International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 04 | Apr 2023 www.irjet.net p-ISSN: 2395-0072

SMART STREET LIGHTING Using IOT

Sakshi Dhoke[1], Sharda Jadhav[2], Mayuri Jasturkar[3], Meghal Baile[4], Archana Wankhade[5]

[1,2,3,4] *Students, Department of Information Technology, GCE Amravati, Maharashtra 444604, India*
[5]*Asst.Prof. Department of Information Technology GCE Amravati, Maharashtra 444604, India*

Abstract – *This paper addresses the objective of providing an "IoT-based automatic street lighting system" during the night. Street lighting is an essential part of all cities and highways, helping to prevent accidents and unwanted thefts or robberies. Thousands of street lights are installed along highways and main roads. But the main problem is that these street lights consume about 25-30% of the total energy used in the city. A simple and effective solution would be dimming the off-peak lights. Whenever a presence is detected, the lights around it turns on in normal (bright) mode. This would save a lot of energy and also reduce the cost of running public lighting. We can check the status of the street lights on the Internet using IoT (Internet of things) from anywhere in real time and solve problems if they occur during processing.*

Key Words: **Internet of Things**, **Embedded Systems Programming**, **PIR**, **Arduino UNO**, **Smart Street Lights**.

1. INTRODUCTION

Street lighting is an integral part of any development site. They are present on all major roads as well as in the suburbs. The street lights are powered from sunset to sunrise every day at full power, even when no one is around. Globally, millions of dollars are spent on these street lights every day to provide the required electricity. The maintenance and replacement costs of conventional light bulbs are huge. They use a lot of electricity to function and their heat emissions are also quite high. All of this contributes to greater demand for electricity generation and, consequently, greater carbon dioxide emissions from power plants. Along with unnecessary light pollution, this practice also damages our planet. This system is very easy to implement, the key components of this project are LDR, IR Sensor, Arduino Board and LED. The Arduino board is the brain of this project that controls the entire system. The IR sensor acts as the eye of this project to detect the presence of vehicles or people on the road and the LDR senses the presence or absence of sunlight and the LEDs represent the street lights.

During the day, the system detects LDR sunlight and turns off the street lighting (LED). When the system detects darkness (in the evenings), it turns on the street lights (LED). When the street lamp is turned on, if the system does not detect any vehicles or people moving on the road using the IR sensor, it will turn on the low-intensity lights. When the system detects the movement of vehicles or people using the IR sensor, it turns on the street lights with high intensity.

1.1 EXISTING SURVEY

There already exists many ideas about the Smart Street Light Systems.

S. Suganya et al. designed a street light beam to detect vehicle movement using the isa sensor system, which uses the latest technology for light sources such as LED lamps. It is also used to automatically control street light switching based on light intensity to develop dynamic flow-based control statistics using infrared detection technology and maintain wireless communication between the street light pole and the control terminal using the ZigBee Wireless protocol. It also combines various technologies: timer, operating current size statistics, photodiodes, LEDs, power transistors.

K. Santha et al conducted a survey on vehicle movement-based street lighting system. The system works in automatic mode, which regulates the street lighting according to the brightness and dimming algorithm and light intensity. Regulation can be made according to seasonal fluctuations. It is equipped with a time-off function and an automatic control pattern to save electricity. The entire project was implemented using a PIC microcontroller. He designed an automatic remote-control system for public lighting based on ZigBee. The system is designed with the help of ZigBee modules that help in detecting faulty lights and controlling the light. It also discusses an intelligent system that automatically decides on/off/dimming based on vehicle or pedestrian movement as well as the surrounding environment. The PIR motion sensor is used to detect the movement of living and non-living things.

In 2015, M. Abhishek et al implemented a traffic flow-based street lighting control system design with efficient use of solar energy. For street lighting, they used a renewable source of energy, i.e., solar energy. They also used 8052 series microcontrollers and is developed by replacing normal LED bulbs, thanks to which energy consumption is reduced by 3 times. On both sides of the road, there are sensors that detect the movement of the vehicle and send commands to the microcontroller to turn the lights on and off. Here, all street lights remain off and only come on when it detects vehicle movement. Therefore, because of the microcontroller, even if it is night, the lights are on or off.

C. Bhuvaneshwari et al. analysed street lighting with an automatic tracking system can increase solar energy conversion efficiency. Here, tracking the sun a sensor is a sensing device that detects the position of the sun from time to time and indicates output to amplifier based on sunlight density. The sun tracking sensor is LDR, an amplifier unit is used to amplify the signals of the LDR which converts the low level signals to high level signals and the output is given to the comparator. LM324 IC is used as amplifier. The comparator compares the signals and gives a command to the AT89C51 microcontroller.

1.2 BLOCK DIAGRAM

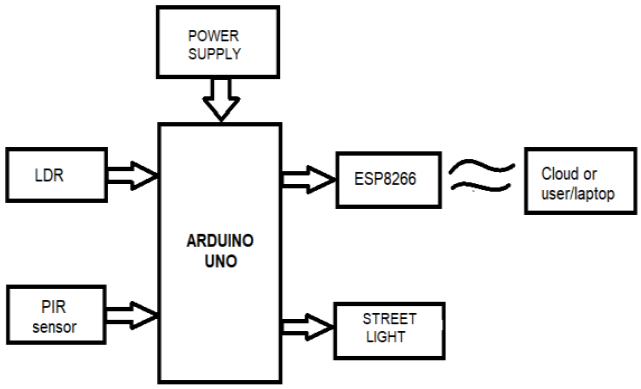

Fig 1. Block Diagram

2. MODULES AND DESCRIPTION

2.1 Arduino UNO

Arduino UNO WIFI Rev.2 is the simplest entry point to basic IoT with the standard form factor of the UNO family. Whether you're looking to build a sensor network connected to your office or home router, or if you want to create a Bluetooth® Low Energy device that sends data to a mobile phone, the Arduino UNO WiFi Rev.2 is your one-stop solution for many of the basic IoT application scenarios.

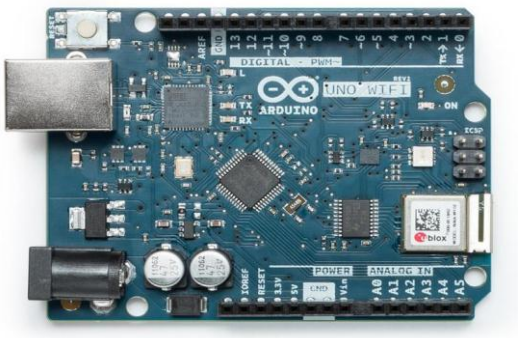

Fig 2. Arduino UNO

Arduino UNO WiFi Rev.2 has 14 digital input/output pins - 5 can be used as PWM outputs - 6 analog inputs, USB connection, power connector, ICSP header and reset button. It contains everything needed to support the microcontroller. To get started, just connect it to your computer with a USB cable or power it with an AC adapter or battery.

2.2 ATmega328

The ATmega328 is 32KB (with 0.5KB consumed by the bootloader). It also has an extra 2 KB of SRAM and 1 KB of EEPROM (which can be read and written using the EEPROM library)

Using this device allows Arduino code to be used in your own embedded project without the need for an actual Arduino board.

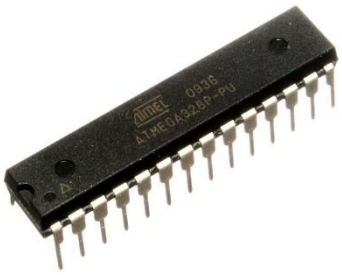

Fig 3. ATmega328

2.3 NODEMCU

NodeMCU is an open-source platform, its hardware design is open to modification/modification/build. The NodeMCU Dev Kit/board consists of ESP8266 chip with WIFI support. ESP8266 is a low-cost Wi-Fi chip developed by Espressif Systems with TCP/IP protocol. The NodeMCU Dev Kit has Arduino pins on its board as analog (i.e., A0) and digital (D0-D8). It supports serial communication protocols, i.e., UART, SPI, I2C, etc. Using these serial protocols, we can interface it with serial devices such as I2C-enabled LCD display, HMC5883 magnetometer, MPU-6050 gyro meter + accelerometer, RTC chips, GPS modules, touch screens, SD cards etc.

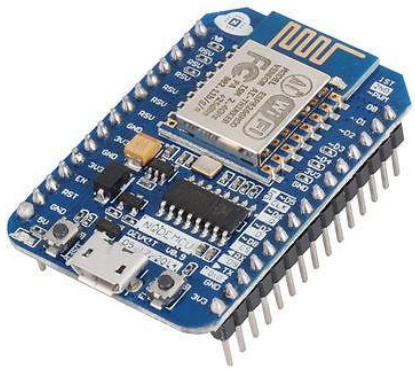

Fig 4. NODEMCU

2.4 ESP32

The ESP32 is a series of low-cost, low-power microcontroller systems on a chip with integrated Wi-Fi and dual Bluetooth. The ESP32 series uses either the Tensilica Extensa LX6 microprocessor in dual-core or single-core variants, the Xtensa LX7 dual-core microprocessor or the RISC-V single-core microprocessor and includes built-in antenna switches, an RF balun, a power amplifier, a low-noise receiving amplifier, filters and power management modules. The ESP32 is created and developed by Espressif Systems, a Chinese company based in Shanghai, and is manufactured by TSMC using their 40 nm process.[2] It is the successor of the ESP8266 microcontroller

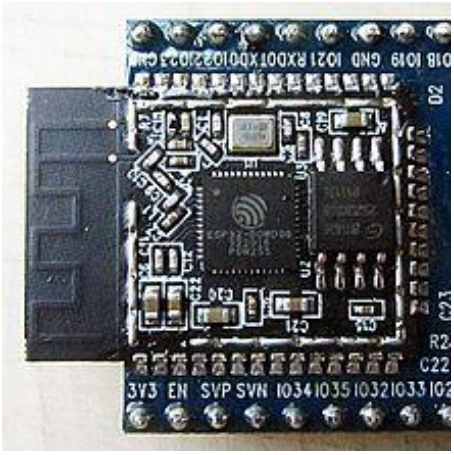

Fig 5. ESP32

2.5 Photo Light Dependent Resistors (LDR)

A light-dependent resistor (LDR) also called a photoresistor is a device whose resistance factor is a function of electromagnetic radiation. That's why they are light-sensitive devices that are similar to human eyes. They are also called as photoconductors, conductive cells or simply photocells. They are made of semiconductor materials with high resistance.

LDR works on the principle of photoconductivity. Photoconductivity is an optical phenomenon in which the conductivity of materials decreases when light is actually absorbed by the material. However, when light shines on the LDR, its resistance drops and current flows to the base of the first transistor and then the second transistor. The preset resistance can be turned up or down to increase or decrease the resistance, this way the circuit can be more or less sensitive. LDR send response to Arduino.

Fig 6. LDR

2.6 PIR Sensors

PIR sensors are also known as passive infrared sensors. A passive infrared (PIR) sensor detects infrared light emitted from nearby objects. PIR sensors only detect infrared radiation and do not emit it from LEDs.

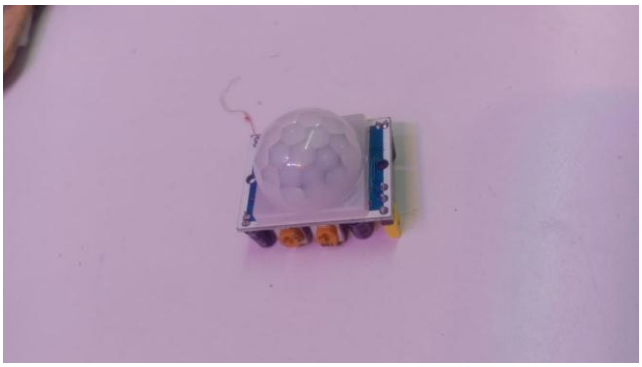

Fig 7. PIR Sensors

Passive infrared sensors consist of:

Two strips of pyroelectric material (pyroelectric sensor)

Infrared filter

(This blocks all other wavelengths of light)

Fresnel lens (which collects light from many angles to a single point)

Case (to protect the sensor from other environmental variables such as humidity)

2.7 LED

A light-emitting diode (LED) is a junction diode that emits light when activated. When we apply voltage to its wires, the electrons can recombine with the holes in the LED and release energy in the form of photons that give light. It is therefore a two-wire semiconductor light source.

Fig 8. LED

2.8 OLatus OL-BREADBOARD-400

A breadboard is simply a board for prototyping or building circuits. It allows you to place components and connections on the board and create circuits without soldering. Holes in a breadboard take care of your connections by physically holding the parts or wires where you place them and electrically connecting them inside the board. Each column is also labeled with a letter from A to J, which can be easily referenced in the instructions (like squares on a chessboard).

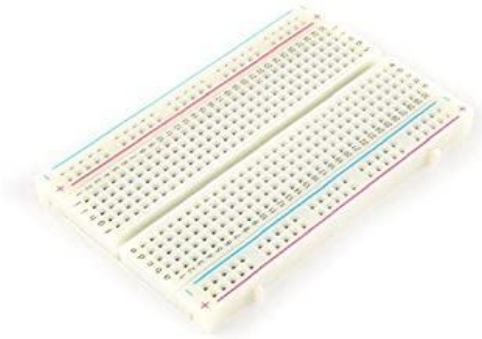

Fig 9. BREADBOARD

3. SOFTWARE REQUIREMENTS

3.1 ARDUINO IDE

The Arduino Software (IDE) is open-source software and makes coding and uploading to the board easy. Running on a device other than Windows, MAC OS, Linux. The environment is written in Java and can be used with any Arduino board before running the Java IDE software to be installed on the machine.

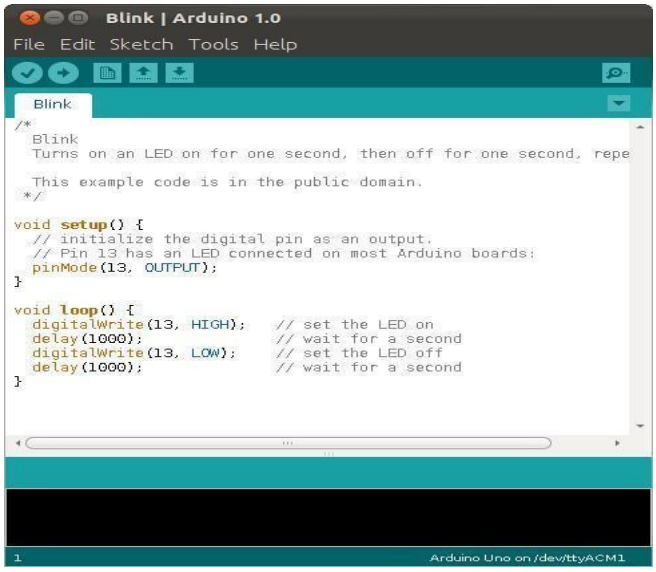

Fig 10. Arduino IDE

3.2 MQTT

It is a lightweight protocol used to communicate between devices. Devices typically "publish" (i.e., send) data to an MQTT "broker" (or server), which is then stored for delivery to other devices or web applications. Another device or web application "subscribes" to this dataset (i.e., requests data) from the MQTT broker, and the MQTT broker then delivers the data to them.

Think of it really as just a glorified web server with two major exceptions:

Data packets are very light (which increases speed, efficiency and cost)

MQTT can use other communication modes than just the Internet (e.g., Bluetooth)

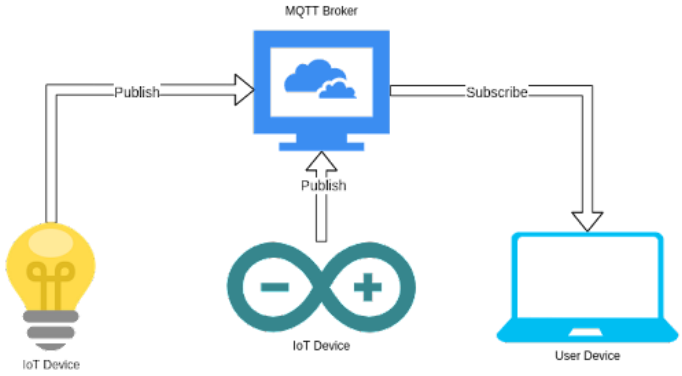

Fig 11. MQTT Broker with Devices

4. SPECIFICATIONS

Dynamic lighting controls based on movement detection;

Environmental and weather monitoring;

Digital signage that can update as needed, such as parking regulations or accident alerts;

Parking management, such as alerting officials of illegally parked vehicles or drivers of open spaces;

Extended cellular and wireless communications;

Traffic management through real-time data feeds that track congestion and speed.

Automatic emergency response in the event of a car crash or crime.

5. WORKING APPROACH

The LDR is connected to the analog pin of the Arduino. Controls LEDs by detecting the presence or absence of sunlight.

Condition 1:

When there is enough sunlight around, then the LDR offers high resistance and acts as an insulator. In this case, the Arduino will read the high values of the analog output from the LDR and automatically turn off all the LEDs (street lights).

Condition 2:

During the absence of sunlight, the LDR detects darkness and offers low resistance and acts as a conductor. In this case, the Arduino reads the low analog input values from the LDR and automatically turns on the LED (street lights).

Condition 3:

At the same time, the PIR sensor is also activated and starts to detect any vehicles or people moving on the road.

In this project we are using 2 PIR sensors which are connected to the digital pins of the Arduino. We also use 4 LEDs to represent the street lights, with each LED connected to the PWM pins of the Arduino. Each PIR sensor controls 2 LEDs. When one of the PIR sensors detects the position of a vehicle or person, its output will go LOW (0). Then the Arduino read the low output value from this sensor and increased the light intensity of the two LEDs using the Pulse Width Modulation (PWM) technique. When the PIR sensors do not detect any vehicle or human position or obstacle, its output will go to High (1). Then the Arduino read the high output value from this sensor. Now the Arduino reduces the intensity of the LED light using the Pulse Width Modulation (PWM) technique.

Condition 4:

At night, street lights dim to lower levels during off-peak hours, but automatically brighten when the presence of vehicles, cyclists and pedestrians are detected.

6. CONCLUSIONS

This paper "IOT Based Smart Lighting" can be an effective, eco-friendly and thus the safest technique to avoid energy wastage, and with this technique, sunshine status data can be accessed anytime, anywhere. It solves the problem that the earth is facing recently and saves energy. This document has scope in various different applications to provide lighting in industries, campuses and parking lots in countless large areas such as shopping malls. The article presents several advantages that could overshadow the current limitations. Considering the long-term benefits and thus the initial value would never be a problem as the payback period is extremely less.

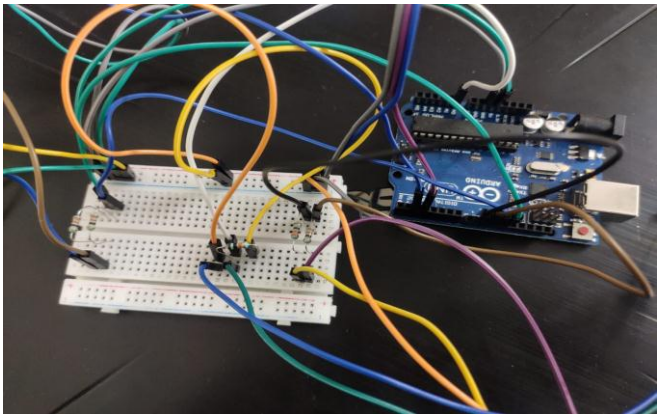

Fig 12. Circuit Connect of Smart Street Lighting System

ACKNOWLEDGEMENT

Prof A.D. Wankhade, Department of Information Technology, Government College of Engineering, Amravati, has been a tremendous source of support and guidance to the authors throughout this project.

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