SMART STREET LIGHTING AND MONITORING SYSTEM BASED ON SUNLIGHT INTENSITY DETECTION USING IOT AND CLOUD

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Abstract - *The aim of the smart street lighting system using IOT is the preservation of energy by dropping electricity consumption as well as to diminish the work force. Streetlights are the rudimentary part of any city since it eases better night visions, protected roads, and experience to community areas nonetheless it devours a impartially huge amount of electricity. In the labor-intensive streetlight system lights are power-driven from dusk to dawn with thoroughgoing intensity even when there is adequate light available. This energy wastage can be dodged by switching off lights automatically. This can be accomplished using an IOT enabled streetlight managing system. The main purpose of this project is to design an automated street lighting system which senses the sunlight intensity in its surrounds and automatically switches on and off depending on the sunlight intensity. The IOT based smart street lighting system also directs the data from the sensors to an open cloud server for monitoring and visualization. The working principle of the smart street lighting system is wholly controlled by microcontroller. It controls working of all the components. We can program the microcontroller and control the working of all the components to detect the light intensity, switch the lights on and off accordingly and send the data to the cloud server. We also focus on using LED lights instead of the HID lamps to improve the lifespan and reduce energy consumption.*

Key Words: **Microcontroller, Cloud Server, IOT, Sunlight intensity detection, LED.**

1. INTRODUCTION

The chief reflection in present field technologies are Automation, Power usage and cost efficiency. Automation is envisioned to lessen man power with the assistance of intelligent systems. Power saving is the main attention forever as the source of the power are getting weakened due to several reasons. This project aims to define a way for adjusting and automating street light illumination by using sensors at minutest electrical energy consumption. When incidence of sunlight is not sensed, all surrounding street lights glow at their brightest mode, and when the presence of sunlight is detected the bulbs will automatically turn off.

The use of LED lights is required because they outperform traditional incandescent lamps in every way. As a result, there will be a decrease in carbon dioxide emissions, power usage, maintenance and replacement expenses, and heat emissions. This project has the potential to save a lot of energy. The Internet of Things (IoT) will be used to create the implementation process, which will display the street light system's real-time updates and alert users to any modifications that are made.

To gather data from the sensors and provide visualizations based on the incoming light intensity, the threshold that has been set, and the starting light intensity with regard to time, we will be using an open cloud server called Thing Speak API in this project. We can more effectively monitor and maintain the street lights with the help of this data and visualizations.

2. LITERATURE REVIEW

Fathima Dheena, Greema S Raj,Gopika Dutt, Vinila Jinny[1]presented a review of researches done on the subject of Street Light automation. It included LED lights, LDR sensors, Arduino Nano and DHT11 Temperature-Humidity sensor. This delivers the precise temperature and humidity of a particular region. The street lights are turned off automatically based on the readings from these sensors. The projected work has attained an improved performance compared to the present system.

Sk Mahammad Sorif, Dipanjan Saha, Dipanjan Saha [2] In this paper, a streetlight control system built on the Bolt IoT platform is presented. This project's goal is to conserve energy by cutting down on wasted electricity and labour. The plan makes use of Light Emitting Diodes (LED). After detecting the density and movement of vehicles, IR sensors placed along the roadside give signals to the LEDs to begin shining for the next particular segment of the road. When compared to the current systems, the proposed work has produced better results.

Seher Kadirova, Teodor Nenov, Daniel Kajtsanov [3] By only switching on the lights through the darkest hours of the day, the goal is to maximize energy efficiency. The time for switching on and off the lights varies depending on the day of the year using GPS coordinates and the sun's trajectory.

The core tenet of the operation is based on the transmission and reception of information via the GPRS, GPS, and GSM networks to a built-in physical server that is connected in some way to the Internet network and receives position data and precise time from the GPS navigation system.

3. THE OBJECTIVE OF PROJECT

The specific objective of this project was

1. The major goal of this project is to create an IoT-based Automatic Street Lighting System, in which the street lights automatically turn on at nightfall and turn out at morning.
2. Traditional HID lights are replaced in the street lighting system by Light Emitting Diodes (LED). The high intensity discharge (HID) lamp, which is frequently used in inner-city street lights, is unlikely to be able to manage the intensity.
3. This proposed system uses an Arduino UNO board as the microcontroller which is programmed to control the entire system.
4. LDR sensors are used to detect the light intensity in the surroundings and a relay driver module is used to switch the LED on/off depending on the light intensity.
5. Data from the sensors is transmitted via an ESP8266 Wi-Fi module to the cloud server, or ThingSpeak API, where it is monitored and displayed.

4. COMPONENTS

4.1. Microcontroller

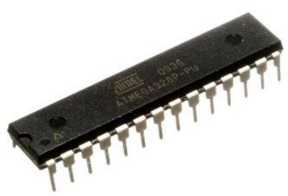

Figure -Microcontroller ATmega328p

The ATmega328P, is a single-chip microcontroller based on an 8-bit RISC CPU core. This little microcontroller is a great option for many applications because its low powered and reasonably priced. For many embedded control applications, it's a sensible solution in terms of cost .

4.2. LDR sensor

Figure -LDR sensors

A light-controlled variable resistor is referred to as a photoresistor, light-dependent resistor (LDR), or photocell. A photoresistor's resistance diminishes as the concentration of the incident light increases. It determines photoconductivity, in other words.

4.3. WIFI Module- ESP8266

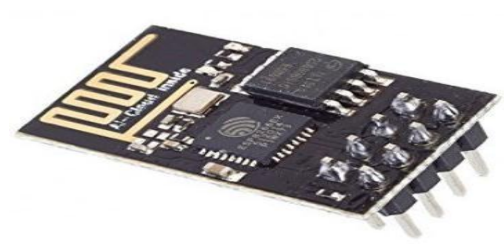

Figure -WIFI Module- ESP8266

The low pass Wi-Fi module ESP8266 allows the microcontroller to establish a connection over Wi-Fi.

ESP8266 module is used to deliver data to and receive data from websites. We are able to connect wirelessly between microcontrollers using the ESP8266 module.

4.4. Relay Driver Module

Figure -Relay Driver Module

Sensors need to drive bigger pieces of equipment that use large currents. Sensors generally produce small currents and relays help to make small currents into active large currents for the usage by the load. In our project we use an electromechanical relay. The relay driver also acts as a switch which turns the light on/off based on the command it receives from Arduino UNO after detecting the light intensity.

4.5. Arduino UNO

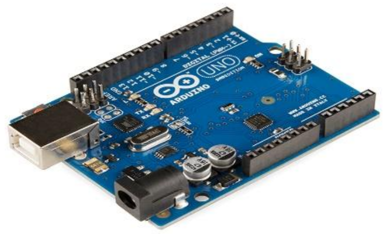

Figure –UNO Arduino

An open-source microcontroller board called Arduino UNO is built around the ATmega328P microprocessor. It is one of the most widely used development boards for DIY projects and prototyping. The board contains a 16 MHz quartz crystal, six analogue inputs, 14 digital input/output pins, a USB port, a power jack, and a reset button. The Arduino Integrated Development Environment (IDE), which employs a condensed form of C++, to program the board

4.6. Arduino IDE

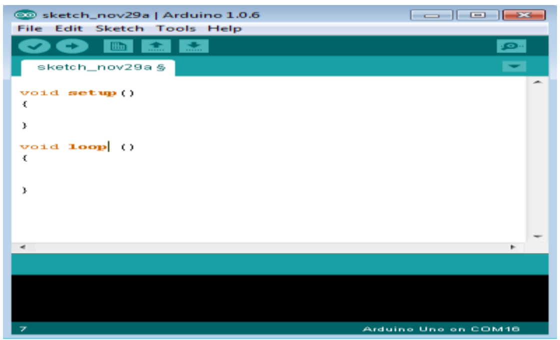

Figure -Arduino IDE

The code written in C++ to program the Arduino uno and control all components is written in the Arduino IDE. The code that you write for your Arduino are called sketches. Each sketch requires two functions SETUP and LOOP, which do not return anything. The commands underneath the setup function are implemented foremost by the Arduino. The commands underneath the loop function run repeatedly until the Arduino is being driven.

4.7. ThingSpeak API

For our project, we will use the ThingSpeak API to visually present past data collected by the sensors. With the assistance of the IoT analytics platform service ThingSpeak, we can collect, visualize, and examine real-time data streams online. Our devices allow us to direct data to ThingSpeak, see live data immediately, and give alarms. alerts.

Figure-ThingSpeak API

5. BLOCK DIAGRAM

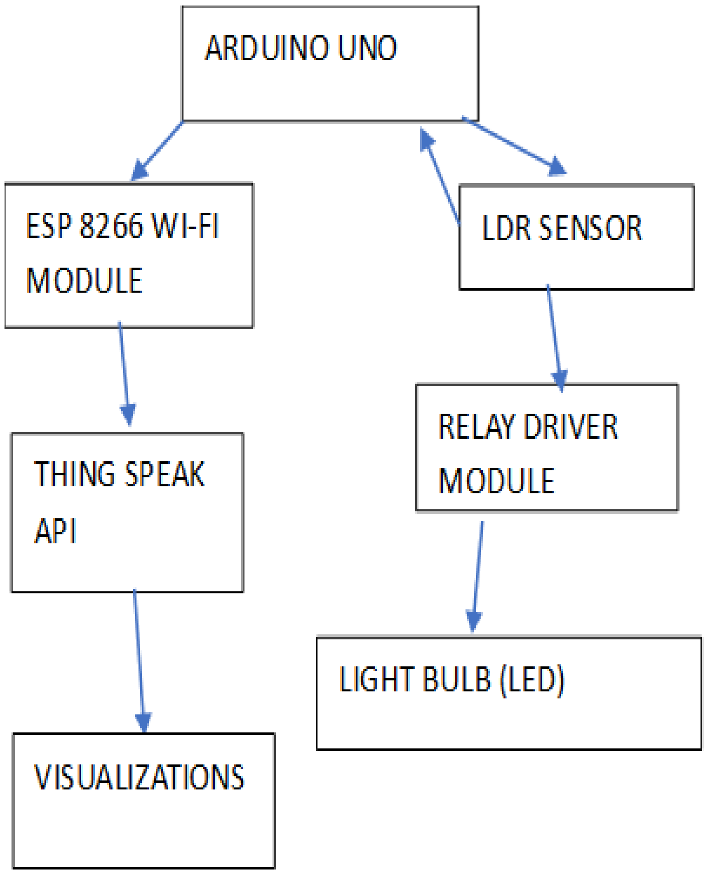

Figure -Block Diagram

6. FLOWCHART

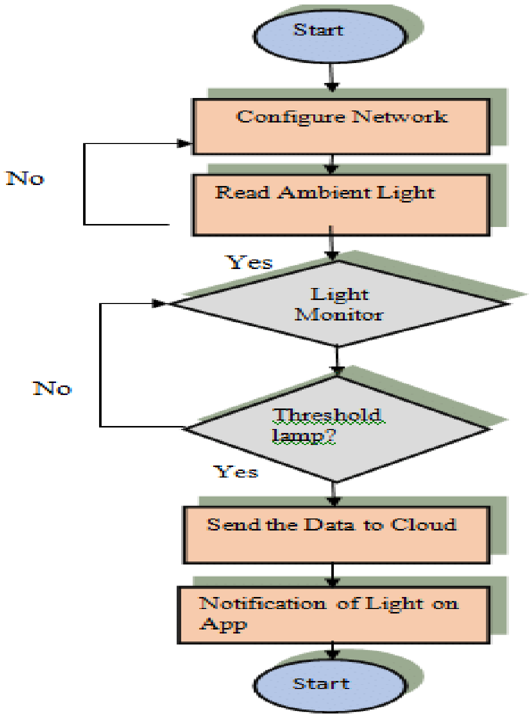

Figure-Flowchart

7. WORKING

The Smart Street Lighting System uses Arduino UNO that can be power by a 9 volt battery or by a USB to UART cable as its microcontroller to control the working of all the components of the system. We program the Arduino UNO using C++ and through the Arduino IDE. The LDR sensors are continuously detecting the intensity of the incoming sunlight. We set a specific threshold value and program the Arduino to detect whether the incoming light intensity on the LDR sensors is less than or greater than this threshold value.

If The street light is automatically switched on during the day if the incoming light intensity exceeds the threshold value, and automatically turned off during the night if the incoming light intensity is less than the threshold value. A known voltage is delivered across the circuit, and an LDR is connected to a known resistance. The microcontroller records the voltage divider circuit's output voltage and uses it to calculate the change in resistance.

Since the incoming and outgoing current to and from the sensors is very small and cannot be used to drive the larger load(LED Bulb), we use a relay driver module to control the current voltage from the sensors. Also, the relay driver is used as a switch to turn the LED light bulb ON/OFF depending on the data from the LDR sensors.

The use of IOT technology also significant here. We use an ESP8266 WI-FI module to send the data from the sensors to an open cloud server(ThingSpeak API) for analysis and visualization. The ESP8266 can only function between 3-3.6 volts any current above this voltage will permanently damage the ESP8266 WI-FI module. We use AT commands to test and configure the ESP8266. AT commands can be used for functions like connecting to the available WI-FI network, Connect a microcontroller to the ESP module and begin sending data to the internet. Open TCP connections without needing your own microcontroller's TCP/IP stack to be operating.

We will be using the ThingSpeak API for our project to display historical data measured by the sensors, in a visual format. We may gather, visualize, and analyze real-time data streams online with the aid of the IoT analytics platform server ThingSpeak. ThingSpeak can receive data from your devices, instantaneously visualize real-time data, and direct notifications.

8. RESULT

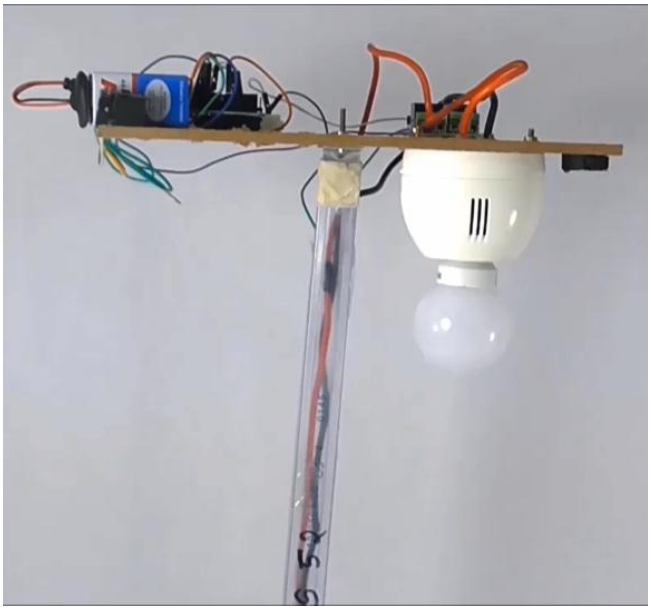

Figure-Hardware of Project

By using this system it is possible to switch the lights ON/OFF automatically by detecting the sunlight intensity in the surroundings, hence we will be saving a large amount of energy when we use this system on a large scale across the world. The involvement of human interaction is also minimized due to the usage of IOT and cloud. If there is any breakdown in our system or failure in any components we can identify it remotely.

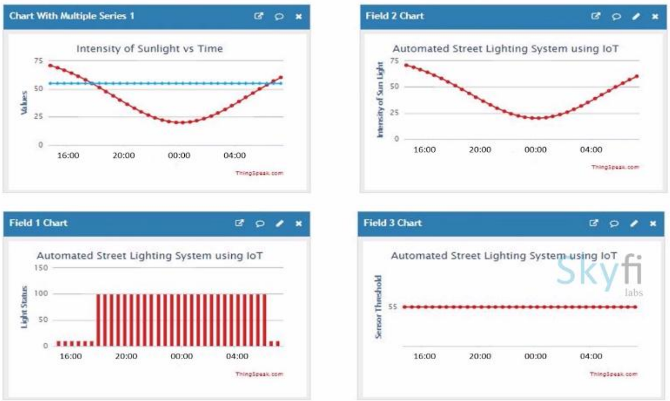

Figure – ThingSpeak analysis

9. ADVANTAGES

- Huge reduction of energy and maintenance cost.
- Increased public safety from improved lighting.
- Quantifiable ecological effect due to abridged energy consumption.
- There are lower chances of the automatic street light system overheating & risk of accident is also minimized.
- Price of functioning automatic street light is far less as and when compared to the orthodox street lighting system.
- The automatic street light system is eco-friendly & hence assists in reducing the carbon footprint.
- Reduced requirement of manpower which caused reduction in probability of errors to occur.
- Higher community satisfaction.
- Fast Payback and easier maintenance as all the information about the LED lights and the intensity is constantly sent to the server for monitoring.
- Promote usage of LED light bulbs to emit light in specific direction thereby optimizing the efficiency of the streetlights.
- LED lights might last up to 45,000 hours while HIDs have a life span of around 15,000 hours.

10. CONCLUSION

In conclusion, a smart street lighting system using IOT and cloud based on sunlight intensity detection has several benefits including energy savings, improved safety and reduced maintenance costs. By using sensors to detect the level of sunlight and adjust the brightness accordingly, this system can optimize energy consumption while still providing adequate lighting for pedestrians, cyclists, and motorists.

There are also several potential future enhancements that could be made to the system, such as integrating with weather data, adding motion detection, using adaptive learning algorithms, incorporating wireless connectivity, and utilizing renewable energy sources. These enhancements could further improve the efficiency and effectiveness of the street light automation system, making it an even more valuable investment for municipalities and communities around the world.

11. REFERENCES

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