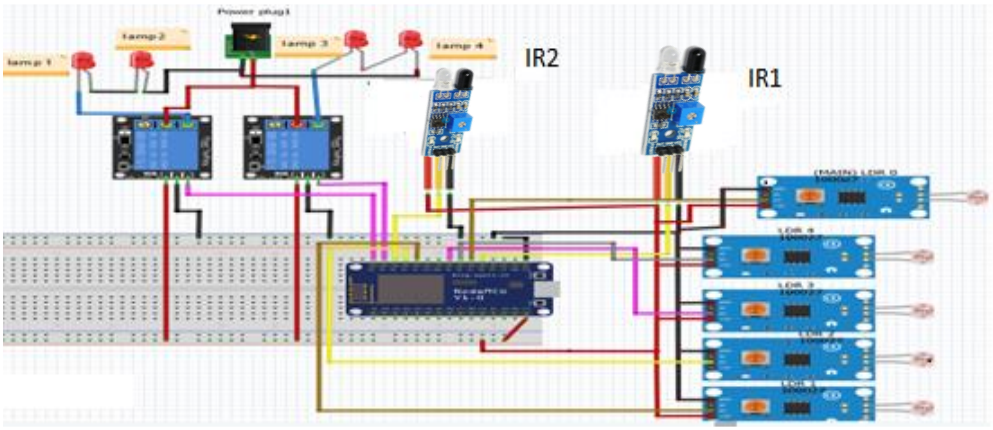

Figure 3. Wiring diagram of project

Another feature of this implemented system is controlling through cloud and Wi-Fi. This feature is provided by cloud developer means in some situation master environmental light status sensor does not work then technician or supervisor can off the environment light measuring sensor through Blynk app that is installed either android or iOS based smart phone.

The important feature that is provided by the system are

- Remote on/off,
- System Fault Detection
- 24-hours online Monitoring.
- Reduce energy use by up to 40%.
- Reduce maintenance by up to 50%.
- Increase bulb life by up to 25%.

This system allows the service and maintenance information to reach to all concerned higher authorities. False reporting by the technician and engineers will be caught and it will help to reduce the corruption in false purchasing and servicing.

5. REQUIREMENTS OF THE PROJECT

The following have been used in implementation of this project

- NodeMCU
- LDR module
- IR Sensor
- Relay cards
- LED's
- Blynk Cloud Server
- Blynk Android App

5.1 LDR Module

LDR sensor module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labeled as AO and DO respectively on the board. When there is light, the resistance of LDR will become low according to the intensity of light and greater the intensity of light, the lower the resistance of LDR. The sensor has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards light.

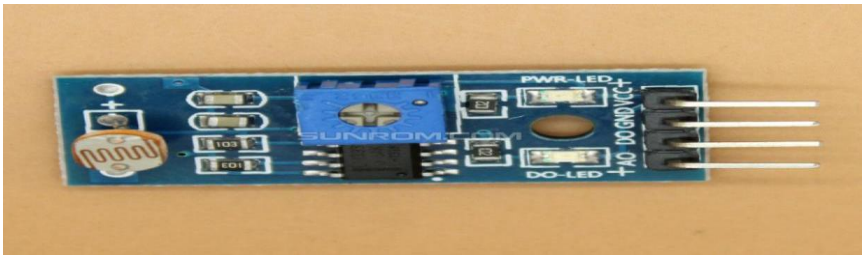

Figure 4. LDR Module

Specifications

- Operating Voltage: 3.3V to 5V DC
- Operating Current: 15ma
- Output Digital - 0V to 5V, Adjustable trigger level from preset
- Output Analog - 0V to 5V based on light falling on the LDR
- LEDs indicating output and power
- PCB Size: 3.2cm x 1.4cm
- LM393 based design

Direction for Using LDR Module

- Photosensitive resistor module most sensitive to environmental light intensity is generally used to detect the ambient brightness and light intensity.
- Module light conditions or light intensity reach the set threshold, DO port output high, when the external ambient light intensity exceeds a set threshold, the module D0 output low;
- Digital output D0 directly connected to the MCU, and detect high or low TTL, thereby detecting ambient light intensity changes;
- Digital output module DO can directly drive the relay module, which can be composed of a photoelectric switch;
- Analog output module AO and AD modules can be connected through the AD converter, you can get a more accurate light intensity.

5.2 IR SENSOR

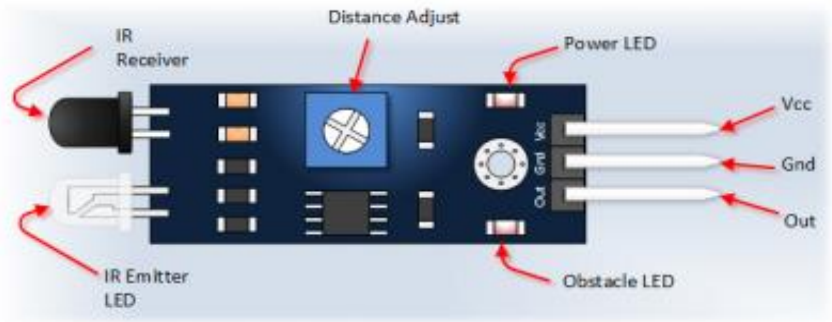

Figure 5. IR Sensor

Specifications

- Operating Voltage: **3.0V – 5.0V**
- Detection range: **2cm – 30cm (Adjustable using potentiometer)**

- Current Consumption: **at 3.3V : ~23 mA**, **at 5.0V: ~43 mA**
- Active output level: **Outputs Low logic level when obstacle is detected**
- On board Obstacle Detection LED indicator

An IR sensor consists of an IR LED and an IR Photodiode; together they are called as Photo–Coupler or Opto–Coupler. As said before, the Infrared Obstacle Sensor has built in IR transmitter and IR receiver. **Infrared Transmitter** is a light emitting diode (LED) which emits infrared radiations. Hence, they are called IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye. **Infrared receivers** are also called as infrared sensors as they detect the radiation from an IR transmitter. IR receivers come in the form of photodiodes and phototransistors. Infrared Photodiodes are different from normal photo diodes as they detect only infrared radiation. When the IR transmitter emits radiation, it reaches the object and some of the radiation reflects back to the IR receiver. Based on the intensity of the reception by the IR receiver, the output of the sensor is defined.

5.3 RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

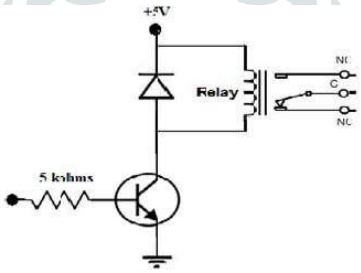

Figure 6. Relay Circuit

When electrical relays used to allow low power electronic computer type circuits to switch relatively high voltage and current both on and off some form of relay switching circuitry is required to control it. In this project we used NPN relay switch circuit.

The relay coil is not only an electromagnetic but also an inductor. When power is applied to coil due to the switching action of transistor, a maximum current will flow as a result of DC resistor coil. Some of this energy is stored within the relay coil's magnetic field. When transistor turns off, the current flowing through relay coil decreases and magnetic field collapses. However stored energy within magnetic field has to go somewhere and reverses voltage is developed across the coil as it tries to maintain the current in the relay coil.

This action produces a high voltage spikes across the relay coil that can damage the switching NPN transistor (BC 548). So, in order to prevent damage to transistor a fly wheeling diode is connected across the relay coil. This diode clamps the reverse voltage across the coil about 0.7V dispatching the stored energy and prevents the transistor.

5.4 CUSTOMER CLOUD ARCHITECTURE FOR INTERNET OF THINGS

The Internet of Things (IoT) is one of the most exciting and most dynamic areas of IT at the present time. IoT involves the linking of physical entities ("things") with IT systems that derive information about or from those things which can be used to drive a wide variety of applications and services which may be directly or indirectly connected or related to those things. IoT covers a very wide spectrum of applications, spanning enterprises, governments and consumers and represents the integration of systems from traditionally different communities: Information Technology

and Operational Technology. As a result, it is important for IoT systems to have architectures, systems principles, and operations that can accommodate the interesting scale, safety, reliability, and privacy requirements.
Some examples of the application of IoT include:

- Logistics applications, fleet telemetry and supply chain management; the tracking of physical objects such as packages and containers
- Manufacturing and Industrial applications, involving control and operation of industrial equipment and smart production lines
- Asset management and smart shelving. Connected storage and vending devices.
- Building automation or "smart buildings" where monitoring and control systems are applied to all the systems within a building, facilitating smooth operation of the building and the proactive management and maintenance of the equipment and facilities
- Intelligent transportation systems in particular the management of road and rail transport
- Connected vehicles, involving such capabilities as information feeds to drivers about road status or the use of "black boxes" which assess insurance risks/premiums dynamically
- Smart cities, where monitoring and control of city-wide systems are handled automatically for greater efficiency and to serve citizens better
- Smart grid systems, involving instrumenting the electrical grid at all scales for better management and maintenance of equipment, for optimizing the use of power in the grid and dealing with intermittent power sources such as wind
- Consumer applications, typically based on the use of smart phones and wearable
- Medical applications, such as remote monitoring and treatment of patients
- Retail and "intelligent shopping" – making use of information about the consumer to make offers and to direct the consumer to items of interest
- The smart home – autonomous management of domestic premises, including control of heating systems, the operation of consumer appliances and extending to automation of maintenance and ordering of consumables (food, etc.)

5.5 NodeMCU

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. The ESP8266, designed and manufactured by Espressif Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK. When purchased at bulk, the ESP8266 chip costs only $2 USD a piece. That makes it an excellent choice for IoT projects of all kinds.
However, as a chip, the ESP8266 is also hard to access and use. You have to solder wires, with the appropriate analog voltage, to its PINs for the simplest tasks such as powering it on or sending a keystroke to the "computer" on the chip. And, you have to program it in low-level machine instructions that can be interpreted by the chip hardware. While this level of integration is not a problem when the ESP8266 is used as an embedded controller chip in mass-produced electronics, it is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.
Borrowing a page from the successful playbooks of Arduino or a Raspberry Pi, the NodeMCU project aims to simplify ESP8266 development. It has two key components.

- An open source ESP8266 firmware that is built on top of the chip manufacturer's proprietary SDK. The firmware provides a simple programming environment based on eLua (embedded Lua), which is a very simple and fast scripting language with an established developer community. For new comers, the Lua scripting language is easy to learn.
- A DEVKIT board that incorporates the ESP8266 chip on a standard circuit board. The board has a built-in USB port that is already wired up with the chip, a hardware reset button, Wi-Fi antenna, LED lights, and standard-sized GPIO (General Purpose Input Output) pins that can plug into a bread board. Figure 12 shows the DEVKIT board, and the schema of its pins.

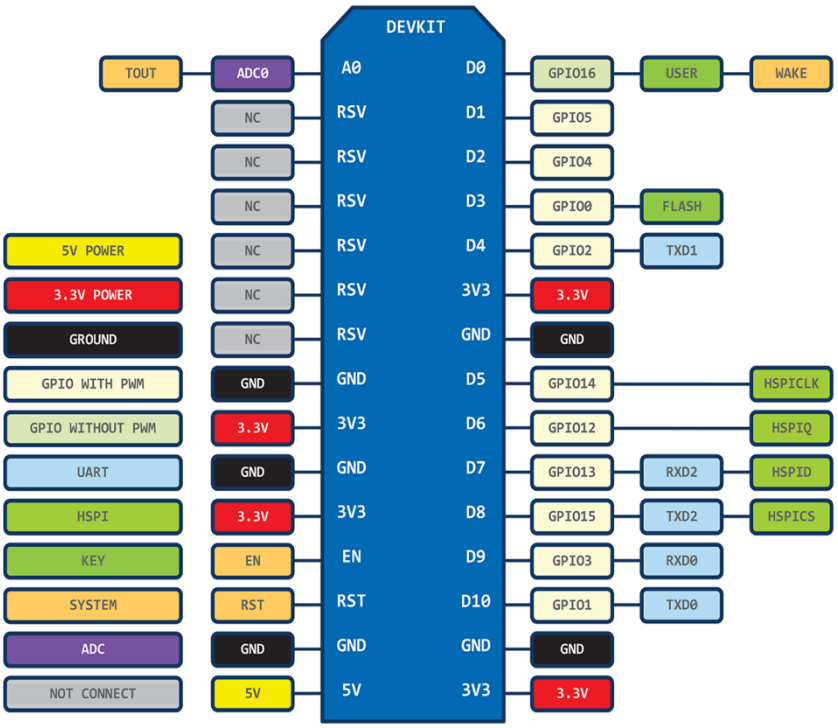

Figure 7. NodeMCU Pin Details

The NodeMCU DEVKIT board that comes preloaded with the firmware can be purchased for $8 USD a piece, which makes it a very economical device for prototyping and even for production use.

But, what about Arduino, you ask? The Arduino project creates an open source hardware design and software SDK for a versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a ready USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. In fact, there is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have Wi-Fi capabilities and some even have a serial data port instead of a USB port.

NodeMCU Specifications

- Voltage:3.3V.
- Wi-Fi Direct (P2P), soft-AP.
- Current consumption: 10uA~170mA.
- Flash memory attachable: 16MB max (512K normal).
- Integrated TCP/IP protocol stack.
- Processor: Tensilica L106 32-bit.
- Processor speed: 80~160MHz.
- RAM: 32K + 80K.
- GPIOs: 17 (multiplexed with other functions).
- Analog to Digital: 1 input with 1024 step resolution.
- +19.5dBm output power in 802.11b mode
- 802.11 support: b/g/n.
- Maximum concurrent TCP connections: 5.

The most basic way to use the ESP8266 module is to use serial commands, as the chip is basically a Wi-Fi/Serial transceiver. However, this is not convenient. What we recommend is using the very cool Arduino ESP8266 project, which is a modified version of the Arduino IDE that you need to install on your computer. This makes it very convenient to use the ESP8266 chip as we will be using the well-known Arduino IDE. Following the below step to

install ESP8266 library to work in Arduino IDE environment.

5.6 BLYNK APP

Allows to you create amazing interfaces for your projects using various widgets we provide.

6. CONCLUSION

This project **NATIONAL HIGHWAY STREET LIGHT FAULTY DETECTION & MONITORING SYSTEM** is a cost effective, practical, ecofriendly and the safest way to save energy. It clearly tackles the two problems that world is facing today, saving of energy and also disposal of incandescent lamps, very efficiently. According to statistical data we can save more that 40 % of electrical energy that is now consumed by the highways. Initial cost and maintenance can be the draw backs of this project. With the advances in technology and good resource planning the cost of the project can be cut down and also with the use of good equipment the maintenance can also be reduced in terms of periodic checks. The LEDs have long life, emit cool light, donor have any toxic material and can be used for fast switching. For these reasons our project presents far more advantages which can over shadow the present limitations. Keeping in view the long-term benefits and the initial cost would never be a problem as the investment return time is very less. The project has scope in various other applications like for providing lighting in industries, campuses and parking lots of huge shopping malls. This can also be used for surveillance in corporate campuses and industries.

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