# DESIGN AND CONSTRUCTION OF IoT BASED STREET-LIGHT FAULT, MONITORING AND CONTROLLING SYSTEM FOR GREEN CAMPUS OF IIUC

by

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INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

AUGUST 2022

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**BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING**

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# CERTIFICATE OF APPROVAL

The project entitled as "**Design and Construction of IoT based Street-Light Fault, Monitoring and Controlling System for Green Campus of IIUC**" submitted by **MD. GOLAM SAMDANI BHUIYAN,** bearing Matric ID. **ET 171057** and **MOHAMMAD BORHAN UDDIN**, bearing Matric ID. **ET 171062** of session **Spring 2021**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **22 JULY, 2022.**

__________________________________

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# DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this project has been submitted elsewhere for the award of any degree or diploma.

Md. GOLAM SAMDANI BHUIYAN

MOHAMMAD BORHAN UDDIN

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All praises and thanks to Allah (SWT), the Lord of the world, the most Beneficent, the most Merciful for helping us to accomplish this work. We would also thank our supervisor Engr. Sk. Md. Golam Mostafa, Associate Professor of Department of Electrical and Electronic Engineering, IIUC for helping us get started by giving the basic ideas and concepts we required for the project and too for his continuous guidance and support. We would also like to thank our parents who gave inspirations all the time for completing the project. At the end, we would like to give our cordial thanks from our heart to our batch people who gave us huge mental support and also shared their knowledge that helpful for establishing our project.

Authors

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# ABSTRACT

The primary focus today is reducing carbon emissions to save the planet. The CFC layer is affected by carbon emissions as well, which raises the earth's temperature. In this era, most of the university campus authorities in Bangladesh have become inspired for making their campus green. Because of green technology, carbon emission is low. In order to fix a problem, we must identify the problem. Nowadays, in developing countries like Bangladesh, the street light system is currently used, where anyone can notice that the street light remains on during the day and not properly on at night. Besides, this existing system is costly from what people can see a lot of energy is being wasted which is a big financial loss for us. Light emitting diodes are the commonly used street lighting solution nowadays. The project is to create a model using some sensors to design a low-cost street lighting system that can save energy consumption and reduce manpower. In this project, considering three types of places for IIUC campus and checking the dimming slot time for the lights. Finally, scheming the electricity consumption cost according to the model having 10% consumption of power at dimming hours and 100% consumption at the rest of the times. After that, lighting cost is saved in comparison with existing street light system in the campus.

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| **ASP** | Active Server Pages |
| **CPU** | Central Processing Unit |
| **GSM** | Global System For Mobile Communication |
| **GUI** | Graphical User Interface |
| **IIC** | Internal Investigation Command |
| **IOT** | Internet of Things |
| **LED** | Light Emitting Diode |
| **LCD** | Liquid Crystal Display |
| **SPI** | Serial Peripheral Interface |
| **SCA** | Surface Charge Analysis |
| **SDA** | System Design Authority |
| **USB** | Universal Serial Bus |
| **UART** | Universal Asynchronous Receiver Transmitter |

# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction

The Internet of Things (IoT) is a connectivity of devices, automobiles, and others which are integrated with various software and hardware present inside a device which helps the devices communicate in two ways with each other. The integrated computing system allows each thing to be identified uniquely with the help of the internet [1]. Internet of things provides us with a lot of new technology which would turn the current cities into smart cities. These new technology can decrease the power consumption of the smart street lighting system (SSLS) by approx 30% [2],[3]. For this reason, university authorities take their steps to make their campus smart, green and also to decrease the waste of power consumption. But due to the frantic lifestyle and the added responsibility which the people have these days the operation of turning the street light on and off manually is not done on time. In some cases the lights are turned on early with a lot of sun light still left and sometimes the street light is not turned on even when the intensity of light has fallen below a particular level. During the morning also the street lights are sometimes not turned off on the right time which results in wastage of electric power. Street light control and monitoring system based on IoT is a project that aims to improve the problem of late-night power usage and street illumination. Today's street lights are being replaced by LED street lighting systems, which consume less energy. Another advantage of LED lighting is that the intensity may be readily changed. As a result, street light control based on movement detection is simple to implement [4]. The need of balancing the demand verses supply have to be focused, and for that reason reducing wastage of electrical power in the street-light area must be drawn attention. The use of street lighting has been shown to reduce walker crashes by nearly half. Street Light Monitoring and Control is an automated system that uses timed, controlled switching of street lights to boost an enterprise's efficiency and accuracy [5]. However, in the future, many developing countries will construct a large number of street lights and need a large amount of electricity to power them. Thus, even if LED lights are utilized, reducing electric energy consumed by street lighting is required to limit greenhouse gas emissions in order to make our environment green more.

For that reason, by making street-light system smart is not sufficient, we must make this smart system as a green project for our campus also. So that our system is based on renewable sources, is controlled by ARDUINO NANO which is further connected with a WIFI-Module to control the whole system. Our system is based on DC power to go the lights into the dimming condition, as well as saving energy also. The battery of our system is charged by the solar, so the system produces green energy into the environment. To make a smart, cost effective and power consuming in our system is the main focus issue.

## 1.2 Background

The Internet of Things is a network of connected gadgets, cars, and other objects that have diverse software and hardware inside them that enable two-way communication between them. The integrated computing system enables with the aid of the internet, each item will be uniquely identifiable. In order to reduce power consumption, the IoT based street light control and monitoring system is a project on intelligent illumination control of street lights whereas manual controlling and using other street lamp instead of LED costs much. Consequently, it is easy to build movement detection-based automatic street light control.

## 1.3 Problem Statement

Lighting might contribute for (10–38) % of the total energy cost in frequent region globally [6]. According to Dhaka Tribune, 420 MW of power worth about 34 lakh is wasted every month because of the negligence of the city corporation staff in switching street-lamps off and on. This could have been used to meet the demand of 4000 non-urban households or an entire district town. Same problem is also happened in any university campus. Sometimes we see that some of street-light in the roadside or campus is remain ON early in the morning, some of street-light will remain OFF after the sunset also. Those are totally mismanagement of wasting electricity day by day.

That's why our proposed project is to minimize those problems by the combination of using green energy and Internet of Things (IoT) and take the initiative so that it can help other research team who are trying to assuage this problem.

## 1.4 Objectives

- To design and construct the IoT based Street light fault, monitoring and controlling system;
- To reduce the electricity cost in comparison with the existing system;
- To make an easier process in monitoring.

## 1.5 Motivation

Energy loss is a significant issue in Bangladesh, much like in other emerging nations. Also our population is increasing day by day. 420 MW of electricity are required each month for the street lighting system [7]. So everyone should concern about ensuring the economical usage of electricity. The motivation of our project work came from noticing these kinds of problem. So our proposed work will help to design and construct a smart, power saving and green street light system controlled by IoT.

## 1.6 Outline of the Report

➢ Chapter 1 is the introductory chapter that gives the overview, motivation and objective of the project.

➢ Chapter 2 is literature review. Previous work related of this project has discussed in this chapter.

➢ Chapter 3 is hardware description. In this chapter, all the components used in this project has described elaborately.

➢ Chapter 4 deals with the system design of the project. In this chapter Block diagram, Circuit diagram, Flow chart and Programming of the project has discussed.

➢ Chapter 5 deals with the system implementation and results, Objective verification and system specification.

➢ Finally, the summary of this project has discussed in detail in chapter 6. The limitation of the project, advantage and future development has discussed on this topic.

# CHAPTER 2
# LITERATURE REVIEW

## 2.1 Introduction

Saving energy is very important for development country like us. Most of the time, the huge amount of electricity were lost just because of negligence. This negligence rate is high on street light system. To make a smart street system and also a green effective system, the combination of IoT and renewable sources must be in action.

## 2.2 Review of Previous works

The reviews of our project is done by some authors and accumulating of information or data from research paper published in journals to progress our project. This is a nice path through which we can find new ideas and concept to make our university campus green with implementing a prototype of smart streetlight system.

### *2.2.1 Smart and adaptive street lighting system using IoT:*

R. Keerthana, B. Magila, R. Vaishnavi [8] gave us an explanation of "**Smart and Adaptive Street Lighting System using IoT**". The proposed study outlines the Wi-Fi-based Internet of Things (IoT) street light automation system. The Wi-Fi module and the IoT system built on Arduino are coupled in this system. It makes use of wireless technology and is Wi-Fi based. The system consists of three main parts: an Arduino, a Wi-Fi adaptor for signal transmission, and a smartphone for operating the web page server. The smartphone communicates with the independent Arduino. Wi-Fi board using Wi-Fi, and the components are connected to this board using a relay. Using a smartphone application, this was put together and the work was completed. The system that is being suggested was created to automatically switch on and off street lights utilizing wireless communication.

### *2.2.2 Solar energy based street light with auto-tracking system:*

A. C. Kalaiarasan [9]: deals with solar energy based street light with auto-tracking system for maximizing power output. For maximizing the power output from the solar panels, someone needs to keep panels aligned with the sun. As such the sun is required for tracking. This is a by far the most cost-effective solution than purchasing additional solar panels. It has been estimated that the yield from solar panels can be increased by 30 to 60 percent by utilizing a tracking system instead of a stationary array. The control mechanism created in this project will spin the panel up and down, as well as right and left, according to the angles, as if it were vertically aligned with the sun position. This closer approach will allow the sun's rays to be utilized to their potential.

### *2.2.3 IoT Based Intelligent Street Lighting System for Smart Cities:*

K. Bhagavan, G. Mounika and others [10], exertion on IoT based intelligent street lighting system that combines new technologies to simplify maintenance and save energy. This system provided automatic streetlights ON/OFF, reduce the upkeep price and light pollution and also save the wasted energy.

### *2.2.4 Streetlight monitoring using IoT:*

Sagar Patil, kiran Wable and others [11], furnish with a clear concept about the **'Smart Street Lamp System'**. The basic goal is to automate the conventional lighting system. They discovered that the majority of current smart light systems use a network sensor that detects motion and sends the information to every bulb linked to the network, resulting in wasteful electricity use by the lamps where no motion was even detected. They suggest placing the sensors individually around the lamps to get around that. Consequently, it will be guaranteed that just the appropriate amount of energy is being used.

### *2.2.5 ZigBee Based Remote Control Automatic Street Light System:*

Srikanth M, Sudhakare K N [12], in their work on ZigBee Based Remote Control Automatic Street Light System. Here, street light are powered by solar energy. Secondly sensors senses the data, gather the information and sends to microcontroller. Then microcontroller controls the signal and runs the software to analyse the system. Light sensor gets activated if light illumination is achieved

less than fixed threshold to switch the lights ON, else OFF. For example in rainy or winter season automatically control takes action over DIMMING illumination, acts as supporting feature for natural light. Finally, ZigBee device (at transmission side) is ready to receive information from streetlight and communicate with ZigBee device (at receiver side), then sends to terminal via USB cable. ZigBee device communicates point-to-point to detect the faulty lights in the system.

### *2.2. 6 The core technology of the street light control system:*

Hengyu Wu, MinliTang [13] proposed 'The core technology of the street light control system is an AT89S52 single-chip microcomputer'. This paper is and theoretic proof and shows only simulation result but not as a real time set up experiments. The focus of this paper to build a way for the framework which may leads to many follow up research activities in the Low-rate and also plan to investigate the applicability of this proposal to detect performance. This project integrates a power circuit, a fault detecting circuit, an infrared detecting circuit, an LCD display circuit, a photosensitive detection circuit, a street light control circuit, a pressed key control circuit and so on. This system can automatically turn on or off the lights and controls the switches according to traffic flow. Main weakness is that it didn't say anything about the working principle behind the system. It also said to use fault detection circuit which when damaged, causes the voltage to drop to zero, thereby creating a problem.

### *2.2.7 Street light controller with GSM technology:*

GSM based street light automation is basically used to control street light automatic by the help of GSM module. It is designed to performing and increase the efficiency of street light even more during in night. It consists of an 89C51 microcontroller which is on settings of time delays switch On /off the street light and sends the update through a phone to a specific phone number.

**Table 2.1:** Comparative Study

| **Comparison** | **Related Project** | **Proposed Project** |
|---|---|---|
| Management system | Most management systems are manually. | The management system can be controlled totally automatically. |
| Monitoring and Controlling Section | Physically monitoring and controlling system; some time need to collect data. | Server based monitoring and controlling. |
| Purpose of User | User friendly. | So more user friendly to use. |
| Extra Features | Not having smart and green to use for university campus. | Our project is easier to use, smart with reducing CO2 to make our campus green |

From the comparative table, our proposed project system can be controlled automatically as well as the maintaining cost will be reduced. It is a combination of a smart street-light system and IoT based where the carbon emission can be possible to our university green. Most of the related previous works are not user friendly, but our proposed model is easy to use and to control as well.

# CHAPTER 3

# HARDWARE SUMMERY

## 3.1 Introduction

In this chapter we are going to describe the hardware used for this project. We will also discuss the function of the chosen parts. By the end of this chapter one will understand the reason behind choosing the used components and their function to this project

## 3.2 Methodology

Firstly the sun rays fall down to solar panel and the battery energized from the solar panel. We used 12V battery, but all our equipment has voltage rating of 5V. We generated 5V by using regulator IC. To check light intensity we used 7 LDR, where one LDR is checking the sunlight and others are checking the intensity level of LED lights. We also used ultrasonic sensor to detect any moving cars or obstacles. When any obstacles detected, the LDR full bright up the LED lights and at the other hand all the lights will be dimming condition. All these info were sent through WIFI module and stored in the server.

## 3.3 List of Components

1. 20W Solar Panel
2. Battery
3. ARDUINO NANO
4. LCD
5. LDR
6. Thermistor
7. Current Sensor
8. Resistor
9. Ultrasonic sensor
10. Vero Board
11. Wifi- Module
12. Regulator IC

### *3.3.1 Solar panel*

Solar panels are devices that absorb the sun's rays and convert them to power or heat. In essence, it is a collection of solar (or photovoltaic) cells that can be used to create electricity via the photovoltaic effect. Installation panels made of solar in anywhere assists to combat the pernicious emission of carbon dioxide and also helps reduce global warming [14].

**Figure 3.1** shows the solar panel & its' configuration using in the project to produce green energy for the university campus.


**Fig.3.1** Solar Panel

The above figure indicates the 20W solar panel configuration. The operating voltage and the operating current of this panel are 18.48V, 1.08A. The short circuit voltage and the open circuit current are 22.17V, 1.16A

### *3.3.2 12v Battery*

Uninterruptible Power Supply (UPS) is a type of power supply when the electrical power dips to an unacceptably low voltage level, a battery backup is required. Utilizing a modest UPS for a few minutes to power down the computer or IT instruments in a controlled manner, while larger systems have enough battery to last several hours. This system can be put up to vigilant file servers to shut down in an orderly manner when an outage has occurred, and the drying up [15].

This **Figure 3.2** shows us the configuration of the battery.


**Fig. 3.2** 12V Battery

Hhere the maximum voltage is 12V and the current rating is 7.5AH. The initial current of this battery is less than 2.1A.

### *3.3.3 Arduino Nano*

Arduino Nano is a microcontroller board built on the Atmega328p/Atmega168 by Arduino.cc. Robotics, embedded systems, automation, Internet of Things (IoT), and electronics applications frequently use Arduino boards. Originally intended for non-technical consumers and students, these boards are now often employed in industrial projects. input voltage ranges from 7V to 12V. 16MHz is the clock frequency of this unit which is used to generate a clock of certain frequency using constant voltage [16].

**Figure 3.3** gives a schematic view of Arduino Nano.

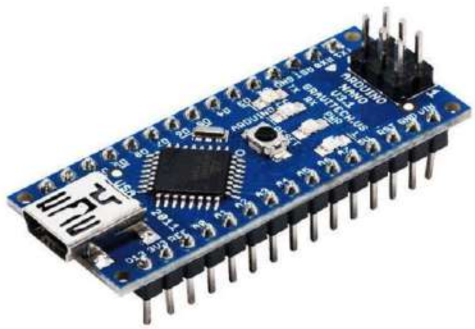


**Fig.3.3** ARDUINO NANO [17]

From that figure, we can easily make tables about the ARDUINO NANO specification as well as PIN description also.

**Table 3.1:** Arduino Nano Specification [18]

| | |
|---|---|
| Microcontroller | Atmega328p/Atmega168 |
| Operating Voltage | 5V DC |
| Digital I/O Pins | 14 |
| Input Voltage | 7-12 V DC |
| Flash Memory | 16KB or 32KB |
| USB | Mini |
| Max. Current Rating | 40mA |
| PWM | 6 out of 14 digits pin |
| Analog pins | 8 |
| Crystal Oscillator | 16MHz |
| SRAM | 1KB or 2KB |
| USART | Yes |
| EEPROM | 512bytes or 1KB |

From the table, the Arduino Nano has the atmega328p or atmega168 microcontroller. The operating voltage will be 5V DC and the input voltage is between 7-12V DC. It includes also a mini USB Port, 16KB/ 32KB flash memory. It has 14 Digital I/O PINS where 6 PINS is used for PWM. The maximum current rating of this device is 40mA.

**Table 3.2:** Arduino Nano Pins Decription [18]

| Pin | Name | Type | Function |
|---|---|---|---|
| 30 | VIN | Power | Supply voltage |
| 29 | GND | Power | Supply Ground |
| 28 | RESET | Input | Reset (Active Low) |
| 27 | +5V | Output or Input | +5V Output (From On-board Regulator)<br>+5V (Input from External Power Supply) |
| 19-26 | A0-A7 | Input | Analog input (0-7) |
| 18 | AREF | I/O | ADC reference |
| 17 | 3V3 | I/O | +3.3V Output (from FTDI) |
| 5-16 | D2-D13 | I/O | Digital I/O pin |
| 4 | GND | Power | Supply Ground |
| 3 | RESET | Input | Reset (Active Low) |
| 2 | D0/RX | I/O | Digital I/O pin<br>Serial RX pin |
| 1 | D1/Tx | I/O | Digital I/O pin<br>Serial TX pin |

### *3.3.4 LCD*

LCD is known as a type of flat panel display that uses liquid crystals as its principal mode of operation. It improves visual quality and supports high resolutions. This device works on blocking light. The idea is that when an electrical current is passed through a liquid crystal molecule, it causes the molecule to change shape. As a result, the angle of light traveling through the polarized glass molecule changes, causing the angle of the top polarized filter to vary as well. Through a certain location of the LCD, a small amount of light is allowed to pass through the polarized glass [19].

**Figure 3.4** exhibits a 16*2 LCD graphic view in both sides view and from that, the characteristics of Liquid Crystal Display, pins description can be introduced.

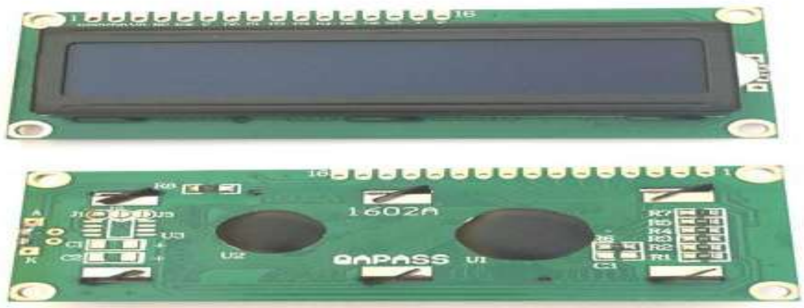


**Fig.3.4** LCD 16*2 [20]

- The operating of this LCD is 4.7v – 5.3v
- It includes 2 rows where each row can produce 16 characters
- The utilization of current is 1 mA with no backlight
- Every character can be built with a 5 X 8 pixel box
- The alphanumerical LCDs alphabet and numbers
- It display can work on 2 mode like 4-bit and 8-bits
- These are obtainable in blue and green backlight
- It displays a few custom generated characters.

**Vss Pin ➔** It displays GND pin connects to the microcontroller unit’s GND terminal or a power source.

**Vdd Pin ➔** This connection connects the power source's supply pin to the display's voltage supply pin.

**V0 Pin ➔** This pin controls the display’s contrast by using a variable POT to deliver 0 to 5V.

**RS (Register Select) Pin ➔** That pin selects between command and data registers and is used to connect a microcontroller unit pin. It can be set to 0 (Data Mode) or 1 (Command Mode).

**RW(Read/Write) Pin ➔** This pin switches the display between reading and writing operations and is connected to a microcontroller unit pin that accepts a value of 0 (Write Operation) or 1(Read Operation).

**E (Enable) Pin ➔** To execute the Read/Write procedure, this pin must be held high. It is connected to the microcontroller unit and must be kept high at all times.

**D0 - D7 Pins ➔** Data is sent to the display through these pins. Two-wire modes, such as 4-wire mode and 8-wire mode, are used to connect these pins. Only four pins are connected to the microcontroller unit in 4-wire mode, whereas eight pins are connected to the microcontroller unit in 8-wire mode.

**A (Anode) & K (Cathode) Pin ➔** For LEDs, A pin is connected to +5V and the K pin is connected to GND.

### *3.3.5 LDR*

Light-dependent resistor is also known as LDR, or photo-resistors are electronic components used to detect light and change the operation of a circuit dependent upon the light levels. Light-dependent resistors are often used in electronic circuit design, where the presence or level of light needs to be detected [21].

**Figure 3.5** is the graphical representation of a Light Dependent Resistor.

**Fig. 3.5** LDR [22]

The LDR is having two resistors, one is fixed and other is varying according to light. When any light is near to that variable resistor the resistance will be reducing and when there is no light, that variable resistor increase his resistance.

### *3.3.6 Thermistor*

A thermistor is a resistor whose resistance is dependent on temperature. It is made of metallic oxides, pressed into bead, disk or cylindrical shape and then summarized with an impermeable material such as epoxy or glass. Temperature coefficients can be negative or positive. When using an NTC thermistor, the resistance reduces as the temperature rises. The resistance of a PTC thermistor increases as the temperature drops [23]. The NTC thermistor is shown in **Figure 3.4.**


**Fig. 3.6** NTC Thermistor (10Kohm) [24]

We use thermistor for the project to see the temperature of the sun in our controlling server. According to the temperature we can easily understand which day is perfect for our solar to charge up the battery for a long time.

### *3.3.7 Current Sensor*

A device that detects current and converts it to a quantifiable output voltage proportionate to the current flowing along the measured path is known as current sensor. This sensor is based on open or closed loop hall-effect technology. Because different sensors have distinct qualities for different purposes, the technology that uses this sensor is vital [25].

**Figure 3.7** introduces with the image view of ACS-71 Current sensor.


**Fig. 3.7** Current Sensor ACS-71 (5A**) [**26]

The current sensor we use for this project to check the load current of the system. The rating of our current sensor is 5A.

*3.3.8 Resistor*

Passive electrical component with two terminals that are used for either limiting or regulating the flow of electric current in electrical circuits is resistor. The main reason of resistor is to reduce the current flow and to lower the voltage in any particular portion of the circuit. In a direct-current (DC) circuit, assuming all other things are equal, the current through a resistor is inversely proportional to its resistance and directly proportional to the voltage across it. This is the well-known Ohm's Law. This criterion also holds true in alternating-current (AC) circuits as long as the resistor has no inductance or capacitance [27].

**Figure 3.8** is the simplified view of a resistor.

**Fig. 3.8** Resistor [28]

The resistors are using for this project having the value of 4.7Kohm and 10Kohm.

*3.3.9 Ultrasonic Sensor*

An electrical device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into electrical signal is familiar as Ultrasonic sensor. Ultrasonic sensors have two main components: The transmitter which emits the sound using piezoelectric crystals and after it has travelled to and from the target, the receiver encounters the sound [29].

**Figure 3.9** is the graphical representation of HC-SR04 ultrasonic sensor.


**Fig. 3.9** Ultrasonic Sensor (HC-SR04) [30]

This Device has four pins. One pin is for VCC and other is for grounding. Other two pins are ECHO and TRIGGER where the echo takes the input wave signal and is transmitting the signal to the trigger as output.

### *3.3.10 Vero Board*

Vero board is a printed circuit board having holes drilled on it for electronic components to be attached to build an electric circuit. This wiring board can be used for developing electronic circuits from the ground up, building prototypes for bench testing, or mass-producing full electronic products in small quantities [31].

**Figure 3.10** depicts the Vero Board.

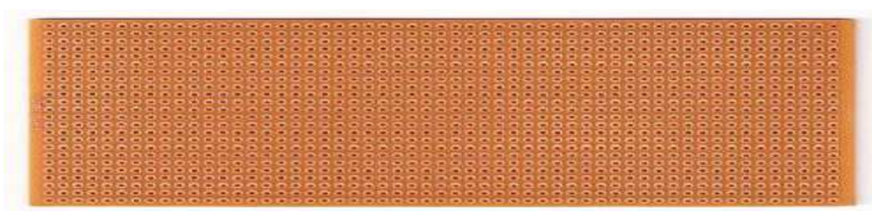


**Fig. 3.10** Vero Board [32]

We should place the equipments in the VERO Board with the proper way. Interfacing the sensor with ARDUINOs and the interfacing between Wifi- Module and NANOs must be placed according to circuit Diagram.

*3.3.11 ESP-8266 WeMos D1 Mini*

The low-profile WeMos D1 Mini is an affordable ESP8266-based WiFi board that is just as potent as any NodeMCU or ESP8266-based microcontroller. The D1 Mini is very adaptable because to its low cost, WiFi capability, and complete compatibility with the Arduino platform. The D1 Mini will function as an Arduino board after completing this lesson, which introduces the ESP8266 library and board manager. In order to use the module's WiFi capabilities, a basic web page will then be introduced. Any WiFi-enabled device can communicate with the board and wirelessly control its pins thanks to the D1 Mini's web server function [33].

WeMos D1 mini pinout is shown in **Figure 3.11.**

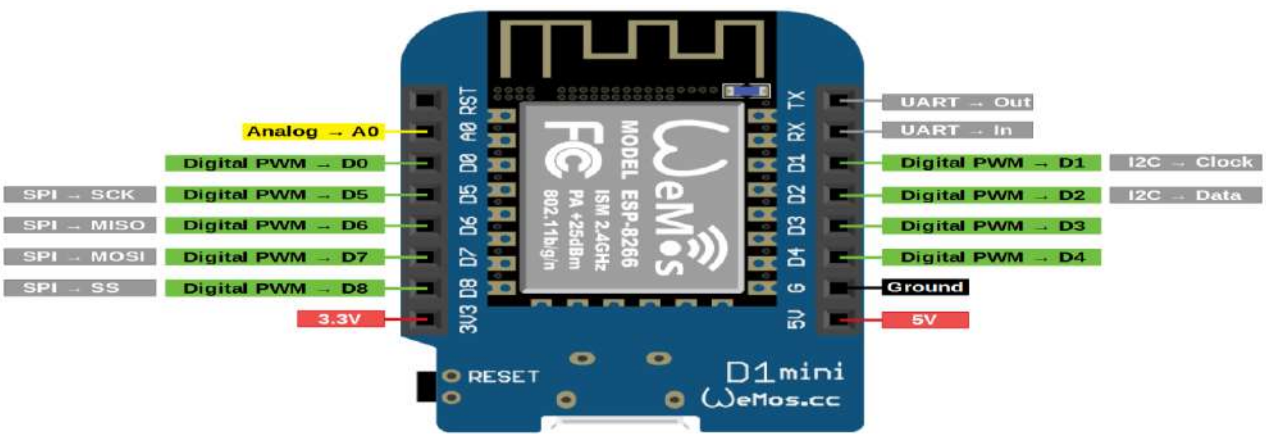



**Fig. 3.11** Pinout Configuration of ESP-8266 WeMos D1 mini [34]

The technical highlights and capabilities of ESP-8266 WeMos D1 mini are here [35]-

- Easy to use for I0T projects with micro-USB connection and build in WiFi (IEEE 802.11 b/g/n)
- Low energy consumption in the deep sleep power mode (0.17mA) and therefore very well suited for battery powered projects.
- Fast processing power with up to 160 MHz compared to 16 MHz for the ATmega328p (Arduino)

### *3.3.12 Regulator IC*

A voltage regulator is an integrated circuit (IC) that provides a constant fixed output voltage regardless of a change in the load or input voltage. It can do this many ways depending on the topology of the circuit within, but for the purpose of keeping this project basic, we will mainly focus on the linear regulator. A linear voltage regulator works by automatically adjusting the resistance via a feedback loop, accounting for changes in both load and input, all while keeping the output voltage constant. Regulator in integrated circuit form have substantially simplified power supply design, and the variety of designs, power handling capability, and reliability have continually improved since their introduction [36].

**Figure 3.12** reflects the schematic view and pins name of the LM7805 regulator IC.

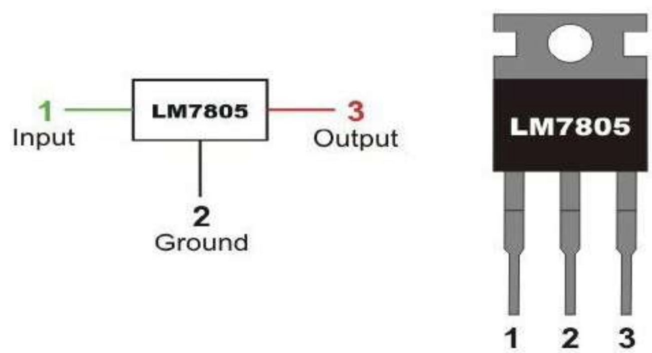



**Fig. 3.12** LM7805 PINS Configuration [37]

In our project we used 12V battery, but most of the components are having the operating voltage 5V; that's why we converted our 12V voltage into 5V by using the Regulator IC.

# CHAPTER 4

# SYSTEM DESIGN

## 4.1 Introduction

For our system, we used six lights, six LDRs. Extra 1 LDR is for checking the light intensity of the sun. For each light we used 6 switching circuits also which are connected ARDUINO NANO.

The solar charged the battery, and the whole system starts. 6 ultrasonic sensors connected to ARDUINO NANO to detect any movement near the lights. IoT controlling & monitoring can be possible with using the D1 mini to ARDUINO NANO, which further gave us the IoT report. All data will save in the server. That’s way an easy, smart and green street light system can be provided for our university campus also.

## 4.2 Block Diagram

First of all, the 20W solar charges up the batter and after that battery is charged up. Then our system is initially ON. 6 street lights are used in our system where Street-Light01 is 10W and others are 1.25w each. One extra LDR is used for checking the light intensity at the daylight time. For movement checking six ultrasonic sensors are used also. Thermistor is for checking the temperature. Both these sensors are interfacing with ARDUINO NANO to send data to Wifi-Module. Switching circuits are here for controlling the current in each light and for switching. Here, transistors are taken as switching circuits.

Then wifi-module D1 mini is linked to ARDUINO in order to transport data from the ARDUINO NANO to the module. After that we see the IoT repot from the local server and can control, monitor of the system. All data from those sensors are saved in the server. The whole block diagram of our system is given here: **Figure 4.1** is the whole system block diagram of Iot based street-light fault, controlling and monitoring as well as to emit CO2 from the university environment

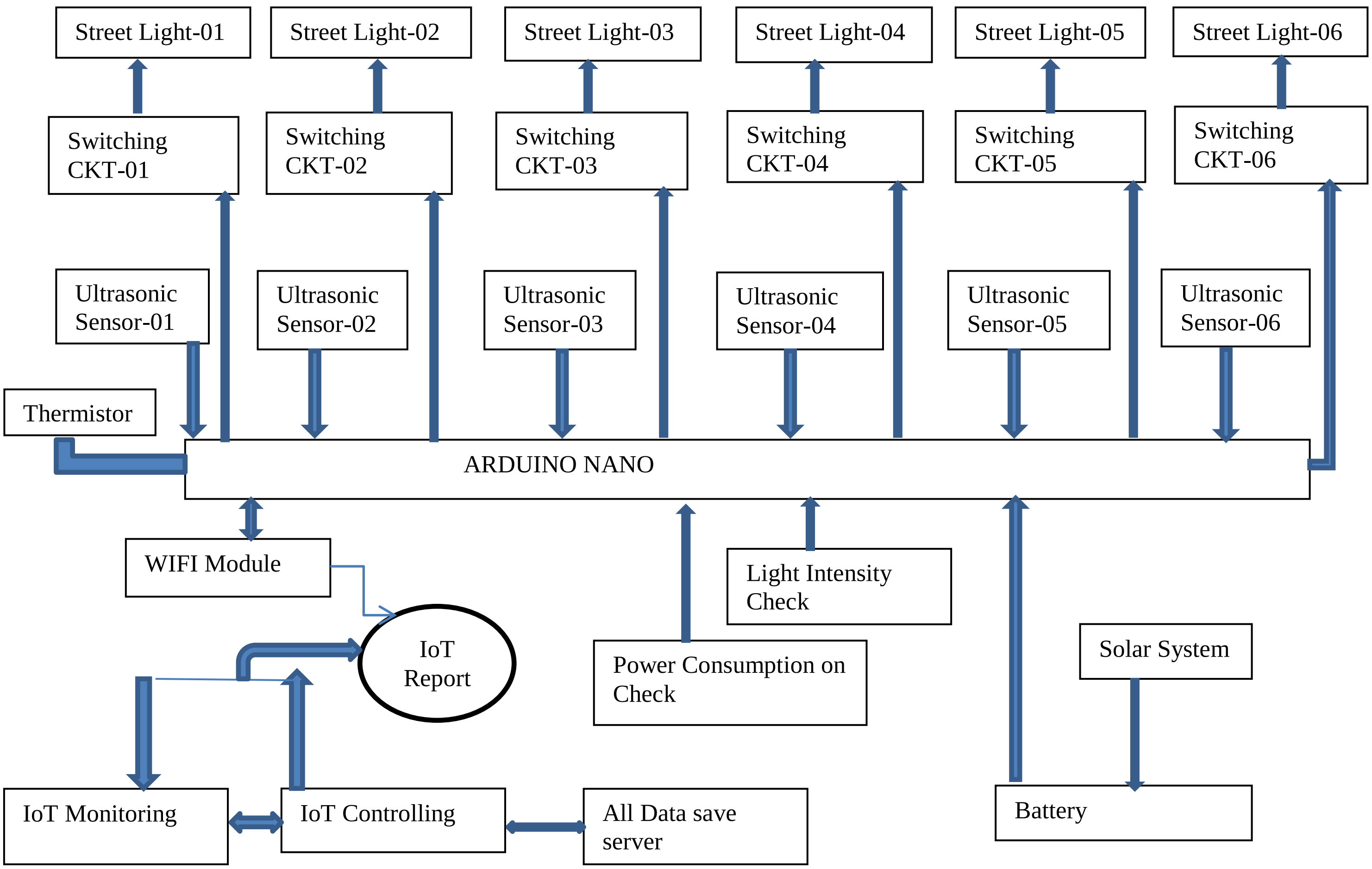



**Fig. 4.1** Block Diagram of the System

## 4.3 Flow Diagram

After charging the battery from the solar, our system starts and ready to initialize. Then 3 parts are noticed in our system-

- Sensing initialize from the sensors;
- Sensing any light in the daylight;
- Admin Login.

If the sense is yes, data are gotten from the different sensors. Any addressing error in our system, we can be notified via server.

If there is any existence of sunlight via LDR, the whole system will be off in the day time. If the sense is no, then the system will be ON with full brightness. When the server mood is OFF, then after 10 seconds; the brightness of the lights are going lower. If any vehicles or moving obstacles come to the street-lights, the movement will be sensed via Ultrasonic Sensors and the brightness of the lights are going higher. If no obstacles or vehicles are there, then all the lights will be in dimming condition.

The flow chart of our system is given in the below **Figure 4.2.**

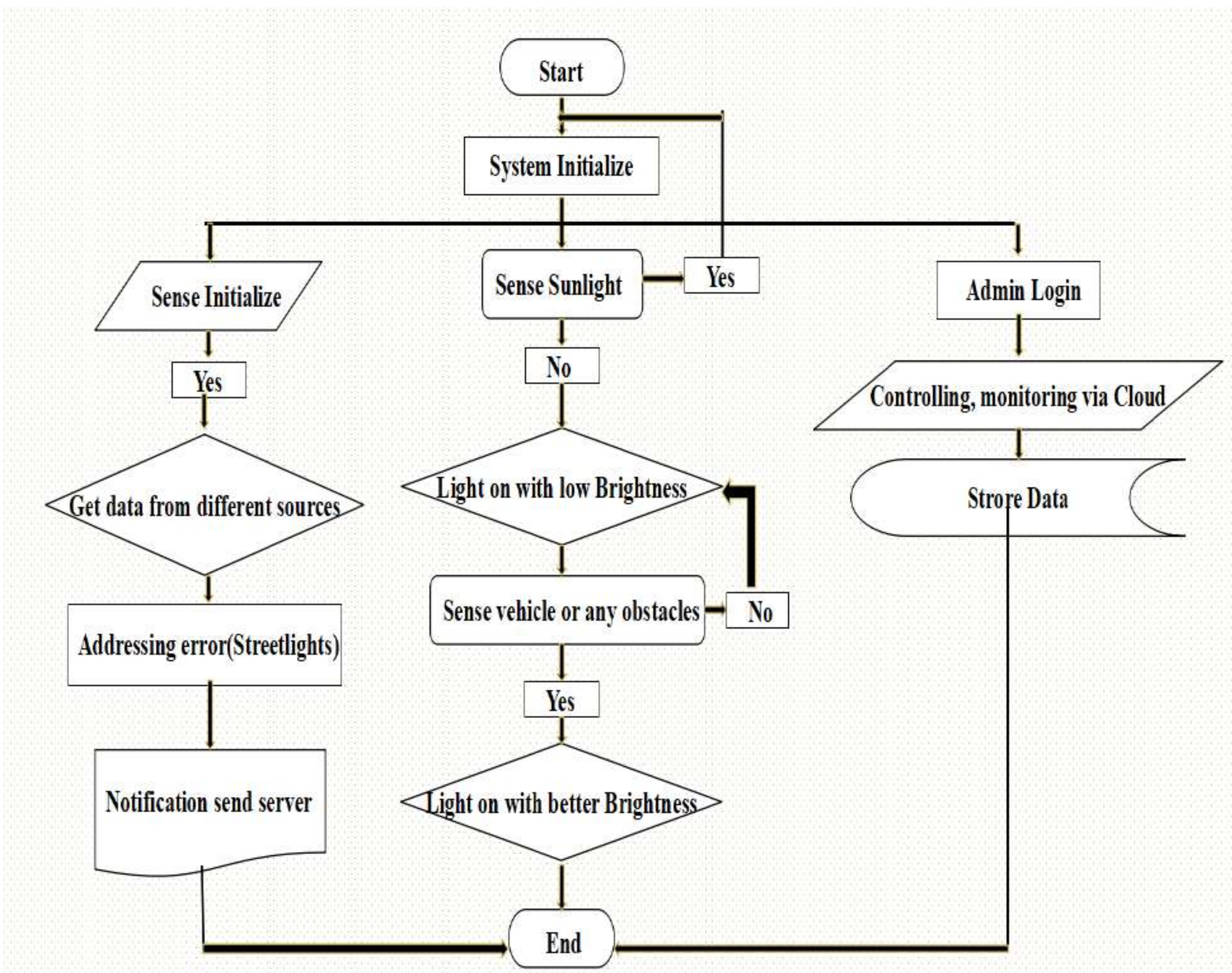



**Fig. 4.2** Flow Chart of the System

## 4.4 Circuit Diagram

The circuit diagram of our system for street-lighting system interfacing with arduino and to display the output in the LCD is shown in the **Figure 4.3.**

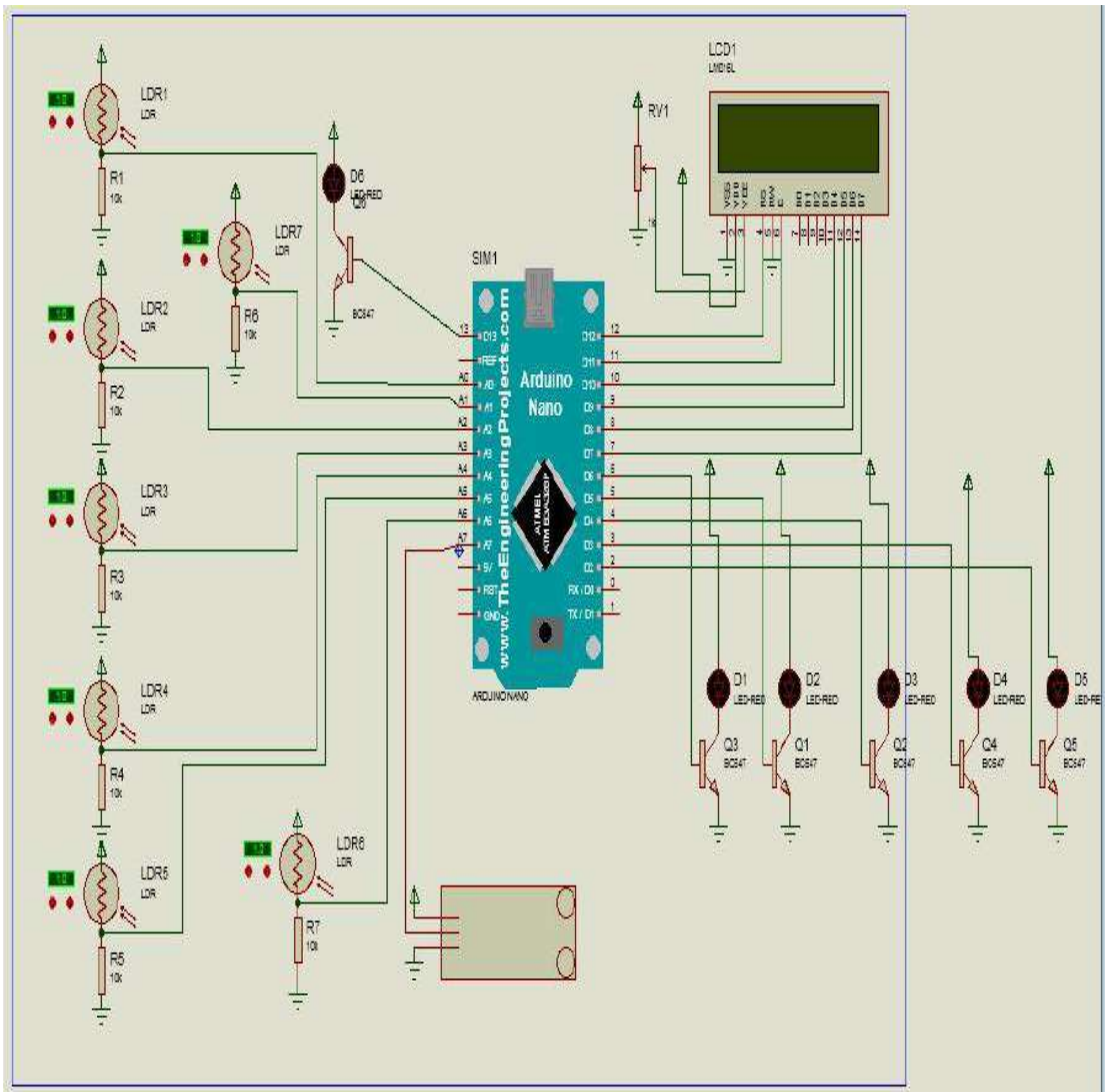



**Fig. 4.3** Circuit Diagram of Street Light System

We used 12V battery, but as all of the equipment has rating of 5V; we converted the 12V into 5V by using regulator IC. For charging the batteries, we used a 20W solar panel. We utilized an Arduino Nano in our system to link all of the devices. The above figure indicates the circuit setup for the street-light system in our project.

The LED is connected with the digital PINS of NANO D1, D2, D3, D4, D5, D6, D13. LCD is connected to the digital PINS (12, 11, 10, 9, 8, 7). The LDRs are connected to the analogue PINS (A0, A1, A2, A3, A4, A5, A6, A7).

The circuit diagram of our system for the sonar system interfacing with arduino and interface WeMos D1 Mini with arduino represents in the **Figure 4.4.**

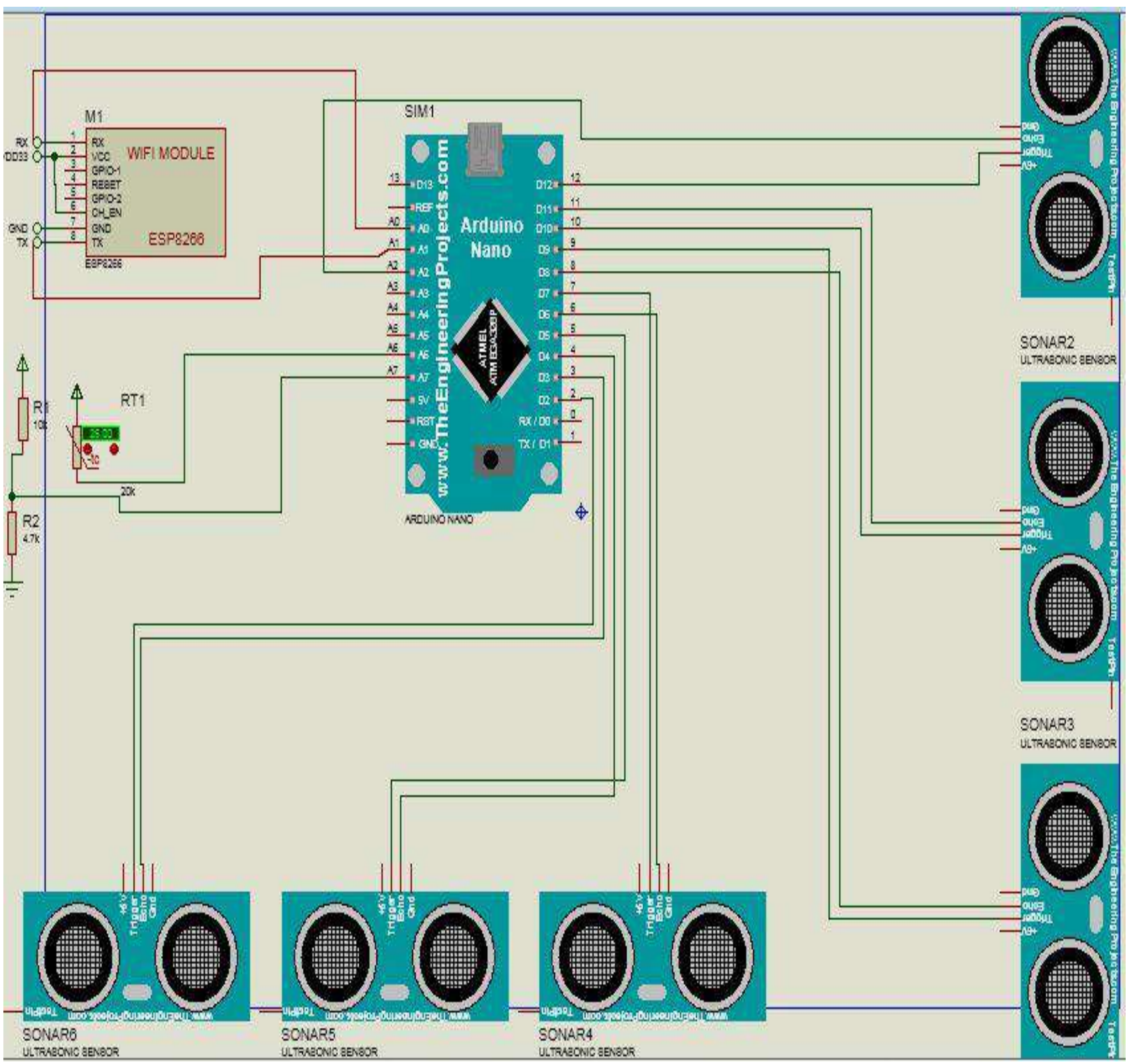


**Fig. 4.4** Circuit Diagram of Sonar

We took six ultrasonic sensors to check any movement. Each ultrasonic sensor, echo and trigger pins are interfacing with the NANO PINS (D12, A2; D10, D11; D8, D9; D6, D7; D4, D5; D2, D3).

# CHAPTER 5

# SYSTEM IMPLEMENTATION AND RESULT

## 5.1 Fundamental

In this section the total output and result of this project is discussed. After starting our system, our project is done successfully and the system is also controlled by the server automatically. We successfully control and monitor our system as well as detection also.

## 5.2 Overview of the Project

The overall image view of our project is in the **Figure 5.1**.

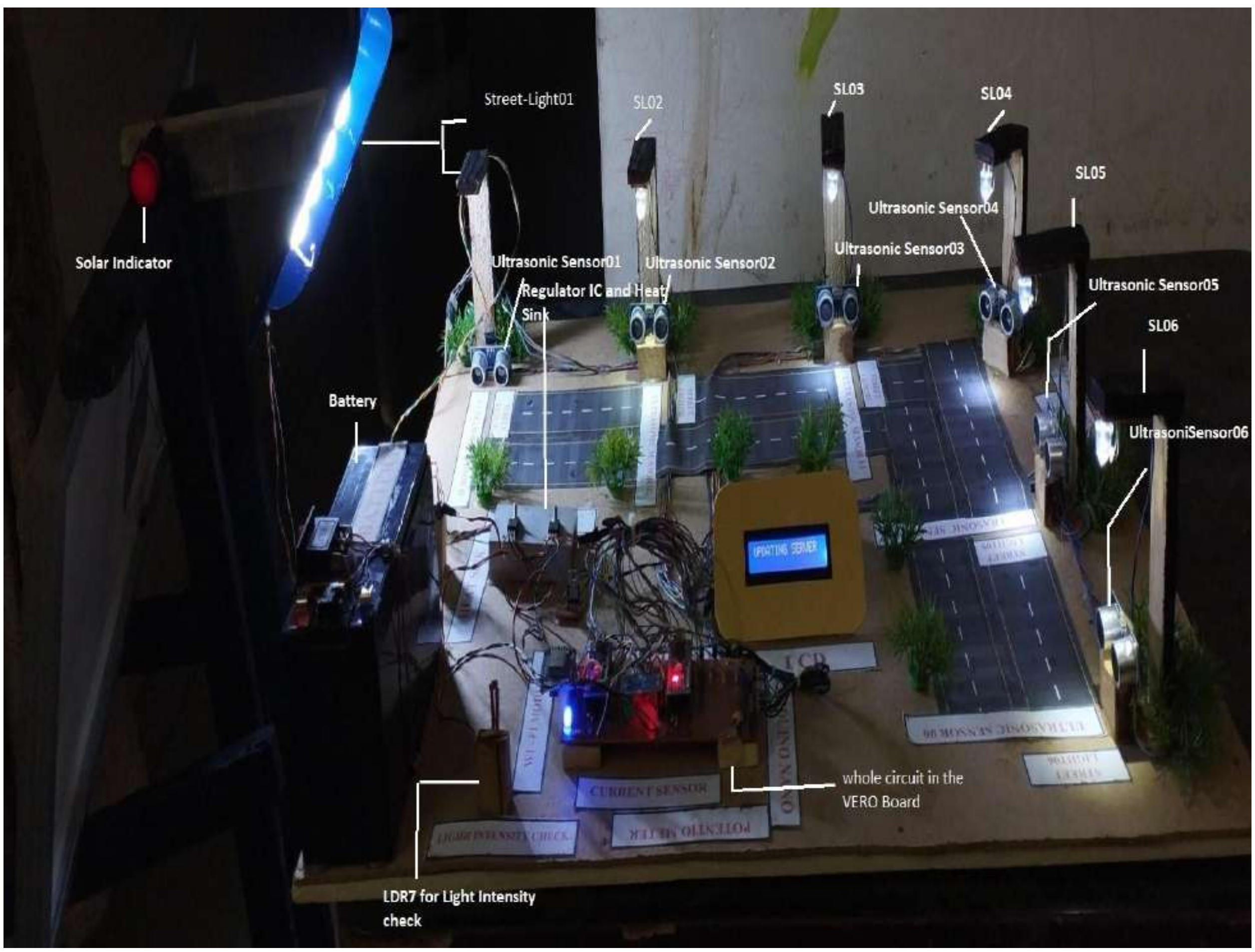



**Fig. 5.1** Overview of the project

## 5.3 Objective Justification

**Figure 5.2** shows the server mode ON view of when the street-light01 is off in the server

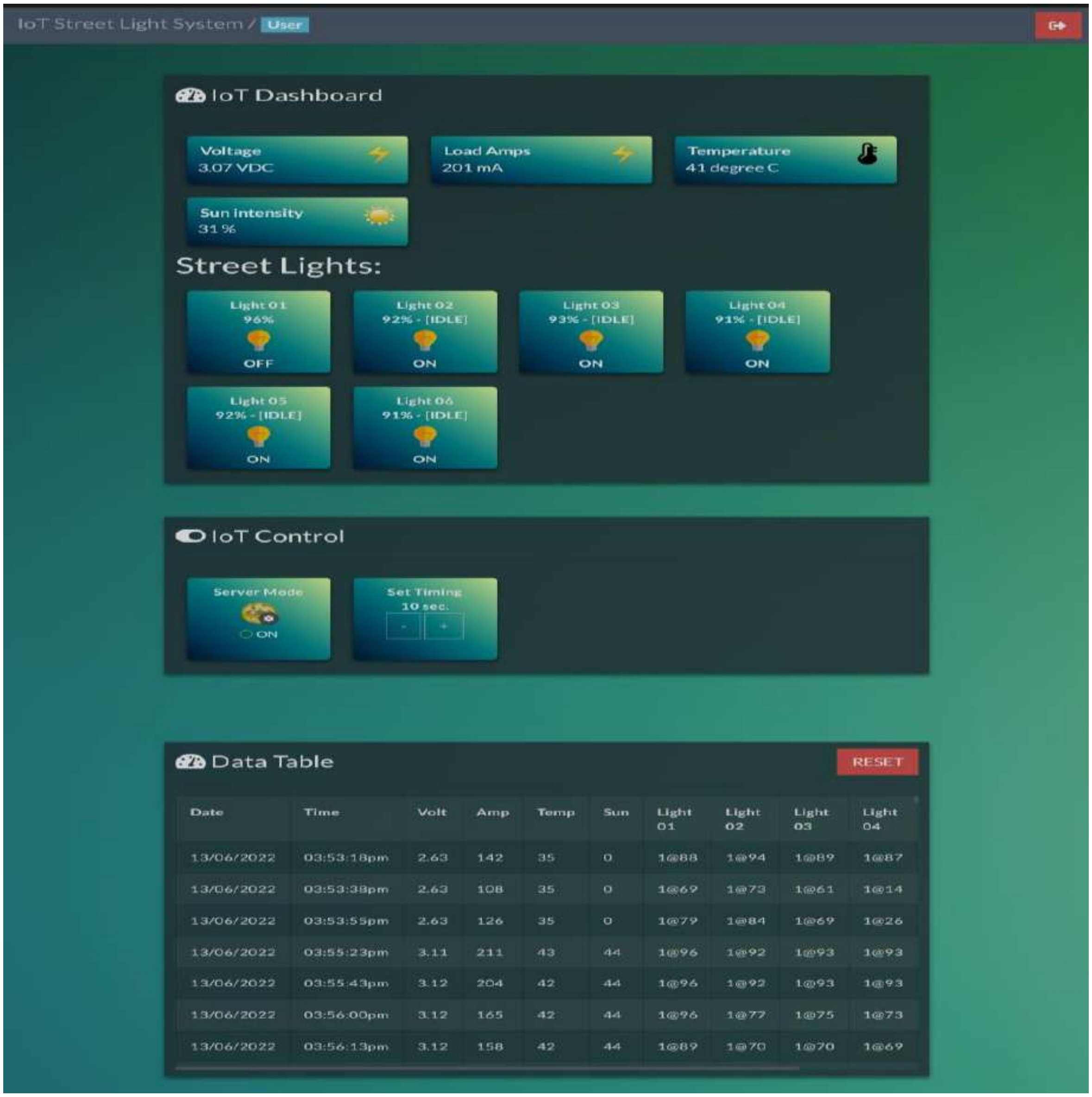



**Fig. 5.2:** Server Mode on and turn off the street- light01

To reduce maintenance cost and to make an easier monitoring process we automatically control individual street lights by using our IoT server. Here we can see the voltage of our system, load current, light intensity status as well as sun intensity also in Server Dashboard. From the controlling section, we can easily control and monitoring our system and the data table showed us different dataset.

The turn OFF view of the street-light01 in our project reflects in the **Figure 5.3.**

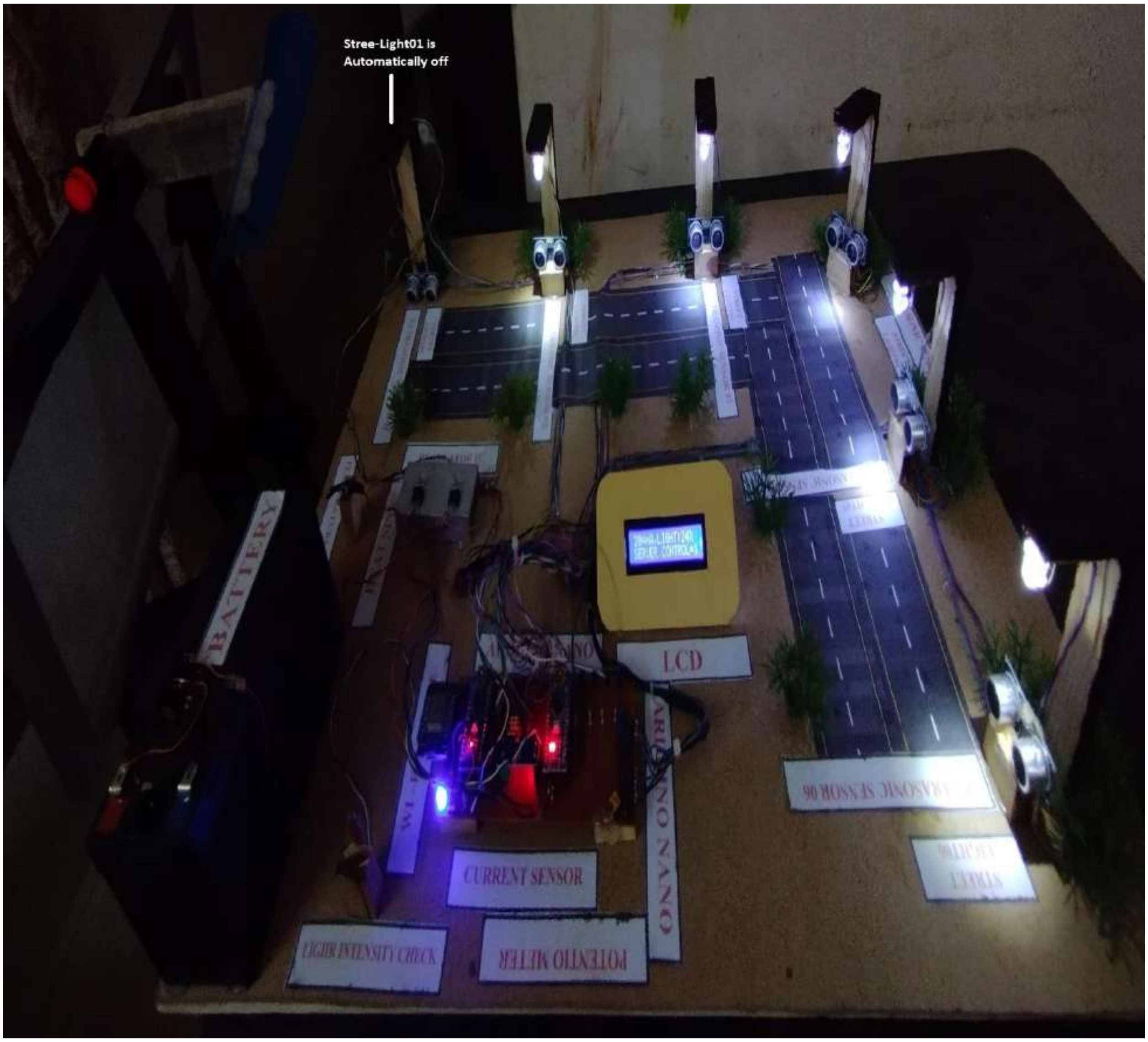



**Fig. 5.3:** Automatically turn off the street-light01.

If any of the street lights are going through the damage then we can easily detect which street-lights are in the faulty condition. When our server mode is ON, we can easily control the lights by doing them ON/OFF. If the light intensity of any lights go down below 20% in our server, then we can easily find the fault light.

The server mode ON view in the server and the turn OFF view of street-light02 in our project are in the **Figure 5.4.**

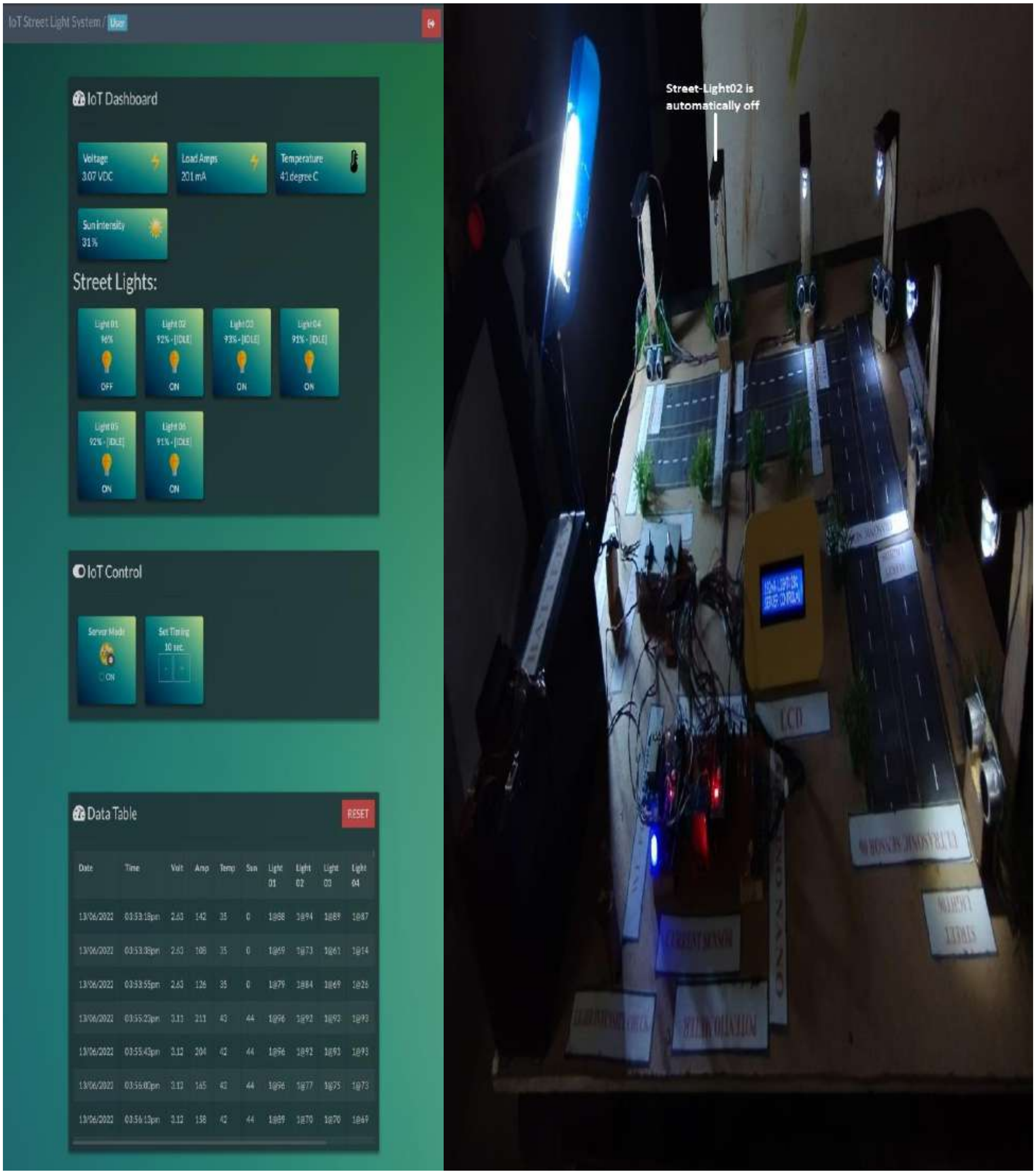



**Fig. 5.4**: Server Mode on and automatically turn off the street-light02.

This figure is another example of automatically control the street-light system where the Street-Light02 is OFF.

The whole system is OFF when the light is checked through the LDR for the daylight which is shown in the **Figure 5.5.**

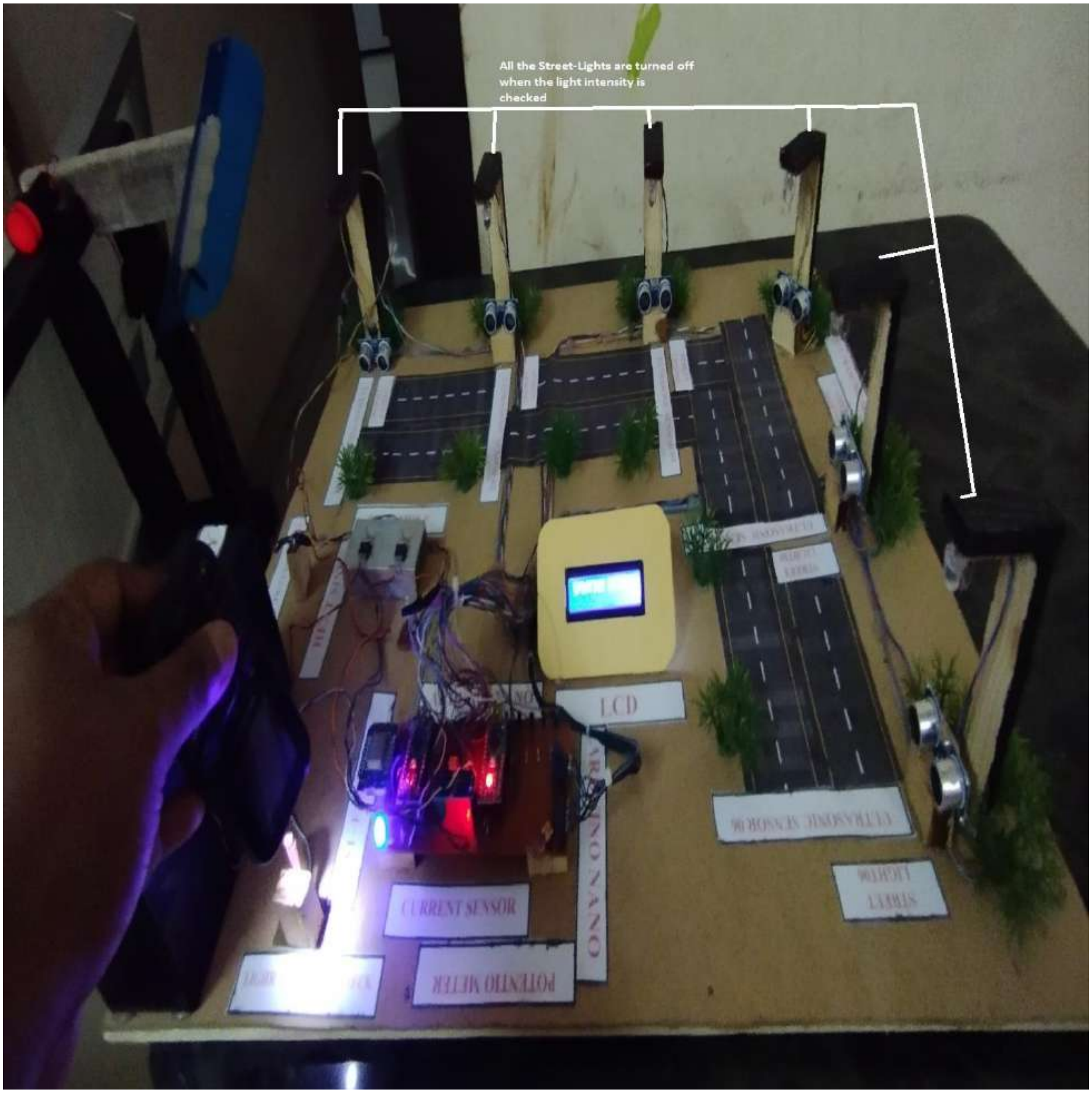
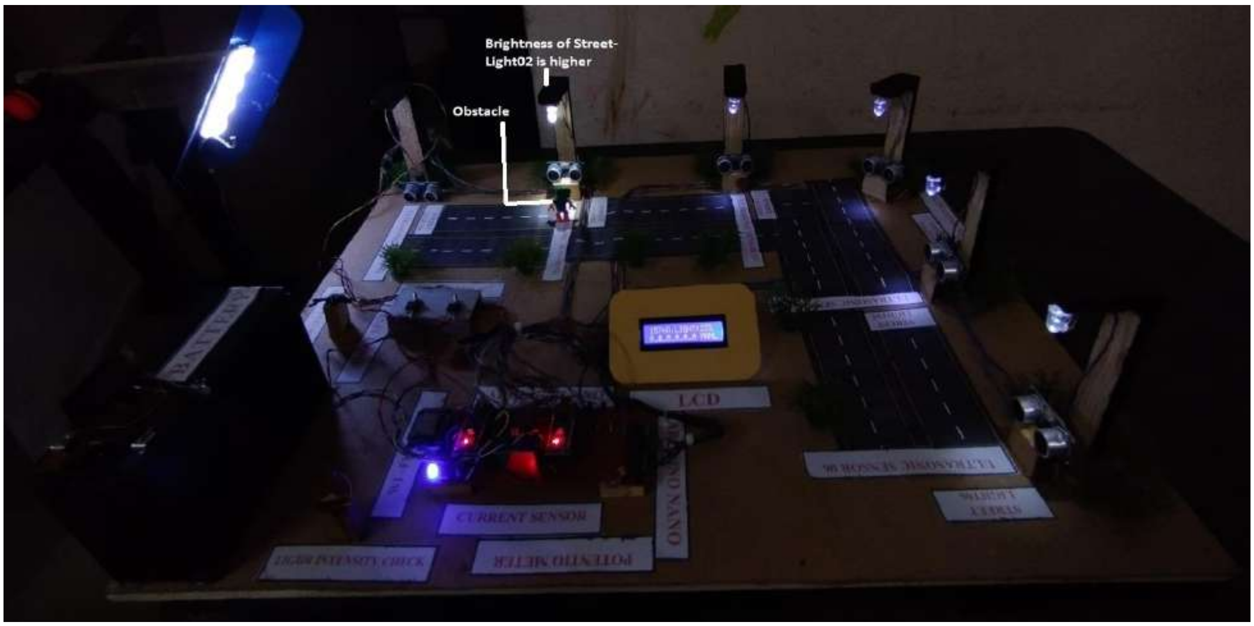


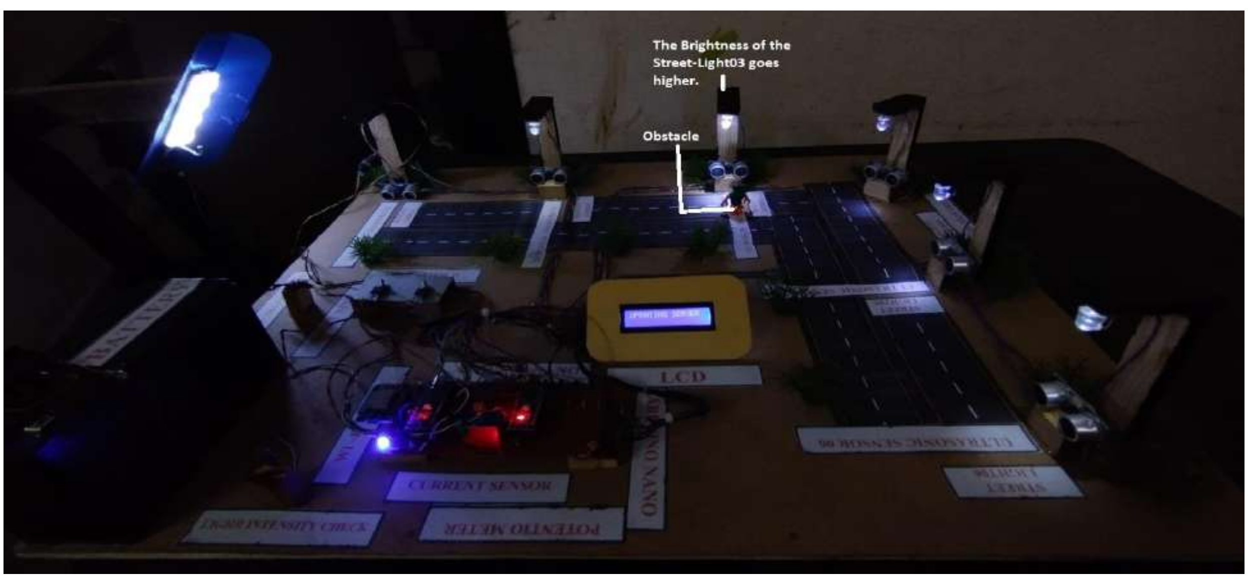

**Fig. 5.5:** Light Intensity Checked and all the Street Lights have been switched off

To test the light intensity, we used an LDR. When we turn ON our mobile torch above that LDR, all the street lights are remain off. In the daylight, this is really needed to turn off the street light automatically. Our smart street light system is followed by focusing in that aim. It reduces the high electricity loss also.

The obstacle checking the ultrasonic sensor and LED under those sensors goes into higher brightness is represented in the **Figure 5.6 (a, b)**




**(a)**




**(b)**

**Fig. 5.6 (a, b):** Obstacle Sense and Bright up The LED 2 and LED 3.

As we used ultrasonic sensor to sense any obstacles, those figure indicates that the sonar sense the obstacles correctly and then bright up the light intensity.

## 5.4 Cost Analysis

**Table 5.1:** Cost Analysis of Our Project

| SL No | Components Name | Price(BDT) |
|---|---|---|
| 01 | Solar panel | 900 |
| 02 | Battery | 900 |
| 03 | ARDUINO NANO | 650 |
| 04 | LCD | 200 |
| 05 | LDR | 30*7= 210 |
| 06 | Thermistor | 20 |
| 07 | Current Sensor | 280 |
| 08 | Resistor | 65 |
| 09 | Ultrasonic Sensor | 500 |
| 10 | Vero Board | 60 |
| 11 | WIFI Module | 280 |
| 12 | Regulator IC | 20 |
| 13 | LED | 25 |
| | | **Total= 4100/==** |

After analyzing the cost, we can say our implementation is much more cost effective. Because original 10w solar street-lights are not available in our local market. It is started from almost 30w-50w and also causing huge cost around 5000-7000Tk.

## 5.5 Load Calculation of IIUC

For our university current system,
Total Load consumption= 18(lights)*20w (per light electricity consumption)
= 360w
Operation duration 11hours
Total energy consumption per day = (11*360) = 3960w = 3.96 unit
Total energy Consumption per month = (3.96*30) =118.8 unit
Total cost = (118.8*8.990) = 1068.012 taka/month
Yearly end = **12816.144tk/year**

In our project, we used 5 LED which consumed 1.25w each, we also used a 10w DC Light. To get a result we assume our project having 10w light for each load.
So the total load consumption = (10w*6) = 60w
Let the operation duration 11hours
Total energy consumption per day= (11*60) = 660w=0.660unit
Total energy consumption per month= (0.660*30) = 19.8 unit
Total cost= (19.8*8.990) = 178.002tk/month
Yearly end= 2136.024tk/year

Our project setup costing is about 4100tk and for making IoT server we spend almost 3500tk
So the overall cost = (2136.024+4100+3500) tk/year= **9736.024tk/year**.+

Our system is comparatively cheaper than our university street-light system. The reason behind this is that our university street-light system is based on AC Power. So, the lighting system can't go at the dimming condition. Our prototype is based on DC Power. We can utilize our model into a higher rate, can save more energy as our system can go at the dimming condition. The overall cost of our project is 9736.024tk/year where our present university street light system is costly higher. So, our system is comparatively cheaper, smarter. Starting the system by charging up the battery from the solar, it makes our project green for our university campus.

Now we calculate the electricity consumption cost according to the model having 10% consumption of power at dimming hours and 100% consumption at the rest of the times [38] –

➔ Here we mentioned major arterial, minor arterial and collector according to Library side, ACAD and FSE Building.
➔ The number vehicle must be higher in the major portion, then high in minor portion and less high in collector potion.

**Table 5.2:** Obstacle/ Vehicle Movement Rate (During Dusk to dawn)

| Time Period | Major Arterial | Minor Arterial | Collector Arterial |
|---|---|---|---|
| 6pm-7pm | 17 | 13 | 12 |
| 7pm-8pm | 20 | 17 | 10 |
| 8pm-9pm | 18 | 15 | 5 |
| 9pm-10pm | 16 | 15 | 6 |
| 10pm-11pm | 14 | 11 | 5 |
| 11pm-12pm | 11 | 9 | 4 |
| 12am-1am | 10 | 7 | 4 |
| 1am-2am | 9 | 6 | 3 |
| 2am-3am | 7 | 5 | 2 |
| 3am-4am | 4 | 4 | 2 |
| 4am-5am | 8 | 3 | 1 |

We selected 3 spots for our university to see the power consumption of our project is less than our present university street-light system. We chose our library road as major arterial. Here major arterial indicates the number of vehicles must be more than other arterial. We also chose the Central Cafeteria road as our minor arterial and the road of FSE building as our collector arterial.

**Table 5.3:** Power consumption by present street light system in the campus

| Time Period | Major Arterial | Minor Arterial | Collector Arterial |
|---|---|---|---|
| 6pm-7pm | 20w | 20w | 20w |
| 7pm-8pm | 20w | 20w | 20w |
| 8pm-9pm | 20w | 20w | 20w |
| 9pm-10pm | 20w | 20w | 20w |

| | | | |
|---|---|---|---|
| 10pm-11pm | 20w | 20w | 20w |
| 11pm-12pm | 20w | 20w | 20w |
| 12am-1am | 20w | 20w | 20w |
| 1am-2am | 20w | 20w | 20w |
| 2am-3am | 20w | 20w | 20w |
| 3am-4am | 20w | 20w | 20w |
| 4am-5am | 20w | 20w | 20w |

As our present university street-light system is in AC, So the power rate will be same at each time. There is no dimming condition for the AC light. So, the consumption of power will be wasted.

**Table 5.4:** The Brightness of LED Light according to Obstacle/ Vehicle Rate

| Time Period | Major Arterial | Minor Arterial | Collector Arterial |
|---|---|---|---|
| 6pm-7pm | 100% | 100% | 100% |
| 7pm-8pm | 100% | 100% | 100% |
| 8pm-9pm | 100% | 100% | 10% |
| 9pm-10pm | 100% | 100% | 10% |
| 10pm-11pm | 100% | 10% | 10% |
| 11pm-12pm | 100% | 10% | 10% |
| 12am-1am | 10% | 10% | 10% |
| 1am-2am | 10% | 10% | 10% |
| 2am-3am | 10% | 10% | 10% |
| 3am-4am | 10% | 10% | 10% |
| 4am-5am | 100% | 10% | 10% |

Using LED Light in DC system in our project, we saw the brightness 100% more in the major arterial at the busy hour. According to the rate of vehicles, the lower brightness was found in the collector arterial.

**Table 5.5:** Power Consumption by LED Light (Dimming Condition)
(Green indicate power consume in dimming condition at 10%)

| Time Period | Major Arterial | Minor Arterial | Collector Arterial |
|---|---|---|---|
| 6pm-7pm | 10w | 10w | 10w |
| 7pm-8pm | 10w | 10w | 10w |
| 8pm-9pm | 10w | 10w | 1w |
| 9pm-10pm | 10w | 10w | 1w |
| 10pm-11pm | 10w | 1w | 1w |
| 11pm-12pm | 10w | 1w | 1w |
| 12am-1am | 1w | 1w | 1w |
| 1am-2am | 1w | 1w | 1w |
| 2am-3am | 1w | 1w | 1w |
| 3am-4am | 1w | 1w | 1w |
| 4am-5am | 1w | 1w | 1w |

The best dimming condition rate for reducing power consumption is 10%. We measured our dimming condition in our system, which is almost 5W. but as we wanted the best outcome, we chose our dimming condition in the rate of 10% of our main load. The less dimming condition found in the major arterial and the most of all found in collector arterial

**Table 5.6:** Comparison of Power Consumption Per Day

| Power Consumption Duration (6pm to 5am) | Present Street Light System | Proposed LED |
|---|---|---|
| **As per tables-** | 660w | 141w |
| **Dimming Condition** | Not applicable | Applied |

From this table, we have seen that in total 11 hours; 20w street-light consume 660w or 0.660kwh per day and 10w proposed LED system consume 141w or .141kwh per day. This is because, from table 5.5; the maximum power consumed by LED is 10w and minimum power consumption is 1w. So that, our proposed model will save electricity cost significantly.

# Chapter 6
# Conclusion

## 6.1 Conclusion

This project demonstrates that the Internet of Things may be used to remotely monitor and control streetlights. Since it takes less time to process a malfunction or keep an eye on the lamps for everyday operations, the data obtained from the sensors can be evaluated, used for prediction, and greatly reduced the need for human labor. The result section clearly indicates that our present street light system in our campus needed cost higher because of the lighting system runs at AC. There is no dimming condition for the AC system. But our DC based prototype has dimming condition. Using sensors, it is easier to save the power. As our system battery is charged up by the PV solar, it helps to make our campus green also.

## 6.2 Benefits and Drawbacks

### *6.2.1 Benefits*

- It is Latest Technology;
- It can be operated very easily;
- This will stop the wastage of electricity;
- With this System, we can in real-time detect street lights, not working at any point;
- With very little manpower need in this system and street lights can be maintained easily.

### *6.2.2 Drawbacks*

- Internet speed may be slow and server may fall down;
- Controlling area is limited.

## 6.3 Future Improvement

- This system can also be developed by using advanced GSM, GPRS technology in the future;
- It can be converted it into Li-Fi Technology that can be used to control automated vehicles running in the city because hacking this network is more difficult than almost secure;
- It can be managed through Artificial intelligence in the Feature.

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# Appendix

## Code for Street-Light

```
#include <Robojax_AllegroACS_Current_Sensor.h>
#include <LiquidCrystal.h>
#include <SoftPWM.h>

#define OFF   0
#define ON  255
#define MID  30

Robojax_AllegroACS_Current_Sensor robojax(0, A7);
LiquidCrystal lcd(12, 11, 10, 9, 8, 7);

byte lights[] = {6, 5, 4, 3, 2, 13};
byte duty[] = {OFF, OFF, OFF, OFF, OFF, OFF};
int dayNight, lumens[6], amp;
bool timeover, serverMode, distance[6];
byte sec, i, count, duration, temp;
long prevMs;

byte off[] = {0x04, 0x0A, 0x11, 0x11, 0x11, 0x11, 0x0E, 0x00};
byte on[] = {0x04, 0x0E, 0x1F, 0x1F, 0x1F, 0x1F, 0x0E, 0x00};
byte mid[] = {0x04, 0x0E, 0x1F, 0x1F, 0x11, 0x11, 0x0E, 0x00};

void setup() {
Serial.begin(9600);
lcd.begin(16, 2);
lcd.createChar(0, off);
lcd.createChar(1, on);
lcd.createChar(2, mid);
SoftPWMBegin();

for (byte i = 0; i < 6; i++) {
pinMode(lights[i], OUTPUT);
SoftPWMSet(lights[i], duty[i]);
SoftPWMSetFadeTime(lights[i], 10, 10);
}
lcd.print(F("WIFI INIT..."));
delay(5000);
}

void loop() {
amp = robojax.getCurrentAverage(300) * 1000;
dayNight = analogRead(A6);
```

```
dayNight = map(dayNight, 0, 1023, 0, 100);
lightControl();

if (millis() - prevMs >= 1000) {
if (serverMode == 0 && duration > 0) {
if (sec != duration) sec++;
else if (sec == duration) timeover = 1;
}
else sec = 0;

count++;
if (count == 10) {
count = 0;
lcd.clear();
lcd.print(F("UPDATING SERVER"));
String cmd1 = (String)"a=" + amp + "&s=" + dayNight
+ "&l1=" + (duty[0] == 0 ? "0" : "1") + "@" + lumens[0]
+ "&l2=" + (duty[1] == 0 ? "0" : "1") + "@" + lumens[1];
String cmd2 = (String)"&l3=" + (duty[2] == 0 ? "0" : "1") + "@" + lumens[2]
+ "&l4=" + (duty[3] == 0 ? "0" : "1") + "@" + lumens[3]
+ "&l5=" + (duty[4] == 0 ? "0" : "1") + "@" + lumens[4]
+ "&l6=" + (duty[5] == 0 ? "0" : "1") + "@" + lumens[5];
// a=0.02&s=341&l1=0@736&l2=0@709&l3=0@851&l4=0@742&l5=0@227&l6=0@812$
Serial.println(cmd1 + cmd2 + "$");
delay(2000);
lcd.clear();
}
lcd.setCursor(0, 0);
lcd.print((String)amp + "mA,LIGHT:" + dayNight + "%  ");
lcd.setCursor(0, 1);
if (serverMode == 0 && timeover == 0)
lcd.print((String)"COUNT: " + sec + " to " + duration + "  ");
else if (serverMode == 1) lcd.print(F("SERVER CONTROL=1"));
prevMs = millis();
}
if (Serial.available()) {
String cmd = Serial.readString();
if (cmd.indexOf("S=") != -1) {
cmd.remove(0, 2);
i = cmd.indexOf("$");
cmd.remove(i);

 for (byte n = 0; n < 6; n++) {
 duty[n] = cmd.toInt();
 if (duty[n] == 0) duty[n] = OFF;
 else duty[n] = ON;
 i = cmd.indexOf(",");
 cmd.remove(0, i + 1);
 }
```

```
serverMode = 1;
timeover = 0;
}
else if (cmd.indexOf("D=") != -1) {
cmd.remove(0, 2);
i = cmd.indexOf("$");
cmd.remove(i);

for (byte n = 0; n < 7; n++) {
if (n == 0) duration = cmd.toInt();
else distance[n - 1] = cmd.toInt();
i = cmd.indexOf(",");
cmd.remove(0, i + 1);
}
serverMode = 0;
}
Serial.flush();
cmd = "";
}
}

void lightControl() {
for (byte i = 0; i < 6; i++) {
if (serverMode == 0) {
if (dayNight < 50) {
if (timeover == 1) {
if (distance[i] == 1) duty[i] = ON;
else duty[i] = MID;
}
else duty[i] = ON;
}
else duty[i] = OFF;
if (timeover == 1) {
lcd.setCursor(i * 2, 1);
if (duty[i] == OFF) lcd.write(byte(0));
else if (duty[i] == ON) lcd.write(byte(1));
else if (duty[i] == MID) lcd.write(byte(2));
if(i != 5) lcd.print("_");
else lcd.print(F(" MANL"));
  }
  }
  SoftPWMSet(lights[i], duty[i]);
  lumens[i] = analogRead(14 + i);
  lumens[i] = map(lumens[i], 0, 1023, 0, 99);
 }
 }
```

## Code for Sonar:

```
#include <SoftwareSerial.h>
#include <NewPing.h>

#define MAX_DISTANCE 10
#define DELAY 30

SoftwareSerial wifi(A0, A1);

NewPing sonar[] = {
NewPing(12, A2, MAX_DISTANCE),
NewPing(10, 11, MAX_DISTANCE),
NewPing(8, 9, MAX_DISTANCE),
NewPing(6, 7, MAX_DISTANCE),
NewPing(4, 5, MAX_DISTANCE),
NewPing(2, 3, MAX_DISTANCE)
};

int i;
byte distance[6], temp;
float volt;
byte state[8];

void setup()
{
Serial.begin(9600);
wifi.begin(9600);

state[1] = DELAY;
}

void loop() {
int adc = analogRead(A6);
temp = adc / 15;
adc = analogRead(A7);
volt = adc * (5. / 1023);
 if (wifi.available() > 0) {
 String cmd = wifi.readString();  // format: M=<sm>,<time>,<light state>,$
 if (cmd.indexOf("M=") != -1) {
 cmd.remove(0, 2);
 i = cmd.indexOf("$");
 cmd.remove(i);
 for (byte n = 0; n < 8; n++)
{
 state[n] = cmd.toInt();
 i = cmd.indexOf(",");
cmd.remove(0, i + 1);
```

```
}
if (state[0] == 1) {  // server mode ON
String msg = "S=";
for (byte n = 2; n < 8; n++)
{
msg += (String) state[n] + ",";
}
Serial.println(msg + "$");  // format: S=<light flag>,$
}
else { // server mode OFF
for (byte i = 0; i < 6; i++) {
delay(50);
distance[i] = sonar[i].ping_cm();
if (distance[i] != 0) distance[i] = 1;
else distance[i] = 0;
}
String msg = (String)"D=" + state[1] + ",";
for (byte i = 0; i < 6; i++) {
msg += (String) distance[i] + ",";
}
Serial.println(msg + "$");  // format: D=<time>,<distance flag>,$
}
}
}
// format: <DATA FROM ARDUINO>$
if (Serial.available() > 0) {
String cmd = Serial.readString();
if (cmd.indexOf("a=") != -1) {
i = cmd.indexOf("$");
cmd.remove(i);
String cmd2 = (String)"&t=" + temp + "&v=" + volt;
wifi.println(cmd + cmd2 + "$");
}
}
}
```