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A Smart Approach for Controlling Street Light using IoT

Vijay Gadre[1], Abhay Patil[2], Prof. Manjushri Joshi[3]

[1, 2]*Student, Dept. of Electronics and Telecommunication Engineering, MIT Polytechnic, Maharashtra, India*
[3]*Professor, Dept. of Electronics and Telecommunication Engineering, MIT Polytechnic, Maharashtra, India*

Abstract –The acronym "SMART" standing for specific, tangible, achievable, appropriate, and time-based objectives. The Internet of Things (IoT) belongs to a vast and broadening set of digital devices that already number in the billions and operate across potentially global networks. People are attracted to the word SMART as the world gets a bit faster. India does have one of the world's fastest growing economies, therefore, implementing a smart technique – accurately, a smart street light system using IoT. Even when power is available, the manual streetlight system lights are turned on from sunset to sunrise at maximum intensity. The saved energy can be used for a variety of purposes, including residential, commercial, and industry. This is accomplished by utilizing the LDR and PIR sensors. We can turn a light ON/OFF based on the intensity of the light. The system's power supply is the main supply, which is converted using a relay. Every city must have an essential street lighting system. Hence, we are utilizing the project via an IoT module to save energy. Everything in the world is changing into automation as a result of the tremendous change in the world, based on accurate real-time field data, this is a smart control and intelligent decision – making device.

Key Words: Automation, Arduino IDE, Energy Efficiency, ESP8266 Wi-Fi Module, IoT, LDR.

1.INTRODUCTION

The Internet of Things (IoT) is a network of interconnected preparing devices, mechanical or virtual machines, articles, animals, and people with fascinating identifiers (UIDs) and the ability to move information over a network without requiring human-to-human communication. IoT employs a variety of advancements and displays to communicate with devices based on their requirements. Street lighting is an important piece of infrastructure for cities to ensure the safety of their citizens and goods. This infrastructure, however, comes at a high economic and environmental cost. As a result, municipalities are looking for creative solutions to control the costs of their streetlights, which can account for up to 60% of their total electricity expenditure.

The main issue that manual controls on street lights face is that they take a long time to turn on in the evening and waste a lot of energy in the morning because they can't all be turned off at the same time. Another example of waste is when lights are turned on at midnight even though there is little traffic. As a result, there is a need to develop a system that overcomes the shortcomings of existing systems. A system that reduces manual control while saving energy. This could be accomplished by utilizing low-power, robust, and efficient components.

This research article discusses advancements in energy-saving street lights and lowering power consumption. Subsequently, the framework has been effectively outlined and executed in programming terminology for building up the product to the Node MCU ESP8266 board. To implement intensity control of street lights, two sensors, Passive Infrared (PIR) and Light Dependent Resistor (LDR), are primarily used. PIR sensors are used to detect object motion, and LDRs are used to distinguish between day and night. When light falls on the LDR, the intensity of light either decreases or increases depending on the resistance of light. The street light turns on automatically at 6 p.m. and stays on until the next morning. We can also control the street light using a mobile app. The intensity control of street lights is implemented using the Node MCU board.

2. LITERATURE SURVEY

A group of researchers from the D.K. Kim Korea Electro Technology Research Institute [6] developed a smart road light GPS beacon using the ZigBee remote module. They will almost certainly screen the street light safety and ahead-of-time results to the control station The light module contains a light ward resistors (LDR) module, a microcontroller module, and a transmission module. The light module will communicate with the control center via Wi-Fi and ZigBee.

Scholars have proposed a variety of methods. The use of the DHT11 sensor is one such technique that has recently emerged [1, 5]. The DHT 11 is, as the name implies, a temperature and humidity sensor with exceptionally precise stickiness and temperature alignment. Its incorporation of an 8bit small scale controller ensures consistent quality and long haul dependability. Has a quick reaction time, high quality, and superior performance. The single-wired sequential interface framework has been incorporated to make it quick and simple. Small in size, low in power, signal transmission ranges up to 20 meters, enabling a wide range of applications even in the most difficult locations or territories. Another recent example of such a method was with the assistance of a Light sensor, Smoke sensor, Carbon outflow sensor, and Noise sensor. [2, 3, 4]

First, the Chips would be created and installed in the lights. These chips may include a small scale controller as well as shifted devices such as an ozone depleting substance sensor, haze sensor, quality device, clamor device, and GSM modules for remote information transmission and gathering between concentrator and PC. The data from the chips would be collected on an external concentrator (PC), and the PC would then transmit the primary activity to the chip. According to the overview of variety within the force of daylight in the field space, prudent programming would be carried out to ensure the least utilization of vitality. The discharges within the atmospheres would be distinguished, as would the utilization of vitality and any power theft.

3. DESCRIPTION OF COMPONENTS

3.1. VOLTAGE SENSOR

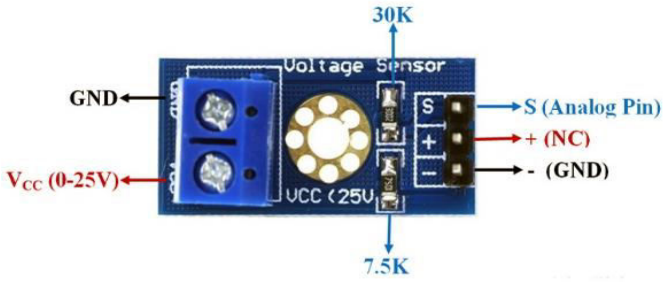

Fig – 1: Voltage Sensor

A voltage sensor is a sensor that measures and calculates the amount of voltage in an object. Voltage sensors can detect either AC or DC voltage levels. This sensor's input is voltage, and its output is a switch, analog voltage signal, current signal, or audible signal. Sensors are devices that detect, identify, and respond to specific electrical or optical signals. The use of voltage sensor and current sensor techniques has become an excellent alternative to traditional current and voltage measurement methods.

3.2. CURRENT SENSOR

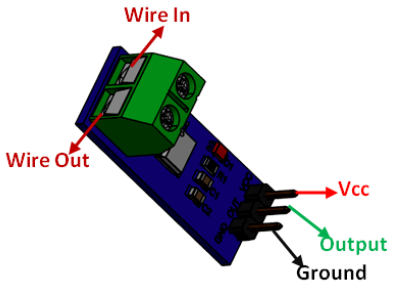

Fig – 2: Current Sensor

A voltage drop occurs when the current flows through a conductor. Ohm's law describes the relationship between current and voltage. An increase in the amount of current above the device's requirement causes overload and can damage the device. Current measurement is required for the proper operation of devices. Current measurement is an obtrusive task that cannot be detected directly as voltage. A sensor is required to measure current in a circuit. The ACS712 Current Sensor is a sensor that can be used to measure and calculate the amount of current applied to a conductor without interfering with the system's performance.

The ACS712 Current Sensor is a fully integrated linear sensor IC based on the Hall effect. This integrated circuit has 2.1kV RMS voltage isolation as well as a low resistance current conductor.

The Current Sensor detects the current in a wire or conductor and generates a signal proportional to the detected current, either as an analog voltage or as a digital output.

Because this integrated circuit can detect both AC and DC, it has a wide range of applications. ACS712 is used in peak detection circuits, gain increase circuits, rectification applications for A/D converters, overcurrent fault latches, and other applications. This IC's filter pin is used to eliminate the attenuation effect in resistor divider circuits.

3.3. LIGHT DEPENDENT RESISTOR (LDR)

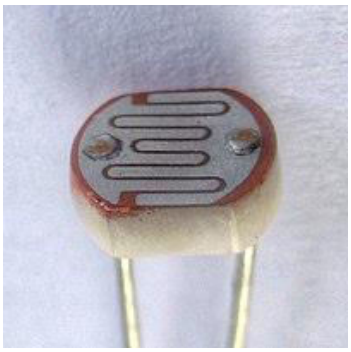

Fig – 3: Light Dependent Resistor Sensor

An LDR is a passive component that reduces resistance to receiving luminosity on the sensitive surface of the component. A photo-resistance resistor decreases as the intensity of incident light increases; in other words, it exhibits photoconductivity. A photo-resistor can be used as a resistance semiconductor in light-sensitive detector circuits as well as light-activated and dark-activated switching circuits. A photo-resistor can have a resistance as high as several mega-ohms (MΩ) in the dark, and resistance as low as a few hundred ohms in the light.

The free electrons (and their hole partners) that result in conduct electricity, lowering resistance. The resistance range and sensitivity of a photo-resistor can vary greatly between devices. Furthermore, unique photo – resistors may react significantly differently to photons within specific wavelength bands.

Photo-resistors also have a latency between exposure to light and the subsequent decrease in resistance, which is typically around 10 milliseconds. When transitioning from lit to a dark environment, the lag time is even greater, often lasting as long as one second. This makes them unsuitable for sensing rapidly flashing lights, but it is occasionally used to smooth the response of audio signal compression.

3.4. PASSIVE INFRARED SENSOR (PIR)

Fig – 4: Passive Infrared Sensor

The PIR sensor has two slots, each of which is made of special IR-sensitive material. Because the lens used here isn't doing much, we can see that the two slots can 'see' out past a certain distance. When the sensor is turned off, both slots detect the same amount of IR, which is the ambient amount radiated from

the room, walls, or outdoors. When a warm body, such as a human, passes by, one-half of the PIR sensor is intercepted, resulting in a positive differential change between the two halves. When the warm body moves away from the sensing area, the sensor produces a negative differential change. These pulses of change are what is detected.

PIR sensors are fairly generic, with the main differences being price and sensitivity. The optics are responsible for the majority of the real magic. This is a good manufacturing idea because the PIR sensor and circuitry are fixed and only cost a few dollars. The lens is inexpensive and allows you to easily change the breadth, range, and sensing pattern.

3.5. NODE MCU CONTROLLER (ESP8266)

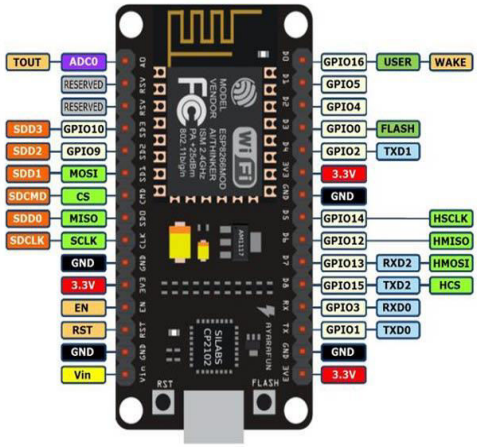

Fig – 5: Node MCU Controller (ESP8266)

Node MCU is an open-source firmware with open source prototyping board designs. A circuit board that functions as a dual in-line package (DIP) and integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna is commonly used for prototyping. The DIP format allows for simple prototyping on breadboards. Initially, the design was based on the ESP8266's ESP-12 module, which is a Wi-Fi System on Chip (SoC) integrated with a TensilicaXtensa LX106 core, which is widely used in IoT applications.

Arduino.cc began to develop new MCU boards based on non-AVR processors, such as the ARM/SAM MCU used in the Arduino. Due to this, they needed to modify the Arduino IDE in such a way that it would be relatively simple to change the IDE to support alternate toolchains, allowing Arduino C/C++ to be compiled for these new processors. They accomplished this by introducing the Board Manager and the SAM Core. A "core" is a set of software components required by the Board Manager and the Arduino IDE to compile an Arduino C/C++ source file for the machine language of the target MCU.

3.6. LIGHT DEPENDING DIODE (LED)

Fig – 6: LED

An LED lamp, also known as an LED light bulb, is a type of electric light that emits light by using light-emitting diodes (LEDs). LED lamps consume significantly less energy than equivalent incandescent lamps and can be significantly more efficient than most fluorescent lamps. The most efficient LED lamps on the market have efficiencies of 200 lumens per watt (Lm/W). Commercial LED lamps have a much longer lifespan than incandescent lamps.

To operate from mains power lines, LED lamps require an electronic LED driver circuit, and losses in this circuit mean that the lamp's efficiency is lower than the efficiency of the LED chips it uses. Special features may be required by the driver circuit.

3.7. 4 – CHANNEL RELAY MODULE

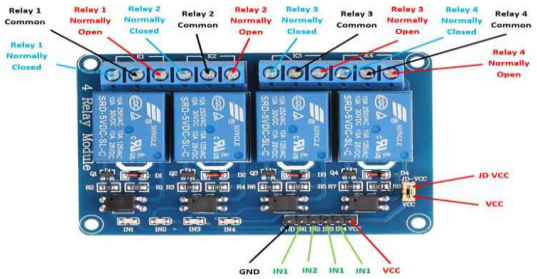

Fig – 7: 4 – Channel Relay Module

The four-channel relay module includes four 5V relays as well as the associated switching and isolating components, allowing for simple interfacing with a microcontroller or sensor with few components and connections. Each terminal block has six terminals, and each block is shared by two relays. The terminals are screw-type, making connections to mains wiring simple and interchangeable. The module's four relays are rated for 5V, which means the relay is activated when there is approximately 5V across the coil. The contacts on each relay are rated for 250V AC, 30V DC, and 10A in each case, as indicated on the relays' bodies.

3.8. 9 – VOLT BATTERY

Fig – 8: 9 – Volt Battery

The majority of nine-volt alkaline batteries are made up of six individual 1.5 V LR61 cells encased in a wrapper. Despite being 3.5 mm shorter, these cells are slightly smaller than LR8D425 AAAA cells and can be used in their place for some devices. Carbon-zinc types are constructed with six flat cells stacked together and wrapped in a moisture-resistant wrapper to prevent drying. Three cells in series are used to make primary lithium types.

4. WORKING PRINCIPLE

4.1. BLOCK DIAGRAM

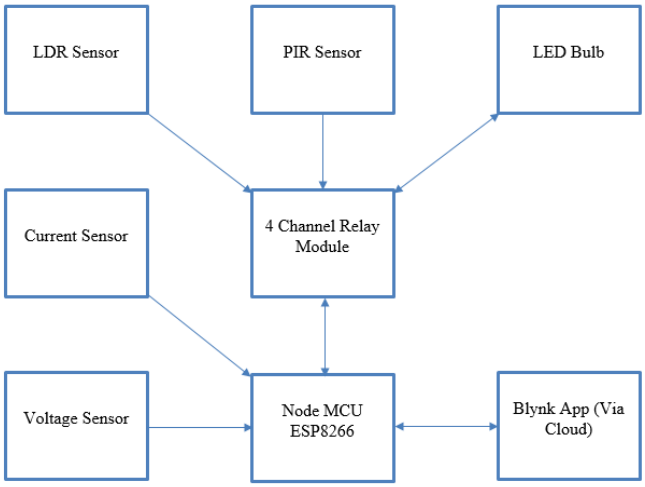

Fig – 9: Block Digram of Smart Street Light System

Manually controlling the system is a really critical method. In this project, two types of sensors will be used: the light sensor LDR and the PIR sensor. The light distinguished will detect shadowiness to activate the ON/OFF switch, causing the streetlights to turn on, and the PIR sensor will detect the enhancement to activate the streetlights. LDR, which changes depending on how much light falls on its surface, gives enrolments for whether it is day or night. Fairly late at night, the PIR sensor will be authorised. If any request crosses the PIR bar, a specific light will turn on. The lighting framework is made up of a Node MCU ESP8266 board, an LDR, a PIR sensor, and other electrical components. LEDs vary depending on whether light falls on LDR or PIR sensors. When the power of light is high, protection is low; when the force of light is low, protection is high. The process is ongoing, and the data is saved in the cloud.

4.2. ALGORITHM

The following algorithm show how the street light would work: -

1. Start
2. Include the required libraries
3. Declare a variable with constant character datatype to declare the Wi-Fi SSID, password and the API key.
4. Declare variables with integer datatype for GPIO pins of LED, LDR, PIR sensors and ADC channel.
5. Set the pin Mode (input or output) for the pins of LED and PIR sensor on Node MCU.
6. Read the digital value from PIR sensor and analog value from the LDR sensor and store them in the variables having integer datatype.
7. Check the value of LDR sensor for low light. If the value of LDR is lower than 700 then, it will be night time and hence it will turn ON the LED if PIR sensor also detects some motion and vice versa during day – time.
8. Stop

Hence, this is how a smart street light works, it only glows if it is a night time and some motion is detected.

4.3. FLOWCHART

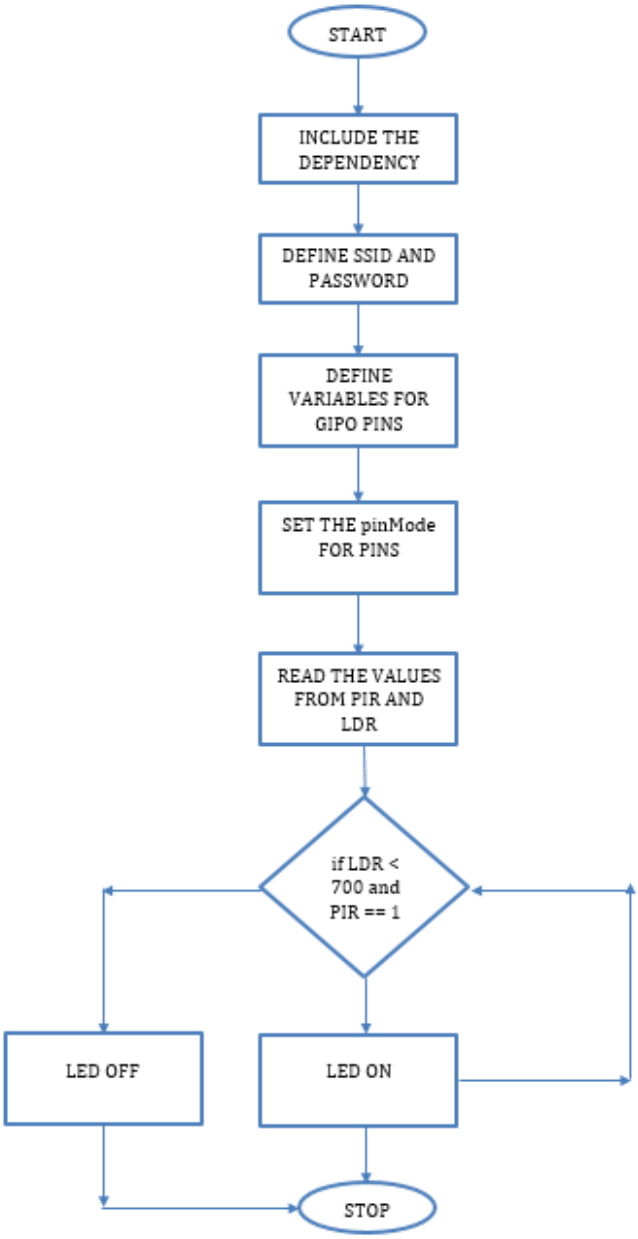

Fig. 10: Flow – Chart

5. CONCLUSIONS

The solution to energy conservation is to eliminate time slots and replace them with a system that can detect the brightness of the environment and act accordingly, ensuring that seasonal changes do not affect the intensity of street lights. LEDs should also be used instead of HID lamps due to their dimming capability, as well as the fact that they are more reliable.

Conserving energy has been a huge task in our generation, and by automating the manual process, we can save an enormous amount of energy. These also save labor and prevent energy waste. Automated systems outperform manual systems in terms of efficiency. These devices can be reprogrammed to meet our specific requirements

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BIOGRAPHIES

Prof. Mrs. Manjushri Joshi, currently working as a Senior Lecturer in the Department of Electronics and Telecommunication Engineering at MIT Polytechnic, Pune, Maharashtra, India.

Mr. Vijay Gadre is a third year diploma in electronics and telecommunication engineering student at MIT Polytechnic, Pune, Maharashtra, India.

Mr. AbhayPatil is a third year diploma in electronics and telecommunication engineering student at MIT Polytechnic, Pune, Maharashtra, India.