# IoT Based Smart Street Lighting System

Prashanth. S U
Electronics and CommunicationEngineering
St.Joseph's Institute of Technology
Chennai, India

Rakshanraj. J
Electronics and CommunicationEngineering
St.Joseph's Institute of Technology
Chennai, India

Mrs. A. Maria Chirstina Blessy,M.E., (Ph.D.)
Electronics and CommunicationEngineering
St.Joseph's Institute of Technology
Chennai, India

***Abstract*—The energy demand is increased day by day. To consume energy in an efficient way is very important. Increasing economic growth and consumption patterns are leading to ever growing demand for energy. It could very well be a totally different energy source that has a greatest impact on certain process. The system aims to develop a system (EMS) based on emerging technology, IoT. In this proposed system, here each electric appliance is connected to the center server. The center server controls all other nodes connected to it based on the current and voltage value measured. The real time clock is used to control the usage of energy in time based. Once the primary source (renewable source-solar energy) is failed ac supply is switched over.**

## 1. INTRODUCTION

When there are people or cars surrounding the post when it is dark, the proposed system uses an energy-efficient approach that controls the lighting by automatically switching them on. The smart street lighting system is extremely adaptable, and it is made up of a variety of sensors and a controller that work together to create an intelligent street lighting system. As a result, it eliminates the drawbacks of traditional street lighting.

Through intelligent on/off mechanisms, targeted progressive dimming, and a structured style of power use, energy expenditures can be reduced by up to 35% right away. By doing routine maintenance, we can save up to 42% on overall consumption expenditures.

Even while installing an IoT-based system across all lamp posts is pricey, the paybacks are often unclear, and they must be fully defined. Therefore, an IoT augmented Lamp Post is highly necessary in municipalities, townships, and cities for the development of Smart cities. The main aim of this project is that it saves energy by increasing the intensity of the lights only when the system detects movement of an object. The system increases the intensity of the streetlight ahead of the movement of an object and decreases the intensity of trailing lights simultaneously. To detect movement of an object, sensors are used. The proposed system can work better than the existing system where the streetlights are kept on throughout the night which helps in saving lot of electricity.

### 1.1. EXISTING SYSTEM

*EB controlled streetlight*

The engineer of the Electricity Board (EB) has responsibility over various areas' streetlights. If there is an overload, the link is severed, and the data is sent to EB via

the Global System for Mobile Communication (GSM). In the event of a jumper detachment (EB line), the information is also sent. In this existing system, lights are switched on manually every day, intensity of the light cannot be controlled, and electricity consumption cannot be reduced.

Since the lights are in maximum intensity for the whole night more electricity is consumed.

*Automatic streetlight using LDR*

When the sun dips below the viewable region of human eyes, it automatically turns on the lights. (For example, in the evening after Sunset). It uses a sensor called LDR (Light Dependent Resistor) that perceives light similarly to our eyes to automatically turn off lights when sunlight fall on it (i.e. on LDR) e.g. in the morning.

In this existing system, the switching of lights is automatic, but intensity of the light cannot be controlled, and electricity consumption cannot be reduced.

## 2. PROPOSED SYSTEM

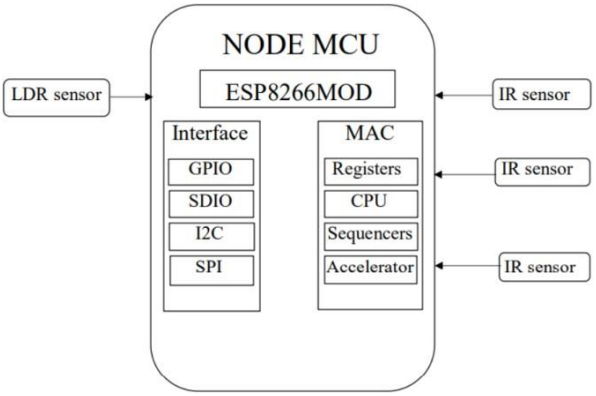


Fig 1. Block diagram of the proposed system

In the proposed system, switching of lights is automatic, intensity of the light can be controlled, and electricity consumption can be reduced. Intensity of the lights can be controlled when there is less traffic in a particular area.

*A. Lamp unit*

It is made up of a power-adjustable LED array, a brightness sensor, a motion sensor, and a communication device like a controller as shown in the [Fig.1].

When a motion is detected in the defined region by the

sensors, including its own sensor, the intensity of the lights increases for many minutes.
The message is then sent to other units. It lowers the intensity if no motion is detected in the defined area.

*B. Sensor Unit*

It is made up of three parts: a motion sensor, a communication device, and a controller. Under the condition that motion is detected, it delivers the message to other units. This item is installed in a variety of settings, including electric poles, house gates, house fences, and inside or outside of doors, to ensure that all streetlights are turned on before passersby notice.
In terms of power supply, a solar battery may be a viable choice.

*C. Microcontroller Unit*

The microcontroller is configured to monitor the LDR sensor, and the intensity of the sunlight is recorded in the microcontroller using this sensor, and the lights are turned on as needed. During the night, the lights' intensity is low, but when the IR sensor detects any activity close, the intensity of the lights is boosted. The traffic in the region can be read using an IoT device, and lamps can be configured to stay on high intensity till there is a lot of traffic in that area.

## 3. WORKING SYSTEM

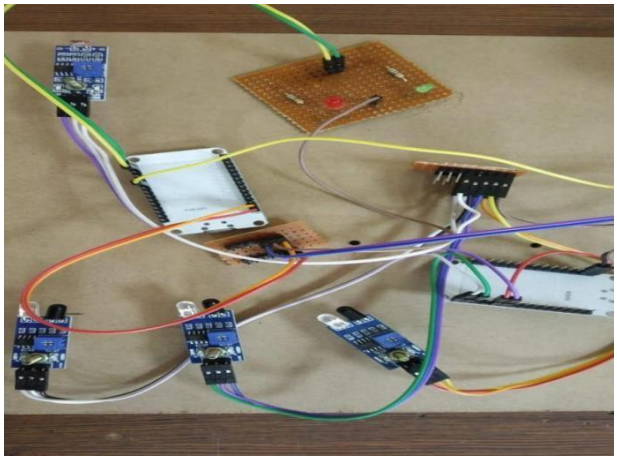

Fig 2. The hardware setup

The above diagram [Fig 2]. shows the hardware setup of the proposed work. First, the LDR sensor detects a decrease in sunlight intensity and activates the entire system. In the morning, when the intensity of the sunlight increases, the LDR sensor detects this and turns off the entire system. When the system is turned on in the evening, the light intensity is normally low because there is no traffic, but when a person or a vehicle approaches the IR sensor, the system immediately identifies it and increases the light intensity. As soon as the vehicle travels away from the sensor, the intensity of the taillight is reduced.

And using the ESP8266 Module the traffic in the area can be saved regularly and the system can use this data to stay
at high intensity during those times. Both manually and automatically, the Smart System can be used. The control system automatically turns the streetlights on and off at the right times, changing the intensity as needed.

### 3.1 HARDWARE REQUIREMENTS

#### 3.1.1. NODEMCU

A GPIO (general-purpose input/output) as shown in [Fig 3]. pin is a pin on an integrated circuit. It can be an input pin or an output pin, and its behaviour can be changed at runtime.

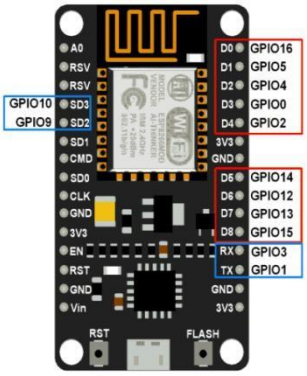


Fig 3. NODE MCU GPIO

#### 3.1.2ESP8266

The ESP8266 as shown in [Fig 4]. is a low-cost and user-friendly gadget for providing internet access to your projects. Because the module can function as both a hotspot and a station (connecting to Wi-Fi), it can quickly retrieve data and publish it to the internet, making Internet of Things as simple as feasible. It can also use APIs to retrieve data from the internet, allowing your project to access any information that is available on the internet, making it smarter. There are numerous ways and IDEs for working with ESP modules, but the Arduino IDE is by far the most popular. The ESP8266 module only works with 3.3V, and anything more than 3.7V will destroy it, so be careful with your circuits. The FTDI board that supports 3.3V programming is the best approach to programme an ESP-01. The ESP8266 can be programmed using a number of different development platforms.

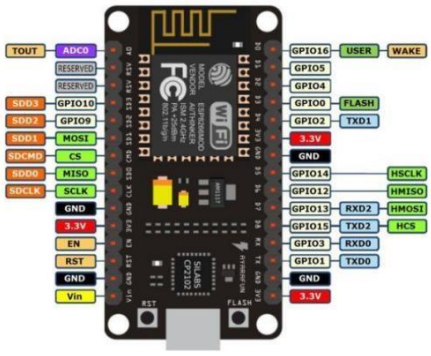


Fig 4. ESP8266 PINOUT

The below [Table 1]. shows the pin names on NodeMCU Development Kit and ESP8266 Internal GPIO Pin number

| Pin Names on NodeMCU Development Kit | ESP8266 Internal GPIO Pin number |
|---|---|
| D0 | GPIO16 |
| D1 | GPIO5 |
| D2 | GPIO4 |
| D3 | GPIO0 |
| D4 | GPIO2 |
| D5 | GPIO14 |
| D6 | GPIO12 |
| D7 | GPIO13 |
| D8 | GPIO15 |
| D9/RX | GPIO3 |
| D10/TX | GPIO1 |
| D11/SD2 | GPIO9 |
| D12/SD3 | GPIO10 |

Table 1. pin numbers on NodeMCU and ESP8266

### 3.1.3 LIGHT DEPENDENT RESISTOR

The resistance of a LIGHT DEPENDENT RESISTOR (LDR) or photo resistor is a function of the incident electromagnetic radiation. As a result, they are photosensitive devices. Photo conductors, photo conducting cells, or simply photocells are other names for them. They are made of high-resistance semiconductor materials. An LDR can be represented by a variety of symbols, one of the most common of which is depicted in the diagram below. Light is falling on it, as shown by the arrow in [Fig 5].

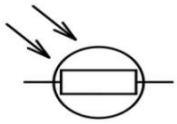

Fig 5. LDR

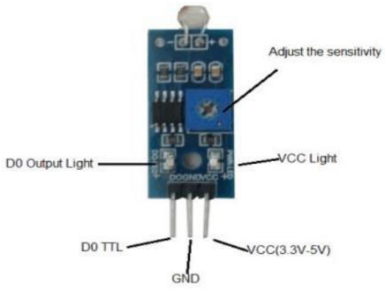


Fig 6. LDR SENSOR PINOUT

The above [Fig 6]. shows the LDR sensor pinout. LDRs are light-dependent devices that have a lower resistance when exposed to light and a higher resistance when exposed to darkness. When a light-dependent resistor is maintained in the dark, it has a very high resistance. Dark resistance is the name given to this type of resistance. It can be as high as 1012 and allowing the device to absorb light reduces its resistance dramatically. When a steady voltage is provided and the light intensity is raised, the current begins to grow. Photo conductivity is used to operate a light-dependent resistor. Photo conductivity is an optical phenomenon in which the conductivity of a material increases as light is absorbed.

### 3.1.4 INFRARED SENSOR(IR)

A basic electronic device that produces and detects infrared radiation to locate specific items or barriers within its range is known as an IR sensor. Heat and motion detection are two of its features. Infrared sensors utilise infrared light with wavelengths ranging from 0.75 to 1000 metres, which falls between the visible and microwave range. Human eyes cannot see the infrared region. The wavelength of the infrared spectrum is divided into three regions: near infrared, mid infrared, and far infrared. The pinout diagram of the IR sensor is shown below [Fig 7].


Fig 7. IR SENSOR PINOUT

*IR Transmitter*

The IR Transmitter is a source of infrared radiation. At a temperature T over 0 Kelvin, every item, according to Plank's Radiation Law, is a source of infrared radiation. The most common sources are black body radiators, tungsten lamps, silicon carbide, infrared lasers, and infrared LEDs .

*IR Receivers*

Photo diodes and photo transistors are the most common IR receivers. They have the ability to detect infrared radiation. As a result, an IR receiver is also known as an IR detector. Receivers are available in a variety of wavelengths, voltages, and packages. Matching parameters are used to select the IR Transmitter and Receivers. Photosensitivity or responsivity, noise equivalent power, and detectivity are some of the receiver parameters to consider.

### 3.2 SOFTWARE REQUIREMENTS

#### 3.2.1 Arduino Software (IDE)

Arduino applications can be created in any programming language that produces binary machine code using a compiler. AVR Studio and the newer Atmel Studio are Atmel's development environments for their microcontrollers. The Arduino Software (IDE) includes a text editor for writing code, a message area, a text console, a toolbar with buttons for basic functions, and a series of menus. It connects to the Arduino hardware, allowing it to upload and communicate with programs.

The Arduino integrated development environment (IDE) is a Java-based cross-platform application provided by the Arduino project. It arose from the Wiring project's IDE and the Processing programming language project. It's intended for artists and other new bees who aren't familiar with software development to learn how to program. It comes with a code editor that incorporates syntax highlighting, brace matching, and automatic indentation, as well as a one-click compilation

and loading mechanism for Arduino boards. A "sketch" is an Arduino program created using the IDE.
Arduino sketches are programs made with the Arduino software (IDE). These sketches were made using a text editor and saved as .ino files. The editor allows you to cut/paste, as well as search for and replace text. While storing and exporting, the message section shows errors and provides feedback. The Arduino Software (IDE) sends text to the console, including comprehensive error warnings and other data. The configured board and serial port are displayed in the window's bottom righthand corner. You may validate and upload programs, generate, open, and save sketches, and open the serial monitor using the toolbar buttons.

3.3. ADMIN SECTION

The timings of when the traffic rate is higher and lower are noted in the admin section. The environment's climatic conditions are also documented. As shown in [Fig.8], the records are kept and monitored on a computer using the internet.


Fig 8. Admin section

## 4. RESULTS AND OBSERVATION

4.1 Consumer Section

When walkers, cyclists, two-wheelers, and cars pass by, the streetlights are designed to adjust their intensity. At other times, it is set to remain at the lowest level of intensity feasible. By specifying the parameters, each unit can be added to the network one by one. The system is self-contained and distributed. There is no need for a host computer.

4.2 IoT Section

Each unit's firmware can be simply updated. For conditions such as a quiet residential area, a shopping street, a portion, a main route, and a mountain road, control algorithms should be designed. The worst-case scenario is that when a pedestrian approaches, the light does not turn on. Each unit keeps track of failures in which motion is sensed in front of it without the other units being notified in advance.

## 5. CONCLUSIONS

In this research, a new model is proposed that will cut the power consumption of street lighting systems by 20-35 percent when compared to traditional designs. We are saving a lot of energy without wasting any, and with these advanced technologies, we can create a lot more systems that can be done with solar lights, and with these solar lights, we can do automatic systems instead of doing it manually like with LDR's. Second, the idea was effectively implemented employing modern integrated circuits and growing technology. The suggested smart street lighting system decreases the demand for staff by a substantial percentage while also reducing human errors to a minimal margin. Because the streetlights are connected to the internet, it decreases the amount of human interaction required to measure the intensity of the light. This helps consumers and governments save money and time by reducing staff and time requirements.

The consumer may monitor power consumption in real time, which can be useful in a variety of applications by indicating ways to reduce power consumption and save electricity. When smart streetlights are combined with smart house features such as smart lamps, smart parking lights, and other smart home features, they aid in active energy conservation. When smart metres are combined with IoT, the possibilities for smart metre applications expand dramatically. When there is a rapid increase in power near the customers, security alarms can be triggered to notify them.

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