

IOT BASED SMART LIGHTING – INTELLIGENT WEATHER AND COLOR ADAPTIVE SYSTEM IN LIGHTS

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ABSTRACT

This Project on IoT proposes productive of lighting structure using relevant exertion microcontroller based on Node MCU. The central objective is to structure imperativeness cable sharp lights for significance confirmation in existing street lights of fundamental zone, urban zone and just for both rural and urban zones especially. Here, our plan is to provide an efficient lighting so that, according to the natural weather conditions the lights would take appropriate weather conditions accordingly from the natural weather database (for ex. Google Weather Database) and can be lit up according to natural weather conditions for power consumption. The sensors would light up according to weather conditions and the sensors would also control the intensity of the light for better viewing angle. When the Weather conditions are updated via database to the sensors, the colours of the LED would also glow up according to weather conditions outside. This would make the light glow and produce the colour according to the conditions to produce better lighting and viewing of light in Darker Weather conditions.

Keywords: IOT, Node Microcontroller Unit, PIR Motion Sensor, etc.

I. INTRODUCTION

Internet of Things (IoT) is an exciting new technology, which will soon connect us to the physical world via the Internet through mobile devices, sensors and actuators. It provides tremendous opportunities to improve industry, energy and resource consumption, agriculture, business productivity, and our health. In particular, it is estimated that by 2020 the number of IoT devices will reach 50 billion. With recent advancements in communication and mobile computing technology, IoT has entered the daily operation of many industries applications include but are not limited to smart agriculture, smart grids, smart buildings, and e-health.

The Main Aim is to provide a smart efficient lighting system in both Indoors and Outdoors such as, Smart Buildings, Smart Homes, Decors and Street Lights. As we know, as per the current rate of the technological improvements and the features that are provided especially in a lighting module, we can able to revolutionise a system by IoT based Modules and Sensors along with some basic Programming Skills. Thus, we can able to Re-design a Structure which is not intent to do a task to do a Do-able one.

IoT based Smart Lighting System helps us in providing Smart Intelligent Weather Adaptive System where the Node MCU microcontroller would concurrently check the weather outside to get the current weather conditions and abstract that data from the Google Weather Database/Open Weather API which is in the cloud. These data information's will be shown in the Admin computer and send this detail to Node MCU microcontroller, which later controls this lighting set up according to the weather. All this happens in a fraction of second 2 when a person enters into a room or a car move along in a street using various miniature sensors.

In our system, the normal lights can be augmented to a smart router by simply replacing legacy product with a low-price wireless module. Since lights are ubiquitous in the building, our solution can eliminate any communication blind spots and thus truly achieve ubiquitous connectivity. Moreover, the light-based smart building system enables two types of business model: 1) PaaS, 2) SaaS and 3) S2aaS.

1. PaaS: In this model, an IoT service provider installs, configures, and manages all necessary IT infrastructures such as gateways and cloud servers, and opens up the hardware reference design and software API to the users. Then, the users can design and develop their own applications based on the platform provided by the IoT service provider.

2. SaaS: Software as a service (SaaS) is a software distribution model in which a third-party provider hosts application and makes them available to customers over the Internet. SaaS is one of three main categories of cloud computing, alongside infrastructure as a service (IaaS) and platform as a service (PaaS). Here in our System, we are using Google weather database (Google Cloud's Public Database) to identify the Weather Conditions on that specific area and the cloud database would sense the outside climate and sent the data to Microcontroller. We also use a Miniature Display to understand the Temperature and Humidity of the Situation Inside so the Intensity of the Light can be tweaked accordingly by the LDR sensor.

3. S2aaS: This model further separates the IoT solution providers from users and mitigate the risks. Any smart objects such as gas meter, electricity meter, and wearable devices are installed, maintained, and owned by solution providers. The users pay monthly leasing fee to the providers instead of a large- 3 scale upfront capital investment, which is similar to the exiting printer-as-a service model but aimed at significantly lower cost embedded.

II. PROBLEM STATEMENT

The main problem of the existing systems is either it is fully manual or it is fully automatic system. There is some system currently that operates both manually and automatically but most likely they are unusable due to a smaller number of features that are in-build in the system. The users must manually control the system by going near the switch board and turn the lights each time on or off according to their wish, but the automatic functioning of the systems such as smart lighting in several smart house will save the amount of time for many users.

Still for many Automatic Lighting setup there are times where errors occur due to inconsistency of the system or machine error. In our proposed system, we are introducing more features and we are concurrently providing both manual and automatic features. We are also adapting, weather form outside using the Cloud and we cross check with our system, so that the system can provide the perfect result.

III. WORKING SCHEMATICS

Case (I): Indoor Smart Lighting System

In this Case, we are mainly concentrating on Smart Building and Smart Homes. When a person is working in an office or a closed room, when he/she enters into a room the PIR sensor automatically detect the motion of the person and the light would lit up accordingly. When the room condition is darker, the light would increase/decrease its Intensity according to the Light situations in the room. The Humidity and Temperature Sensors would detect the situation of the room as soon as a person enter a room and after a PIR detect the motion passing by an object. This current information been cross-checked and matched with the outside weather conditions for color variation using Google Weather API (Google Cloud weather Database) and has been matched accordingly whether if it is Sunny, Cloudy or Rainy and has been sent to Node MCU microcontroller for the colour variations in the light.



PIR MOTION SENSOR

Case (II): Outdoor Lighting System (Street Lighting System) Nowadays, Streetlights uses Warmer or Cooler coloured tones as we know. Some of our street lights mainly in highways use Cooler toned lights such as Bluish-White lighted colours and mainly Orange-Yellowish lighted colours in traffic related area at night in cities. The main fact of the colour technology used in street lights is not to make the city quite beautiful but to help people to see well. The Orange-Yellowish light has more richness in colour than Bluish White lights that why they have been used in Cities due to Traffic at night. And Bluish-White Light have lesser richness compared to Yellowish-White light thus they are been used in Highways and traffic-less areas.

IV. HARDWARES USED

Node MCU is the central source or so-called brain of the system where all the information's or data are stored and are processed. This is an interconnected system where all the hardware's are linked into this system, so that via Node MCU the data are automatically handled by the system by doing computational mechanisms by itself and help to produce less false output.

Node MCU (Node Microcontroller Unit)

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit). The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source.

The firmware uses the Lua scripting language. The firmware 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. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented. The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface mounted board containing the MCU and antenna.



NODE MICROCONTROLLER UNIT

Relay (2 Channels, 5V)

A Relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent lowpower signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

This is a LOW Level 5V 2-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.



RELAY (2C,5V)

DHT-11 Temperature and Humid Sensor

DHT11 module is a digital sensor for measuring the temperature & humidity. There is a number of applications like HVAC, dehumidifier, weather stations, data loggers and indoor agriculture industry where we need to measure the humidity and temperature.

Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates.



DHT - 11 SENSOR

PIR Sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. PIR sensors are commonly used in security alarms and automatic lighting applications. PIR sensors detect general movement, but do not give information on who or what moved.

In this Prototype, we use are using PIR sensor to detect motion of a person. We have setup our prototype as to be working in two Rooms say, PLACE A and PLACE B, where PLACE A will be having a PIR sensor 1 and PLACE B will be having a PIR Sensor 2. This PIR Sensors would have been kept at the edge of the room doors to detect the motion of a person when he/she passes through the area where the sensor is been kept.



PIR SENSOR

LDR Sensor

A photoresistor (acronym LDR for Light Decreasing Resistance, or light dependent resistor, or photoconductive cell) is an active component that decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface. The resistance of a photoresistor decreases with increase in incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits and light activated and dark-activated switching circuits acting as a resistance semiconductor.



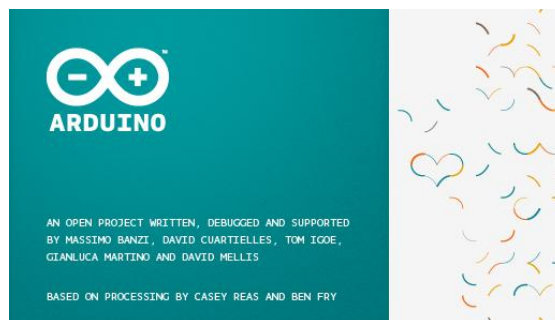
Flood LED

LED Flood Lights are wide angle lights designed to cover a large area or "flood" the area with light. Now powered by efficient LED technology, these lights come in a wide variety of shapes and purposes. LED flood lights are lights that are highly powered and can be used to light large areas.

V. SOFTWARES USED

ARDUINO IDE v1.8.11

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more. Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment 53 mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.



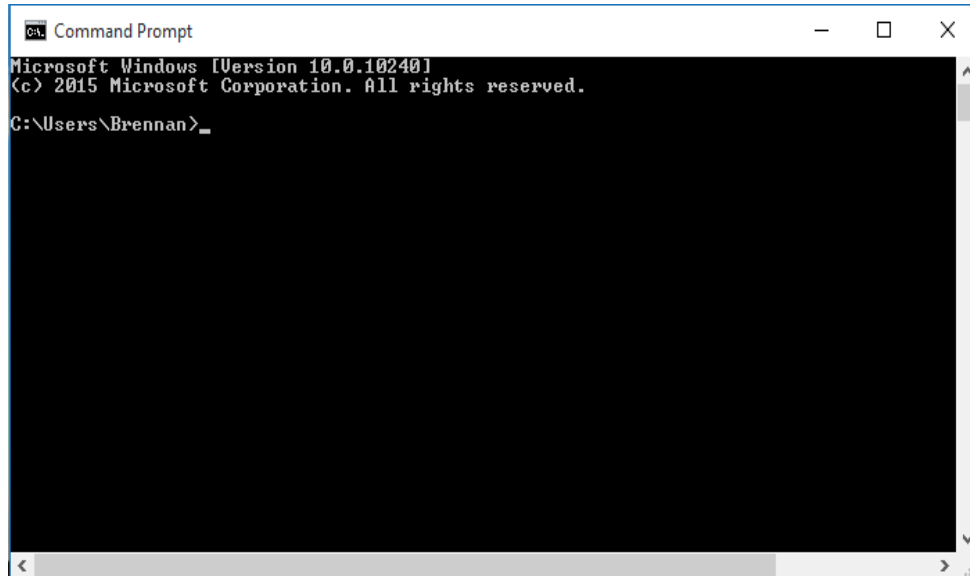
ARDUINO IDE

CMD (Command Prompt)

Command Prompt is a command line interpreter application available in most Windows operating systems. It's used to execute entered commands. Most of those commands automate tasks via scripts and

batch files, perform advanced administrative functions, and troubleshoot or solve certain kinds of Windows issues.

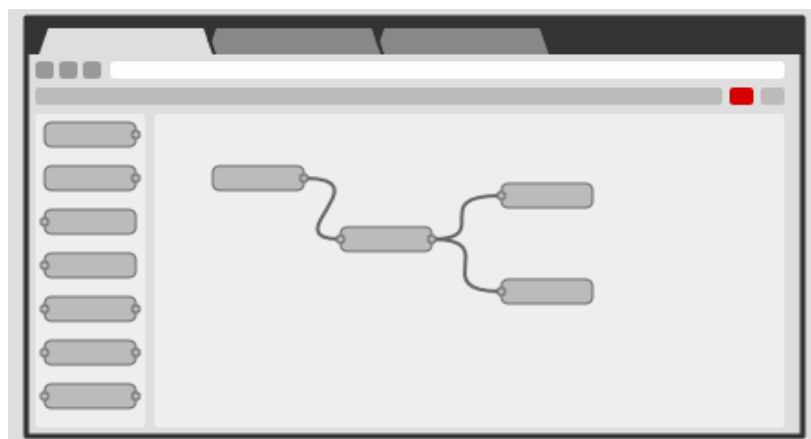
Command Prompt is officially called Windows Command Processor, but it is also sometimes referred to as the command shell or cmd prompt, or even by its filename, cmd.exe.



COMMAND PROMT ON WINDOWS

NODE RED

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click. Node-RED is a flow-based development tool for visual programming developed originally by IBM for wiring together hardware devices, APIs and online services as part of the Internet of Things. Node-RED provides a web browser-based flow editor, which can be used to create JavaScript functions. Elements of applications can be saved or shared for re-use. The runtime is built on Node.js. The flows created in Node-RED are stored using JSON. Since version 0.14 MQTT nodes can make properly configured TLS connections.



NODE RED INTERFACE

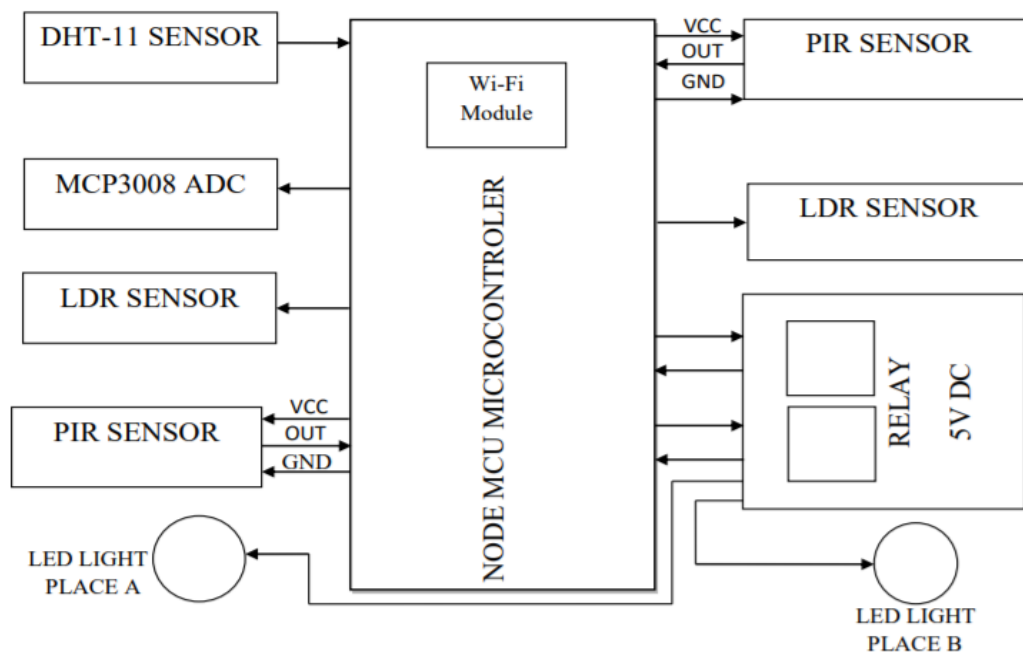
VI. BLOCK DIAGRAM

Here, we are connecting our Node MCU module along with Sensors such as DHT-11 Sensor, MCP 3008 ADC, LDR Sensor and PIR Motion Sensors. The System also contains Relay which is an electrically operated Switch where it mainly helps to refresh the system in low voltage circuit.

DHT-11 sensor is a Temperature and Humidity sensor which is used to measure the room temperature and humidity of a Room or a Place. It is mainly used to evaluate the condition of a room so that the Node MCU can get the information of the room and match the information with the weather database outside, along with Open API using Node Red.

The LDR Sensor is used to measure the light or darkness of a room so that, the LED Light could able to increase/decrease its intensity accordingly. The LDR value is set TO ≥ 1000 in our program and the language used is Embedded C. The Value is set to 1000 or above so that, if the LDR Sensor detects the darkness along with the Motion of a person passing by which is detected by the PIR motion sensor the LED Light would light up.

PIR Sensor is a Motion Sensor which is used to detect the motion of a person passing by. It detects the motion and the value will COUNT +1 and send the value detected to the Node MCU. The changed values are constantly being refreshed by the Node MCU every 2 seconds and can be spectated on the Serial Monitor of Arduino IDE software platform.



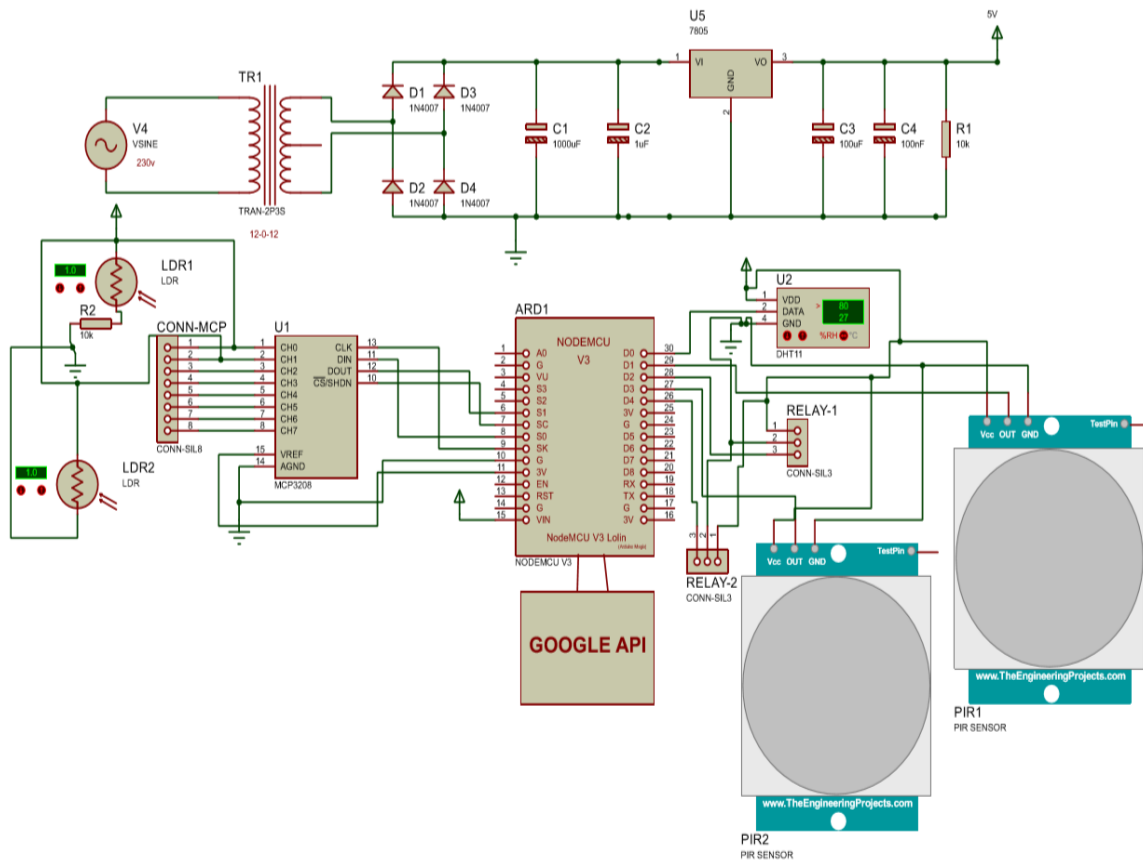
Block Diagram 1: Block Diagram for Proposed System

It detects the Count of PIR Motion Sensor along with the LDR intensity value and the Temperature and Humidity Values acquired from DHT-11 sensor. When a person moves out of the room the value will COUNT -1 and the light gets turned OFF.

MCP 3008 ADC is an Analog to Digital Convertor which is used to Provide an extra Analog Pin to the Node MCU. The Node MCU has only 8 Digital Pins and 1 Analog Pin but we need an extra pin for connecting LDR sensor along with PIR sensor because we use 2 rooms as an example in our prototype. And LDR sensor uses Analog Pin rather than digital pin thus it is compulsory to use an extra ADC MCP 3008 Micro Control Processor for an extra Analog Pin.

Relay acts as a Switch where we are using 2 Channel 5 V relay consisting 2 relay modules for IN and OUT. It mainly helps to refresh the circuit and manage the Voltage Outputs in the system.

VII. CIRCUIT DIAGRAM



VIII. ENTIRE WORKING OF THE SYSTEM

CMD Commands and Triggering of the System

The First Step is to turn ON the system by giving command in the command prompt. Here, the command prompt is linked with the server of NODE – RED with the command “Node-Red”. This will trigger our system to be in contact with the node - red server. But for this, the Node MCU and the System should be connected into a same network which can be a LAN Network or a WAN Network. If the Network is not Connected properly the node red server will be not connected to the admin machine and the command prompt will show the error message i.e, Not Connected and will try to Reconnect with the server every 5 seconds as a loop by its on.

If the connection is successful with the internet by Node MCU, the command prompt will show the Connected message along with some valuable commands and a Server https URL link to connect with the server via a browser.

NODE – RED Local Host Server

Using the help of node red, we could able to interconnect the Hardware's, Software's, API's and Online network interrelations into a computing machine. It's a flow-based programming tool used for ease programming using GUI programming methodology interface.

We import the weather database using OPEN API which help to acquire the free weather database online and link with the flow GUI interface of Node – Red Server.

So, for that first we create an account in the Open Weather API and acquire an API KEY. All the users are provided with a unique API key to interact the system with the OPEN API online weather database. This

API KEY is provided with the Node – red flow GUI interface and we input the requirements accordingly for our System to work perfectly. Now we provided the API KEY to our Node – Red server and we can able to monitor the current weather of the city that we are provided to the Node – Red so that the Open API provides the weather of that area to the node red 71 interface and thus we can view the current weather in the node – red server GUI interface.

The Current weather that is being provided by the Open Weather API is being Displayed by setting and selecting the City and Country and being Deployed so that its being displayed in the Description area on the right side of the Node - Red Server Interface.

Here, the Weather Database from OPEN weather API is being displayed and refreshed every 2 seconds by the Open API and being displayed in the node red interface.

Next, we are providing some user created server code to the node – red function interface so that, the node – red interface is being linked with our Arduino IDE program and the type of color is being coded to display in the output for color adaption in lights. For this, we do some server-based program in Node – Red.

IX. RESULT EVALUATION

As we know already, when a person enters into a room the PIR sensor detects the motion of the person entering and along with the detection the count adds up to 1 (ON/DETECTED STATE) when the motion is being detected. If the state is idle the count is 0 i.e. (OFF/UNDETECTED STATE). All this is being done Automatically by the Node MCU microcontroller. When the Motion is being detected by the PIR sensor the count will be +1 along with it the LDR value is also being cross-checked (to detect the intensity of the light falling on the LDR Sensor). We set the Intensity of the light according to the rooms lighting conditions and we set the LDR value accordingly. For Example, if we set the value >1000 when the darkness occurs and value becomes greater than 1000 the light glows automatically else if doesn't glow. Thus, this is the experimental result of our proposed system for Smart Lighting.

Sl. No.	Person Inside (NO=1)	PIR Sensor Detection		LDR Light Intensity			
		Place A	Place B	When Value >1000		When Value <1000	
				Place A	Place B	Place A	Place B
1	Yes	In	Out	On	Off	Off	Off
2	Yes	Out	In	Off	On	Off	Off
3	Yes	In	In	On	On	Off	Off
4	No	Out	Out	Off	Off	Off	Off

- Person In – On
- Person Out – Off

Colour Variation in Lights

Colour Variation in Lights Occur According to the Humidity and Temperature inside the room. So, we detect this using DHT-11 sensor for understanding the weather conditions of a Room. The weather conditions is being manually checked and is made tweaked in the function of the system's Server.

Sl. No.	Weather Conditions	Color Change
1.	Haze	Bluish – White Light
2.	Cloudy	Orange – Yellowish Light

X. CONCLUSION

In this Work, we present another framework for constraining issues in End User Development for IoT dependent on Semiotic arranging. We developed a better protocol for this issue and provided a new feature by adding additional colour gamut to the system and also helped in consuming power as a better option. This will also provide different weather adaptive lighting system in LED lights and the LED provide different colours according to Weather conditions Outside. The Light can Produce Warmer or Ever Cooler Tones by colour, for example - if it's a hot temperature outside at night the light will tune accordingly and produce a cooler toned colour such as White Light or Bluish-White light so the certain part could reduce some amount of heat. The Intensity of lights in our Proposed System gets varied according to the light rooms lighting condition along with the rooms temperature and humidity. Our System can be tweaked both Automatically and Manually to avoid future problems in IoT systems if any occurs. Thus, when the PIR sensor detects the motion of a person and along with it if, the LDR Sensor picks up the lesser amount of light falling on its surface the light lit up accordingly. This Proposed System is very helpful in future enhancements such as Smart Homes, Smart Buildings, Street Lighting System etc.

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