# Smart Light Design Document

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## Abstract

Many a times we have seen street lights on during day time, this result in precious energy loss. We can see this very frequent in public areas or even in home or buildings using the conventional manual switching on and off the light. But due to ignorance of the person responsible for switching, this method comes with a huge energy loss and in many places there is not even a responsible person to switch the lights. There has been shift towards the timer controller of on-off switching of public lighting. However, this has not been very effective. So, there is a need for smart lighting system. Our product comes a solution to the before mentioned problem. Our smart light is centrally controlled by IOT and facilitate dynamical adjustment of illumination. This would result in lower operating cost and would also help in low downtime of failed lighting systems as the defective light bulbs can be identified over the IOT.

## 1 Introduction

Smart light comes as a solution to the before mentioned problem. Our smart light is centrally controlled by IOT. We created a versatile and compact light bulb prototype that can be used in various settings, such as street lamps or indoor lighting. It offers two modes of operation: manual and automatic. The smart light facilitate dynamical adjustment of illumination. Both manual and automatic modes have two options to glow the light with high or low intensity. This would result in lower operating cost. The product also have the feature of fault detection. In case of any fault, it will be shown on the cloud that the particular product have a fault without physically going there. This will help in low downtime of failed lighting systems. There is no need of any battery as the product will work on the 230V AC main supply.

## 2 Major Componets

### 2.1 LED arrays

Three LED arrays for varying intensity levels. In case of high intensity all the three arrays are lit. In low intensity level, only one array is lit.

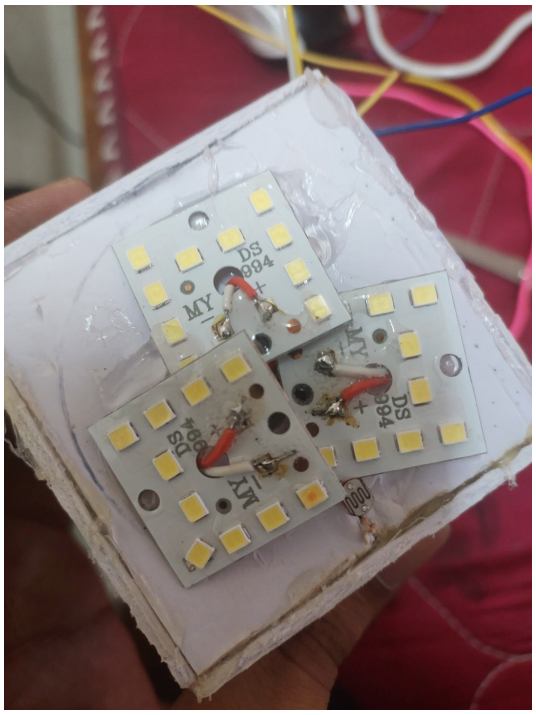


Figure 1: Three led arrays

### 2.2 ESP8266 NodeMCU CP2102 BOARD

The ESP8266 NodeMCU CP2102 Board is an excellent choice for IoT (Internet of Things) projects and WiFi-enabled applications. It is open source. The GPIO pins are easily accessible for prototyping. It can be easily programmed using Arduino IDE and includes an on board USB to serial chip for programming and code upload. The 3.3V regulator ensures sufficient power for WiFi functionality. It low cost also motivated us to use this in our product. It comes with in-built WiFi capabilities.

### 2.3 Power Converter

To power the micro controller, instead of using a battery we have added a Power converter which takes AC input voltage 110 to 240V and provide 5V DC 1A Power Supply. So there is no need to replace any battery.

### 2.4 Light Dependent Resistor

Light Dependent Resistor(LDR) is a cheap sensor to measure the intensity of light. It is made up of a semiconductor whose resistance is inversely proportional to the intensity of light falling on it. We have used LDR of 5mm diameter.

### 2.5 Relay Module

The output signal from micro controller is too low and hence can not be used for switching the lights. Hence relay modules have been used for switching the lights. We have used two 5V 1 Channel relays for two level of intensity whose trigger voltage is 5V DC and trigger current is 20 mA. Its maximum

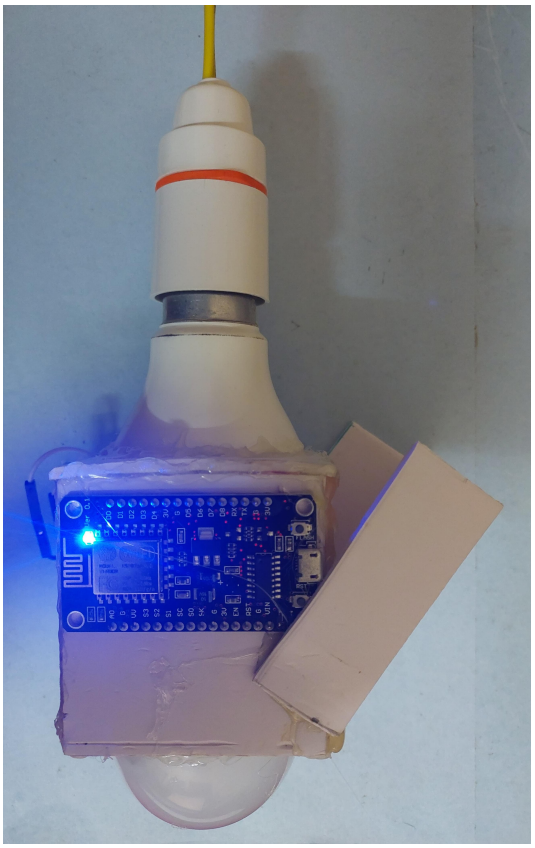


Figure 2: Wifi enabled Smart Light using NodeMCU


Figure 3: 220V AC to 5V DC Power Converter

switching voltage is 250V AC @10A or 30V DC @ 10 A. It works on single pole double throw (SPDT) configuartion.

# 3 Working

## 3.1 Description of the LDR sensor

We have not used any sensor module to reduce the form factor of our product. We designed a voltage divider circuit using a resistor of known value and Light Dependent Resistor (LDR). According to the light intensity resistance of LDR changes and hence the voltage drop by the LDR also changes. This voltage drop is read by the GPIO pin of the controller. Two such LDR have been used in our product. One is facing outward to measure the light intensity of surrounding. The input from this LDR is used to decide the switching and intensity of our light. We faced a challenge, when in dark environment light is switched ON but after switching it on the outward LDR detects the product's own light intensity resulting in switching it OFF. Hence a continuous ON and OFF of the light. To mitigate this issue, we have mounted the sensor at a better position and also made a shed to protect the outward facing sensor from our own bulb light so that we detect only the surrounding light, otherwise our own bulb will affect the reading.

Another such LDR circuit is fixed inside the product near the LEDs for fault detection. This will help identify the particular lamp in case of fault without physically going at the site where product is deployed. If its reading is below a threshold then this information is available on the cloud that this particular bulb or lamp is not working.

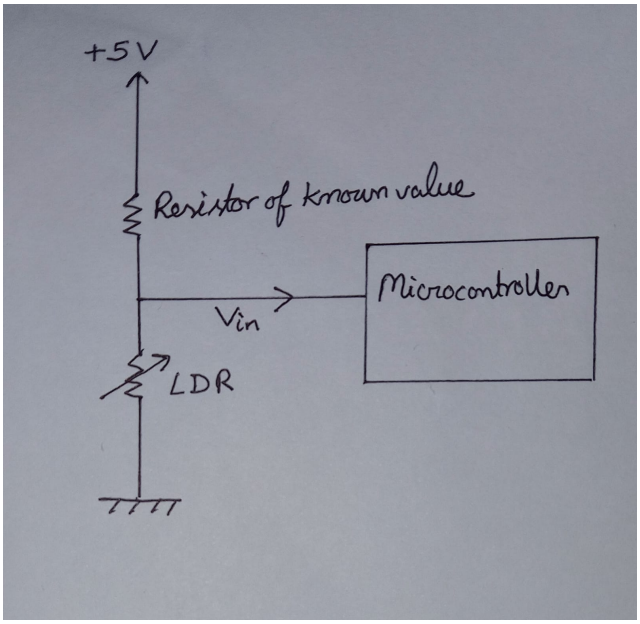



Figure 4: LDR circuit to measure the light intensity

## 3.2 Low and High intensity option

High and low intensity option is available by using three led array modules. If there is a need to switch on the light at low intensity at low intensity, the micro-controller gives output signal to relay 1 which switch on only 1 led array out of three. If there is a need to glow the bulb with full intensity, then the micro-controller give the signal to both the relays 1 and 2. This will switch on all the led array modules. The connections are demonstrated in figure 5

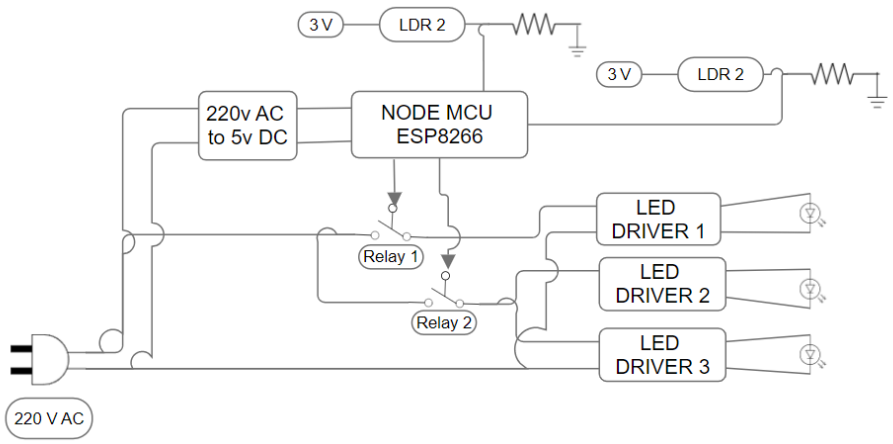



Figure 5: Circuit diagram of the Smart light

### 3.3 Manual Mode

A controller can see the status of all the light bulbs or lamps over the cloud. He have the option to control the light in manual or automatic mode. In manual mode, the controller have option to either switch off the bulb or switch it on with low intensity or switch it on with high intensity. All these functions can be done remotely. He can also see the status of light buns, whether they are glowing or not in case of any fault.

### 3.4 Automatic Mode

The product aims to remove the need of any controller for switching the light. There is an option to switch the light to automatic mode. If the input voltage read by the micro controller is below threshold 1 then it switched on with full intensity. If it is between threshold 1 and threshold 2 then it is switched on with low intensity. In case if it is above the threshold 2 then the light is switched off. This automatic switching result in less power consumption.

### 3.5 Connectivity and Remote monitoring

The lamp need to be connected to a Wi-Fi as decided in the code dumped into the ESP8266 inside it. The controller need to be connected directly to the lamps. He just need to be connected to internet. Hence, there is no issue of distance. Our product can be used at any remote location with internet connection available. All the data is shared over the cloud. We have used Blynk cloud which provided free dashboard (with limited features) for IoT devices. All the features which we used are free available on the Blynk console.

## 4 Results

Our product worked as desired. The dashboard is shown in Figure 6. We can see the light status on the dashboard for fault detection. When the lamp is actually ON, the circle is red. When it is OFF the circle is white. Manual mode working is shown in Figure 7 and automatic mode is shown. 8.

## 5 Cost of our product

The product aims to provide all the features at low cost of 600 INR. The cost breakdown is provided in Table 1

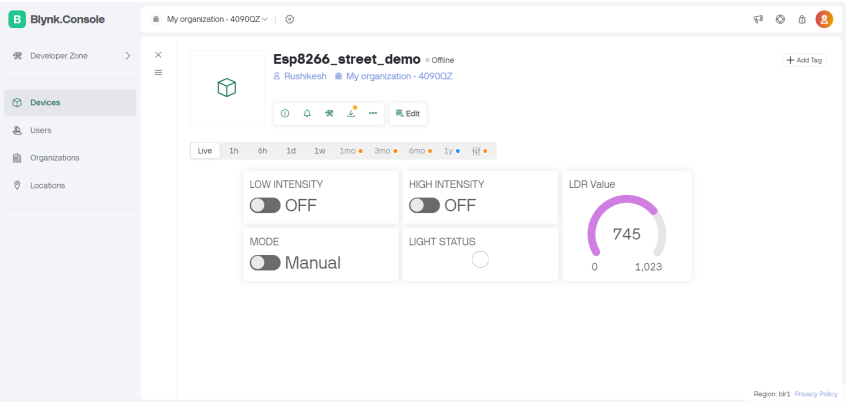
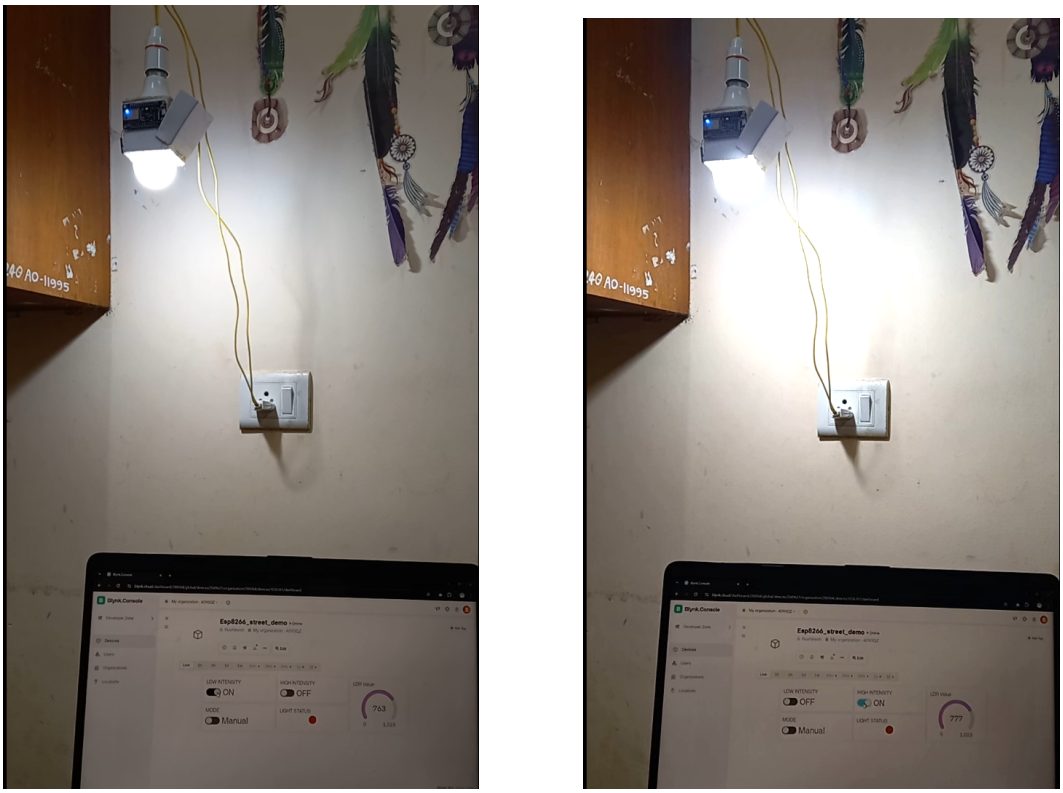



Figure 6: Dashboard for controlling the light



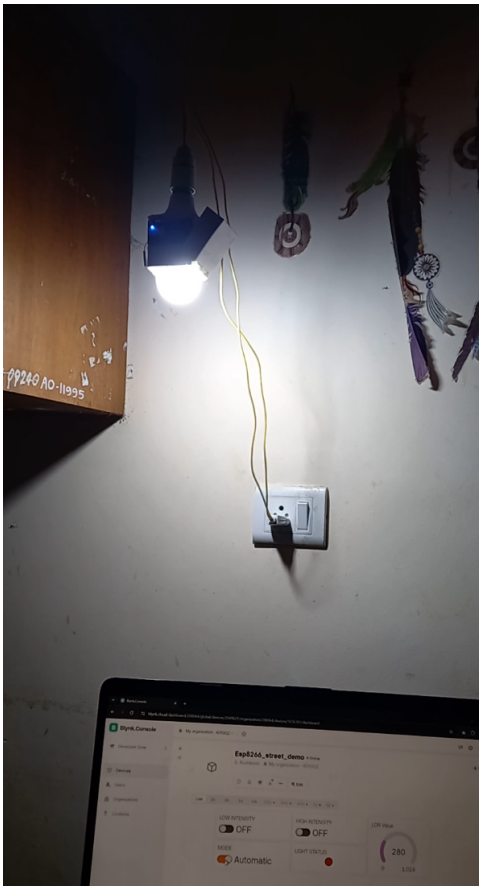
(a) Manual mode with low intensity

(b) Manual mode with high intensity

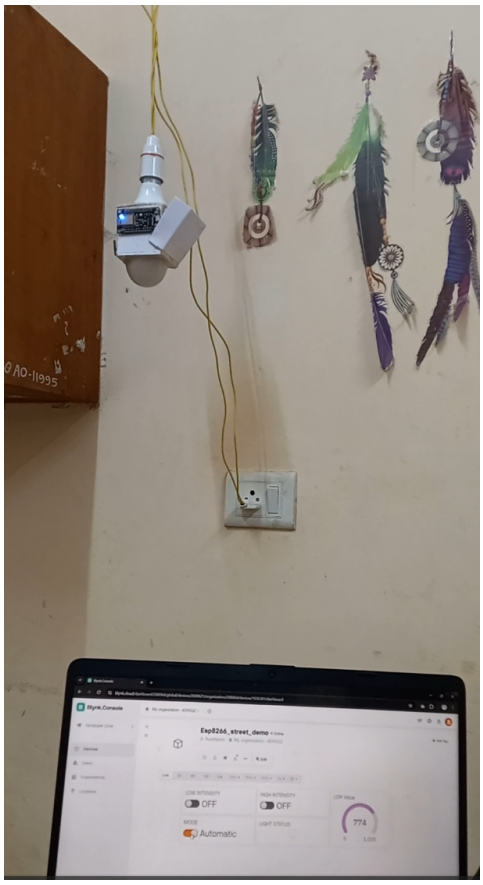
Figure 7: Manual mode

Table 1: Cost Breakdown

| Description | Rate | Quantity | Amount (Rs) |
|---|---|---|---|
| ESP8266 | Rs 262.00 | 1 | Rs 262.00 |
| LED Array & Holders | Rs 200.00 | 1 | Rs 200.00 |
| 220 V to 5V DC Power Converter | Rs 29.00 | 1 | Rs 29.00 |
| 5V Single Channel Relay | Rs 39.00 | 2 | Rs 78.00 |
| LDR | Rs 2.80 | 2 | Rs 5.60 |
| Other Minor Components | Rs 26.00 | | Rs 26.00 |
| Total | | | Rs 600.60 |




(a) Automatic mode when surrounding is dark




(b) Automatic mode when surrounding is bright

Figure 8: Automatic mode