DESIGN AND IMPLEMENTATION OF A LIGHT INTENSITY MONITORING SYSTEM FOR BILLBOARDS FLOODLIGHTS

Report submitted in fulfilment of the requirements for the

Diploma in Electrical Engineering

Department of Electrical

Engineering Faculty of Engineering

and Technology

Mulalo Masia

221917845

Diploma in Electrical Engineering

Supervisor: Mr. D.F OJO-

SERIKI

Date: 17/05/2024

Declaration

I Mulalo Masia, declare that this report is my original work and that it has not been presented to any other university or institution for similar or any other degree award. It is being submitted for Engineering programming 3 (EIENP3A) to the Department of Electrical Engineering at theVaal University of Technology, Vanderbijlpark.

MS MASIA	20/05/24
…………………………………….	………………….
Signature	Date

Acknowledgement

MASIA, MS	221917845
NONKONYANA, K	220172609
CHAUKE ,DK	221121455
MAHLABA, KC	221851216

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Acronyms & Abbreviations

LDR	Light Dependent Resistor
LED	Light Emitting Diode
GPIO	General Input Output Pins.
SQL	Structured Query Language

Chapter 1: Introduction and purpose of the study

1.1 Introduction and Background

The use of artificial lights can be implemented by companies or enterprises on billboard advertisements in order to raise awareness for a specific product, main focus being content visual as advertisement is expanding.

According to (Nyarko, 2015), “Increasing global competition has made many companies want to find more innovative ways of promoting their goods and services. This has contributed to the increased use of billboard advertisement (an example of outdoor advertisement) as a communication tool to enhance the promotional efforts of many organizations”.

(Siddiqui and Azeema, 2016), Stated that billboards are remaining on the top of the list of all other advertising strategies because it’s the most popular activity done in the industry and its all creative strategies are in resulting best because of excellent creativity. All that’s stated emphasizes the significance of billboard advertisements which leads to finding ways to create a distributed light intensity system for monitoring daylight intensity around the billboard.

By developing a light monitoring system for billboard floodlights, the aim is to provide a practical and cost-effective solution for managing outdoor lighting. This report details the design process, implementation steps, and results of the light monitoring system, demonstrating its effectiveness and potential benefits to advertisement.

For instance there’s a paper on a DTMF Controlled Billboard Light System circuit that one can control high wattage LED lights from anywhere and the wastage of electricity is reduced (Misal , 2017).

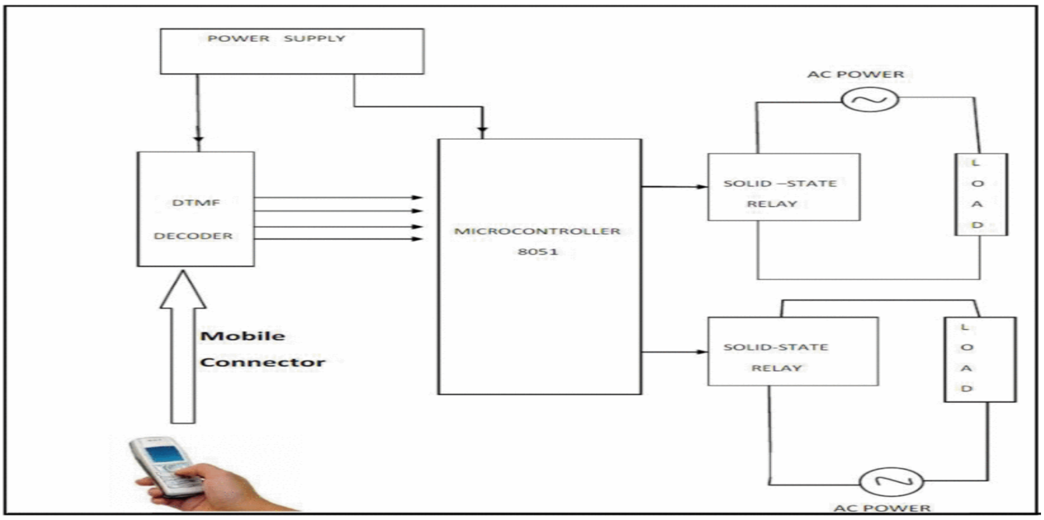

Figure 1: Block Diagram (Misal, 2017)

The paper proposes the design of a stand-alone embedded system that is based on an 8-bit microcontroller, i.e. 89C51 microcontroller which is the mastermind of the system. The setting of on/off of the time of the lights is monitored and controlled using the microcontroller. (Misal, 2017).
Another instance implemented is there of the design, implementation and development of an intelligent floodlight control system based on PIC18F4520 microcontroller (OI & Esenogho).This paper shows a problem with traditional floodlights systems where (OI & Esenogho, 2011) explains that traditional floodlight system designs employ switches that need to be operated by a use , however when the user is not available to fulfill this function, the goal of having the floodlight is defeated.

(OI & Esenogho, 2011) Stated that the microcontroller monitors LDR5 voltage divider network with R5 for a low level or zero logic state that is indicative of darkness or low light intensity. When the microcontroller detects a zero logic state, it checks the preprogrammed time to ascertain if the user desires the lights to be on. If the preprogrammed time condition is met. This usually happens in the evening period of the day. The microcontroller uses only the output of LDR5 for detecting daylight, which happens in the morning periods. When sufficient light is detected, the microcontroller receives a high logic level and switches off the security lights. During the darkness periods (nighttime), the microcontroller monitors the security lights to ensure that they are on or working by their luminance using the light sensors LDR1 to LDR4 (hence there are four lights used for the work).

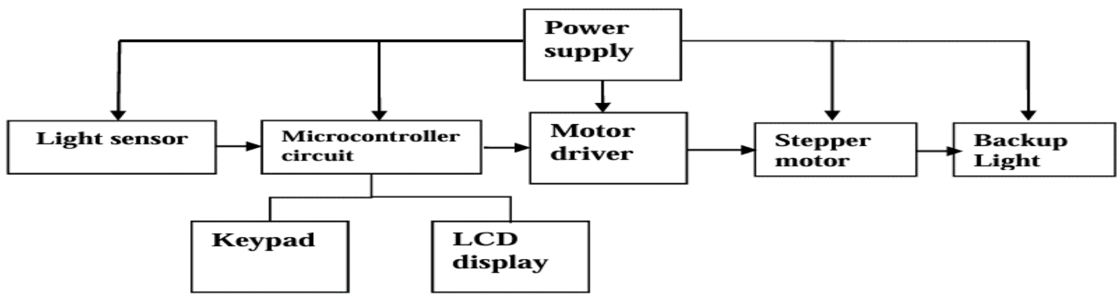

Figure 2: Block diagram of the back-up floodlight system (OI & Esenogho, 2011.)

The circuit uses the microcontroller to monitor light sensors that are connected to each lighting point to detect if the lights are on or off. When the system detects that a lighting point is off, the circuit worked as expected. (OI & Esenogho, 2011)

The opening passage points out different approaches to the creating the system which seem efficient in monitoring these floodlights. Through research efforts came an understanding that these systems make use of a microcontroller as the middle and lights controlled with respect to light intensity measured from a sensor. These common parts are identified as one of the major parts of the system being created on the advertisement billboard

1.2 Problem statement

Traditional billboards that are common in outdoor advertising hardly reach their full potential due to poor lighting at nighttime. Illumination is imperative for billboard advertisements otherwise they cannot be seen when there is not natural light.

Beyond the darkness many people continue to travel at nighttime resulting in poor marketing communication since the contents on the traditional billboard cannot reach this target market, and low investments returns for companies. The problem is occurring on the roadways where billboards are placed on the side or middle of the roadways.

The proposed solution's aim is to create a distributed light intensity system for monitoring daylight intensity around the billboard which will automatically trigger the flood light to switch on during the night and off during the day which will leverage the use of light intensity sensor to measure the sun rise and sunset and a microcontroller to convert the sensor analog data to a digital data and use Wi-Fi to send the information to the webserver to for the technicians to remotely access the status of the floodlight and database to store the status for future usage.

1.3 Significance of the study

This aim of the study is to design and implement a distributed light intensity system for billboard flood lighting which will enhance night time advertising to improve awareness of companies' products, by focusing on the implementation of proper and efficient billboard illumination.

1.4 Objectives

The objectives of the study are:

- To develop a sensing circuit which will be used to measure the light intensity
- To design webserver that will be used by technicians to remotely assess the status of the billboard illumination
- To design a database that will be used to store the status information for future usage
- To develop a system that will enable the floodlight on billboards to illuminate as sunsets in the area.

1.5. Project plan

The purpose of this project is to create a light intensity monitoring system on a billboard floodlight which will turn on and off the floodlight automatically due to light intensity which will enable nighttime advertisement. The research conducted aimed at finding different approaches to achieve monitoring of these floodlights by incorporating a microcontroller, sensor and LEDs.

Steps to accomplish the main goal:

- Identify the type of sensor and microcontroller then make the connection with floodlights included.
- Identify the webserver framework to be used which will receive data from the microcontroller.
- Configure the microcontroller to enable monitoring of the sensor that configures the floodlights and the data is sent to a webserver.
- A website creation which will enable simple and efficient user interaction to see the status of floodlight.
- Database and Tables creation to store data which is circulating in the system to ensure storage and retrieval of the data.

Table 1: Project Timeline

Task	**Timeline**
Objective 1: Research conducted for identification of components	Week 1- 3
Objective 2: Connections	Weeks 4-5
Objective 3: Webserver creation	Weeks 6-7
Objective 3: Database creation	Weeks 8-9
Final Report Preparation	Week 10 -11

By achieving these objectives, the project aims to deliver a robust and sustainable solution for managing light intensity in billboard floodlights.

1.6. Proposed budget

Table 2: Budget of "Outdoor Automatic Lighting System" Project

Description	Cost
Microcontroller	R87,09
Sensor	R45.50
LED Lights (x3)	R80.00
Wiring and Connectors	R180.00
Breadboard	R70.50
Resistors(x3)	R21,06
Total Estimated Cost	**R484,15**

1.7 Time Schedule

Project Timeframe																										
Year 2024																										
	Jan				Feb			Mar				Apr				May				Jun				July		
Activity	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK	WEEK 3	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 1	WEEK 2	WEEK 3
Title definition																										
Proposal writing																										
Literature review																										
Component Collection																										
The Ideas																										
The Ideas																										
Chapter 1 writing																										
Chapter 1 submission																										
Chapter 2 writing																										
Chapter 2 submission																										
Chapter 3 writing																										
Chapter 3 submission																										
Chapter 4 writing																										
Chapter 4 submission																										
Chapter 5 writing																										
Chapter 5 submission																										
Final report writing																										
Final Demonstration																										
Presentation																										

1.7. Limitations

Resource Constraints: The project budget limits the acquisition of advanced components like including solar panels for switching the lights.

Weather Conditions: Outdoor testing of the lighting system can be affected by unpredictable cloudy weather such as a cloudy weather during the day changes the light intensity in a random manner.

Scope: Due to limited time and delays which occurred in the beginning. The project may have not be compiled accordingly and research on other system approaches couldn't be achieved.

1.8. Conclusion

In conclusion, this study proposal emphasizes the significance of establishing an outdoor autonomous lighting system using distributed light intensity control technology, particularly in the context of billboard floodlights.

The proposed project focuses on designing and implementing an automatic lighting system for billboards, utilizing components like microcontrollers and sensors. Through comprehensive investigation, system design, prototype development.

By addressing the shortcomings of current outdoor lighting systems and leveraging technological innovations, the project aims to significantly improve energy efficiency and sustainability in urban infrastructure, particularly in the context of billboard lighting.

Chapter 2: Research Design and Methodology

2.1 Scope of work

The system is integrated with a sensing circuit which determines the light intensity of the floodlight, determining whether the light are on or off. The sensing circuit will make use of a sensor.

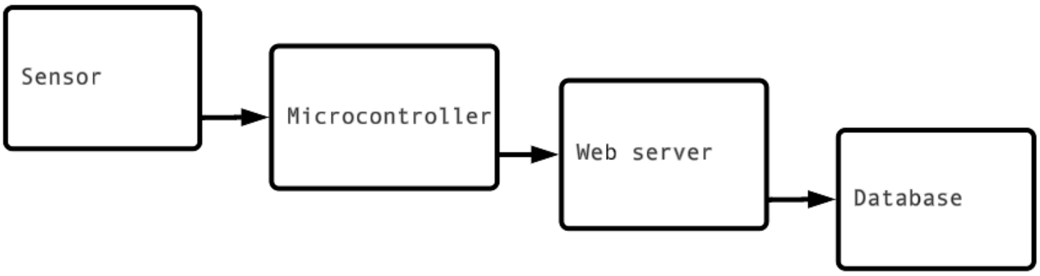

Figure 3: Overall system's Block diagram

The sensor measures the light intensity and configures the LED's based on the monitored light intensity and sends the output signal to the microcontroller, where the microcontroller processes the signal and transfers the information to the web server over Wi-Fi. Information will be transferred and saved to the database for access and viewing.

2.2.1 Sensor

The sensor which is to be utilized is a light sensor which must be able to measure light intensity to achieve lighting automation.There are LDRs, Photodiodes, and Phototransistors that serve the similar purpose of detecting and responding to light, they each have unique characteristics and are suited to different applications (Mecha, 2024).

An understanding of the key differences between these leads to selecting the right component for the system's specific needs. Whether it's the simple operation and cost-effectiveness of an LDR, the speed and sensitivity of a photodiode, or the amplification capabilities of a phototransistor, each component is useful in its own ways (Mecha, 2024).

In this system LDR sensor is chosen due to its quality to be able to simply work with, and the ability to detect a wide range of light levels and its simple operation. LDR is placed at the back of the billboard floodlight exposed to light achieving measurements of the light intensity and sends the data to the microcontroller.

Figure 4: LDR sensor (Manoj R, 2016)

LDR is a form of component that has a change in resistance whose magnitude depends on the light, the LDR electronic component consists of a semi-conducting language plate with two electrodes on its surface, the brighter the light hits the surface, the more free electrons are available, and the lower the electrical resistance value of this semiconductor material. (Ibrahim et al, 2019).

2.2.2 Microcontroller

The system needs to be equipped with a microcontroller which will be utilized to process information from the sensor and must be able to efficiently transmit data. The main types of microcontrollers are the likes of Arduino, ESP32, Raspberry Pi, MSP430, Intel 8051, STM32, AVR, PIC, ARM, NXP LPC, and FPGA (almin, 2024)

The ESP32 WROOM 32 is selected due to its smooth integration and minimal power usage making it perfect for powering and collecting data which is read from the LDR sensor. It comes with integrated Wi Fi which will enable us to transmit data wirelessly to the webserver for technicians to analyze.

Figure 5: ESP32 Wroom 32(Oner, 2021)

According to Oner,2021 “We have a great many tools available to us today for developing exceptional 10T products compared to 5 or 10 years ago”. ESP32 is definitely one of those And there are many reasons as why this is so: Its low cost, Wi-Fi and Bluetooth in a single SOC, great hardware features with many peripheral interfaces, different power modes, and advanced development platforms and frameworks (Oner, 2021)

2.2.3 LEDs

In order to achieve the illuminance required the system makes use of a floodlight which utilizes LEDs. Light emitting diodes (LEDs) are commonly used as an illuminating device due to their overall feasibility including compact size, prolong life span, low power consumption and minimum heat up. The same LEDs with faster response time can efficiently be used in optical wireless communication to provide high speed data links (Dahri, 2020).

The LED will be used as an illuminator inside a floodlight, which will make the billboard contents more visible. The LED, in the floodlight is meant to brighten up the billboard and make its content more visible, to people. By using this LED light the floodlight ensures that the billboards message can be seen clearly when it’s unclear outside.

Figure 6: Through-hole LEDs (Cope, 2021)

2.2.4 Web server

The webserver utilized is python flask which is a lightweight python framework which will enable faster and easier website deployment.

Figure 7: Flask webserver

The Flask framework is actually a glue, a very nice one that sticks together the amazing Werkzeug and Jinja2 frameworks, responsible for answering requests and presenting the output (i.e. HTML) (Maia, 2015).

Flask is a Web framework and is quite different from what most people are used to working with. It is less presumptuous about how your application should look or what you should use to make it available (Maia, 2015)

2.2.5 Database

There are countless commercial as well as open-source databases. The top most popular relational databases are: Oracle, MySQL, Microsoft SQL Server, PostgreSQL, IBM Db2, and SQLite (Dancuk, 2021).

MySQL is used in the project because of its scalability and robust security features including authentication and access control. MySQL is used for the creation and modification of the flood light database schemas.

Figure 9: MySQL workbench (FileEagle.com, n.d, 2022.)

MySQL database stores data as simple as filling out a form. Specialized tables are used to hold different types of information collected by the ESP32. In the project a table specifically for light intensity readings, with columns for timestamp, intensity values, and any relevant identifiers is achieved. Similarly, another table to track LED statuses, containing fields like timestamp and status indicators. Each time the ESP32 sends new data, it's filling out a new row in these tables, neatly organizing the information for easy retrieval later on.

2.3 Conclusion

This chapter aimed on creating a definition of the components used to achieve billboard floodlights that are able to sense light and which transmit information wirelessly and why these resources used are chosen.
Furthermore MySQL databases were introduced as major parts in our system that stores, maintains and secures ESP32 collected data, it also gave an in-depth understanding about the functions of each object during design process.

Chapter 3: Hardware design

3.1 Introduction

This chapter focuses on the physical design of the project that is based on the approach discussed in the previous chapter. This project is intended to create a light monitoring system for billboard floodlights which uses sensors and wireless communication for billboard monitoring. The hardware components of the system as already mentioned are ESP32 nodes, LDR sensors, LEDs and a central web server among others. These elements serve as the foundation of our monitoring system where we can measure light intensity, control LED brightness and send data for analysis wirelessly.

This requires the creation of a sensing circuit which comprises of sensors (LDR) used in measuring light intensity, microcontrollers (ESP32 Wroom 32) responsible for processing information floodlights (LEDs) which produce light so that billboards can be seen at night or modules enabling wireless connection among others then bring them together into one working unit.

3.2 Electronic Circuit Designs

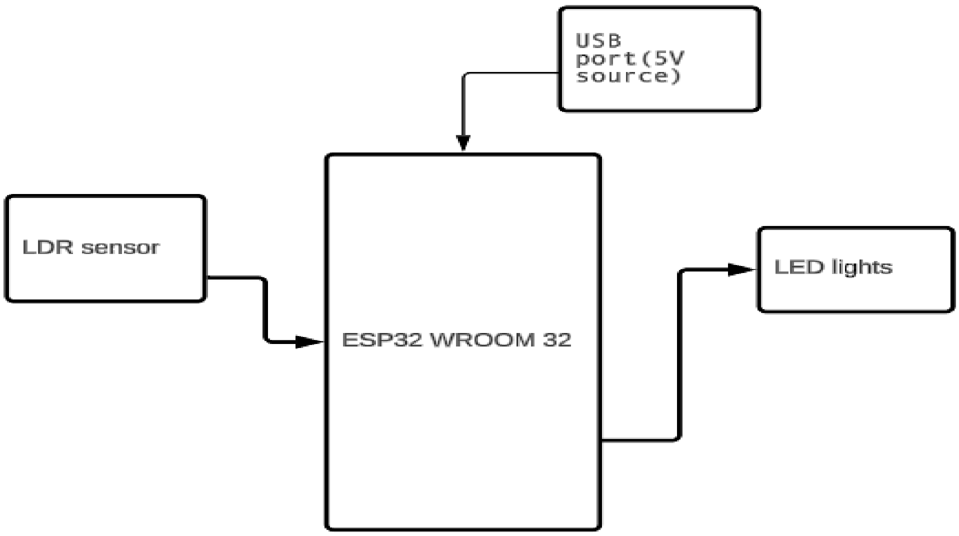

Figure 10: Hardware Block diagram

The figure shows the hardware block diagram which shows the connections of the hardware components, in general the LDR sensor sends its readings to ESP32 Wroom 32 to configure the LED lights, and the microcontroller is supplied by a 5V port which enables it to be powered up.

3.2.1 Light Dependent Resistor (LDR)

LDR sensor is connected to an analog input pin on ESP32 board. The LDR is powered supplied by GND from the microcontroller. The sensor is connected to an analog input pin on the microcontroller. LDR measures light intensity and sends the analog values to the microcontroller through the analog pin.

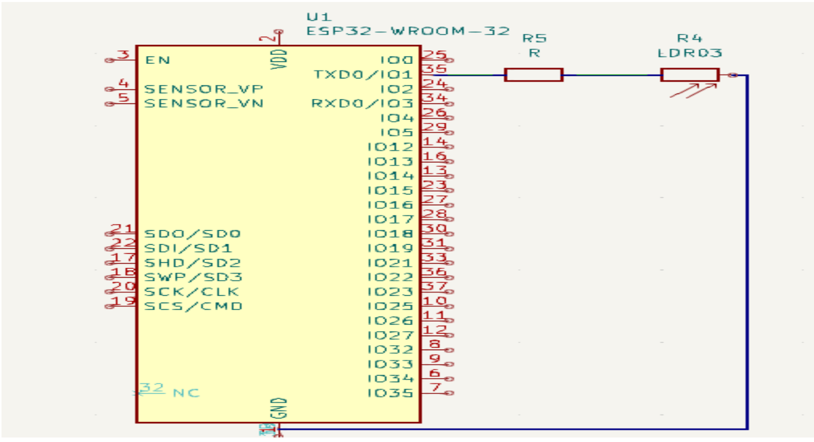

Figure 11: LDR circuit

LDR values need to be justified accurately by the use of a resistor. The resistor value can be justified using ohms law in equation 1 below.

$$I = Vout/R \qquad (1)$$

Equation 1 consist of I which is the value of current that passes through the LDR sensor, V is the value of the voltage and R is the value of the resistor that will be used to justify the accurate reading of the LDR sensor. The LDR analog input value will be converted to a lux value which is the value used to measure light intensity.

$$RLDR=(R*(Vin-Vout))/Vout \qquad (2)$$

$$Lux = 500(1000/RLDR) \qquad (3)$$

Equation 2 shows the conversion of voltage to resistance (RLDR) of an LDR, then equation 3 shows the conversion to lux in Lumen standard.

3.2.2 ESP32 WROOM 32

ESP32 WROOM 32, comprises of General Input Output Pins which enable it to receive and transmit data. The pins enable connection from the LEDs and LDR through defined GPIO's.

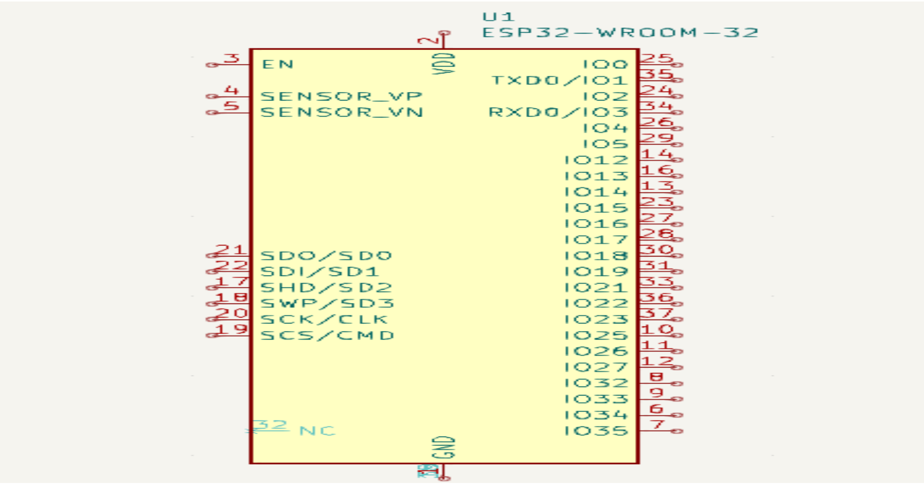

Figure 12: ESP32 Wroom 32 (Arai, 2022)

The board come with power pins: 3V3, GND, and VIN used to power the board (if you're not providing power through the USB port), in this system ESP32 WROOM 32 is used as a major functioning unit which transmit data from LDR then configures the LED lights.

3.2.1.2 Light Emitting Diode (LEDs)

The ESP32 microcontroller's GROUND (GND) pin supplies the three LEDs in the sensing circuit. The pin is connected to the negative terminal, or cathode, of each LED.

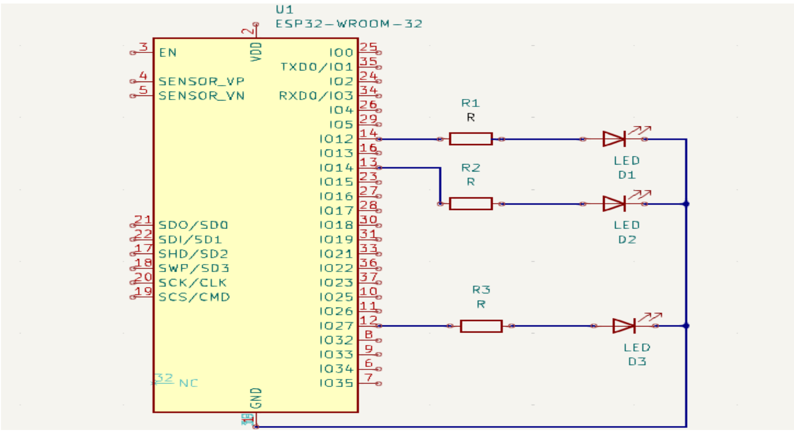

Figure 13: LED circuit Diagram

A resistor is attached to every LED with the anode of the LED connected to it. With their ability to allow only a certain amount of current through, these resistors save the floodlights from burning out caused by excessive current flowing into them. Each resistor's other end is linked to a specific digital input pin on this microcontroller; these pins are defined within the code and used for controlling LED functions.

3.3 Hardware flow chart

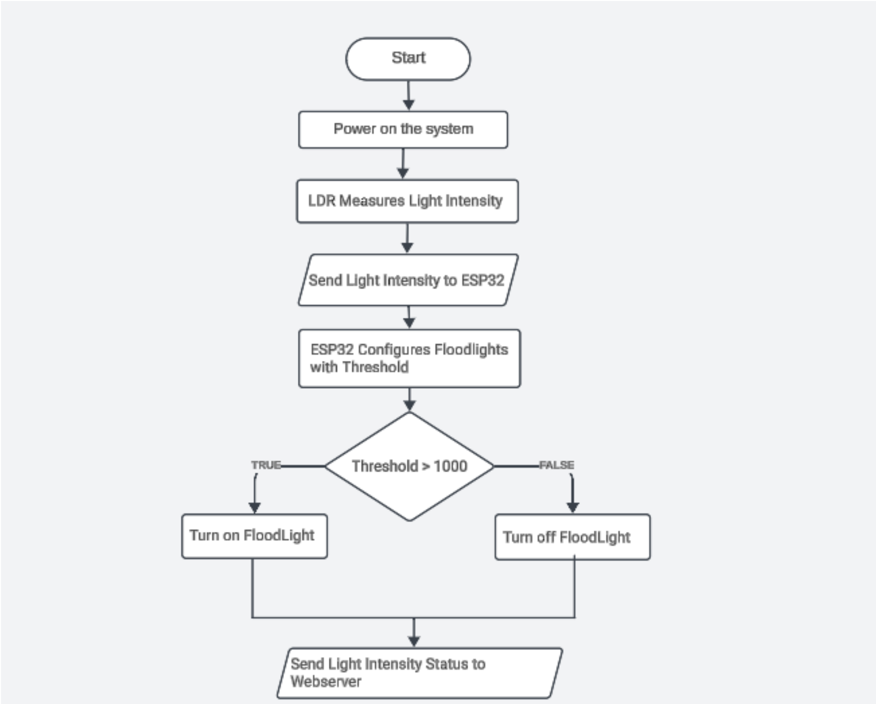

Figure 14: Hardware flowchart

The system is powered on, LDR measures light intensity and sends the value to the ESP32 Wroom 32 ESP32 configures the floodlights, setting a threshold for the light intensity value, If light intensity is >1000 turn off flood light and if <1000 turn on floodlight then ESP32 sends the light intensity status to the webserver.

3.4 Sensing circuit design

The following figure shows the design of the sensing circuit and the indent component schematics that make part of the circuit design.

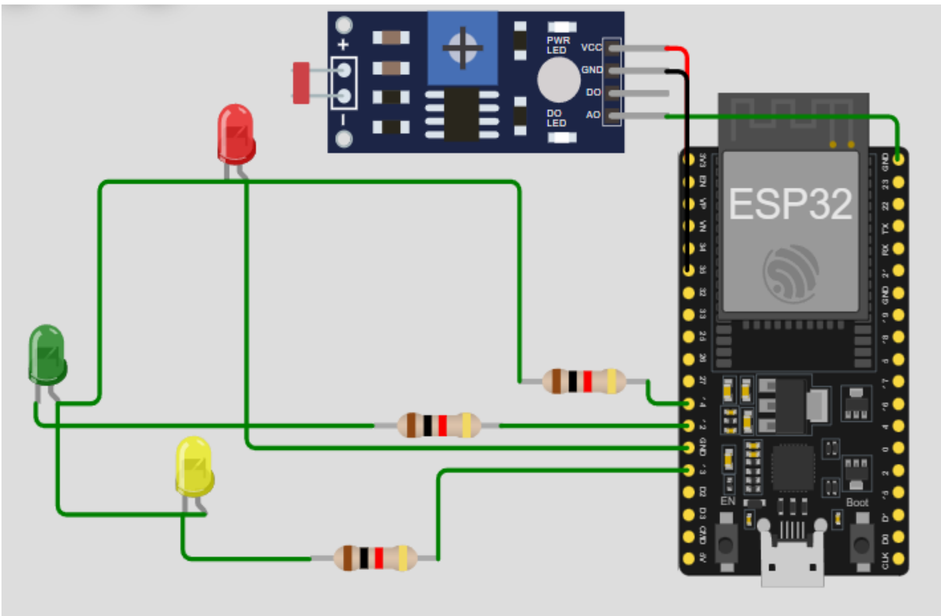

Figure 15: Overall sensing circuit

The USB port on the ESP32 DEV KIT DOIT boards provides both power and data connection which makes it a convenient choice for the project. It is made sure that a steady power supply is present to the microcontroller by linking the ESP32 boards with PC through USB. Furthermore, Arduino IDE tool is used to upload code into ESP32 microcontroller for debugging purposes because of USB connection.

As shown in the figure, the circuit consists of three LEDs and an LDR sensor represented by the corresponding schematic symbols. Light intensity is measured by LDR sensor which then sends analog signal to ESP32 microcontroller for further processing before controlling LEDs appropriately.

When these components are included in the circuit design, a solid monitoring system capable of tracking billboard lighting conditions accurately is acquired.

3.4 Enclosure design

Figure 16 show the physical connection of the prototype which was developed.

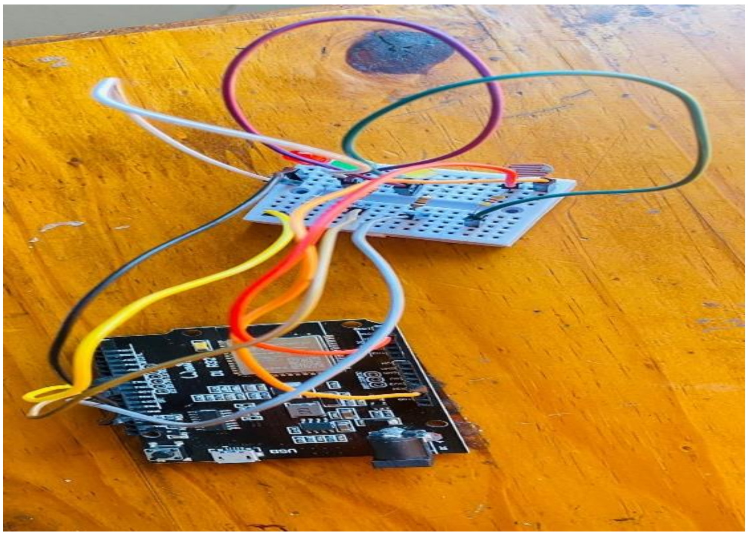

Figure 16: Picture of the hardware

The hardware facilitates proper prototyping and demonstration of the system's functionality which facilitates proper feedback. The LDR and LEDs are connected to the ESP32 pins using shielded cables for proper current transmission.

A breadboard is used to place the LDR, LEDs and resistors connections on the board to make circuits without soldering.

3.8 Conclusion

To sum up, the hardware chapter has presented the design and incorporation of such indispensable parts as ESP32 microcontroller, LDR sensor and LEDs.

Guaranteed its functionality and reliability through proper circuit designing and testing. By using resistors for current control and LDR sensor for measuring intensity of light, a better sensing circuit. This is what should be done before starting the next steps such as hardware development, testing, deployment that will lead to a fully functional surveillance system that can accurately monitor billboard lighting conditions.

Chapter 4: Software design of a light intensity monitoring system for billboards floodlights.

4.1 Introduction

This chapter is about the software design aspect of this research project, speaking about the developed and implemented the monitoring system's software components. A methodical approach towards addressing the project's software has been established. The software design enables data processing, analysis as well as storage that can be applied for effective control and management of billboard lighting conditions.

4.2 Scope of work

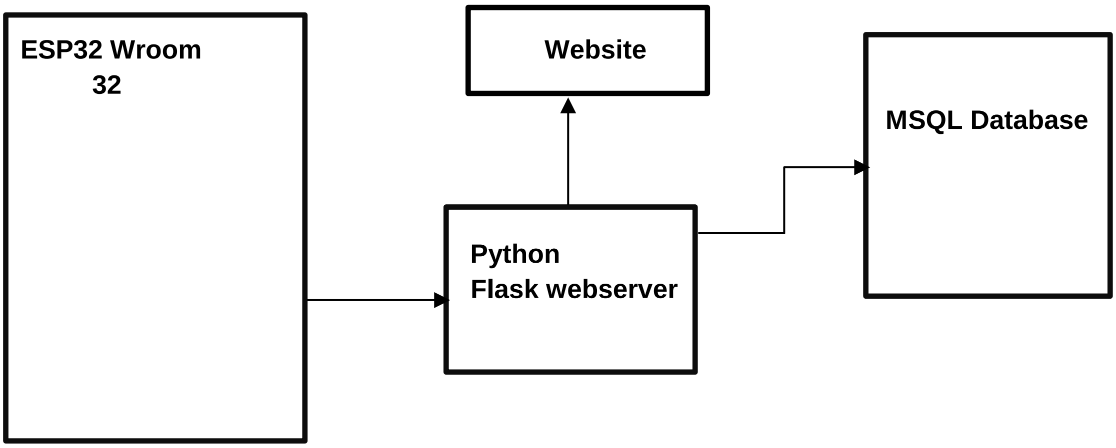

Figure 16: Software block diagram

The block diagram figure shows the connections of the system which make up the software part of the implementation. The ESP32 sends data to python webserver where the values are received and analyzed then sent to MYSQL database for storage and reuse.

4.3 Software designs

4.3.1 MYSQL Database

SQL (Structured Query Language) is designed for managing and manipulating data stored in RDBMS (Relational Database Management Systems) (Ilama, 2013). For the purpose of this project SQL is employed to create a database for the floodlight system.

```
CREATE DATABASE IF NOT EXISTS floodlightDb
```

Figure 18: Database Creation

With the use of the MYSQL workbench tables which store the data from the users details to light intensity status values. SQL is also used within the workbench to create and modify the student, node (billboard), and sensor tables as depicted on the figure below.

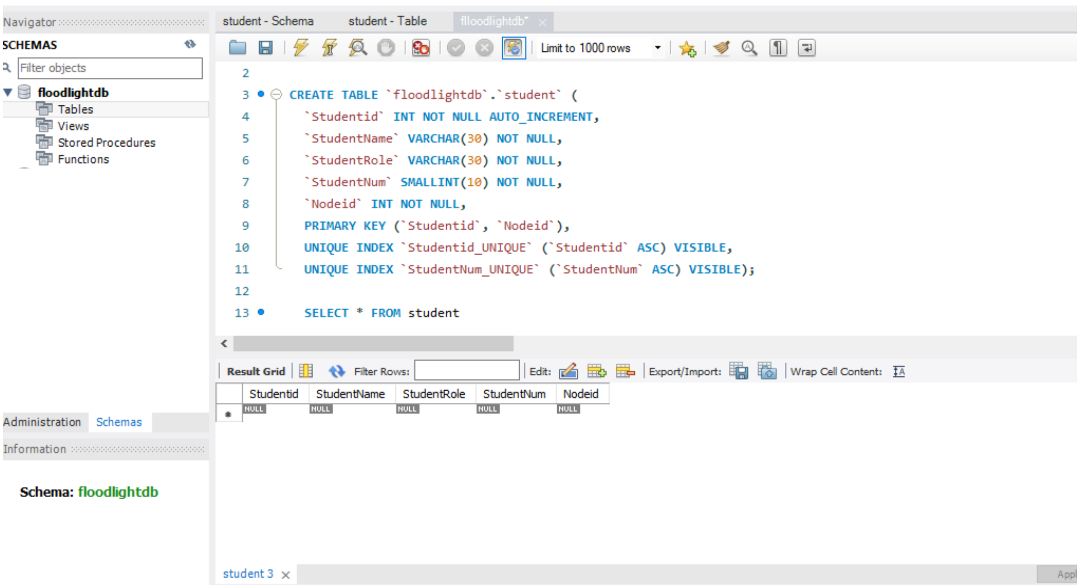

Figure 19: Creation of Tables

4.3.2 Entity Relationship Diagram

The Entity-Relationship Diagram (ERD) presented here illustrates the data structure and relationships within the project, which involves monitoring and managing light intensity data from billboards using ESP32 nodes equipped with LDR sensors The ERD defines the key entities involved, their attributes, and the relationships between these entities.

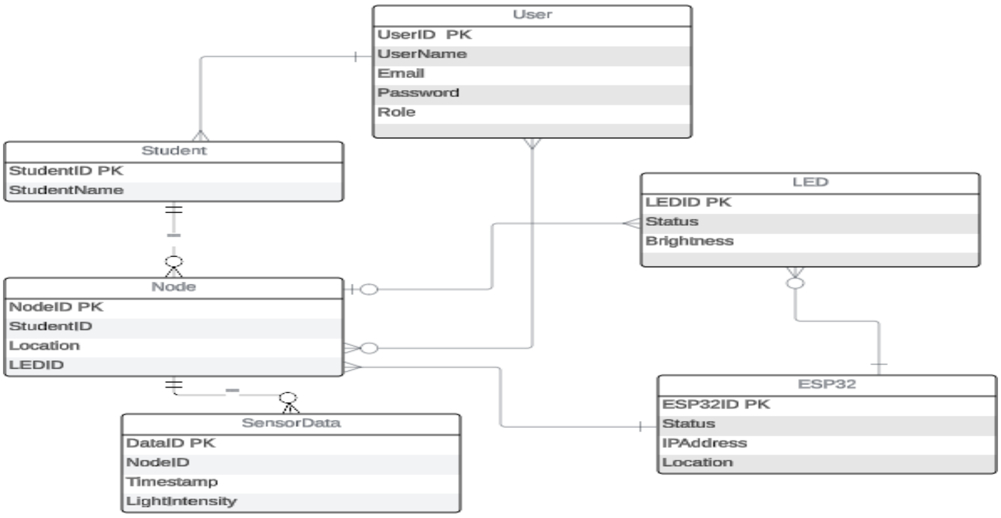

Figure 20: ERD Diagram

Student: Entity
Student ID – Each student has a unique identifier Student Name – The name of the student. Entity Node:
Node ID – A unique identifier for each node.
Student ID – This is used to identify which student owns this node. Location - Physical or logical position of the node.
Entity Sensor Data:
Data ID: It is an exclusive identification of every sensor data item.
Node ID: Where this data was gotten from on the node is a reference to that node Timestamp: When data was recorded
Light Intensity: Light intensity measured by LDR sensor LED Status: Whether LED is on/off

This ERD enables pairing up of sensor data with particular nodes and students which in turn facilitates analyzing the observations specifically per-student-node being looked at.

4.4 Python flask framework

The website serves as the interface through which users can interact with the data, providing functionalities for both administrators and students. Flask is used to create the website framework integrated with languages such as Python used for dynamic routing, SQL for the creation of tables and the database, HTML and CSS for the design of the website.

Administrators have comprehensive access, allowing them to view and analyze data from all nodes, managed by different students. On the other hand, students have access enabling them to view and monitor the data associated with the nodes they manage.

4.4.1 User Interface Design

Consistent navigation bars allow users to easily access different sections, like the home and login pages. Important elements, such as the login forms are included and Python language is used for rendering and routing of the different pages prominently displayed and created using HTML and CSS for style.

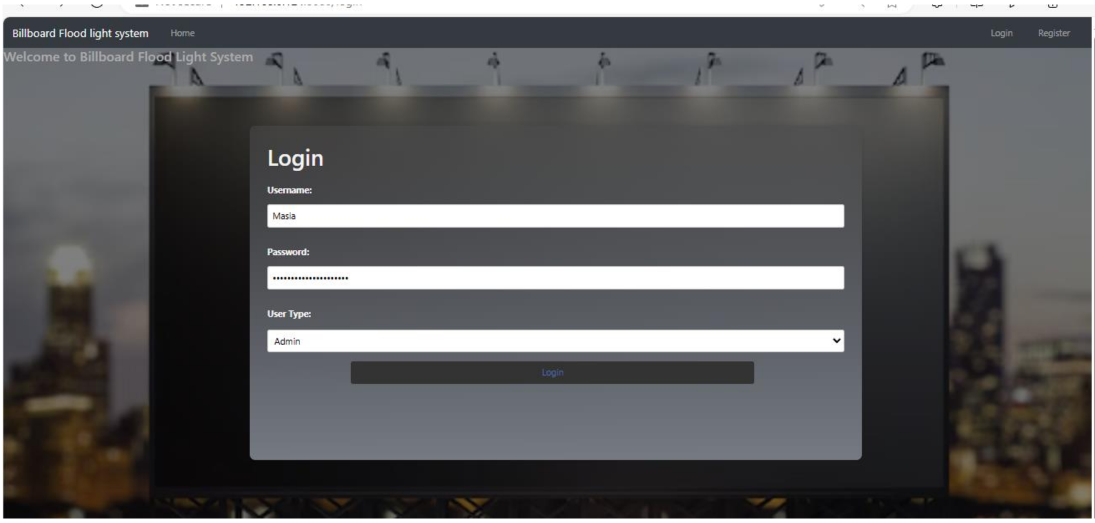

Figure 21: User Interface

Different user types (admin and students) select their role and enter secure login credentials. Passwords are encrypted and securely handled and stored into to the database.

Both client-side and server-side validation ensure data correctness then a particular user choses their user type and be able to be granted access.

4.4.2 Data access

Database visual provide seamless data processing and updating in the database when forms are submitted and immediate feedback is provided to users after form submission. When the admin logins are successful they are directed a node view page which shows available nodes.

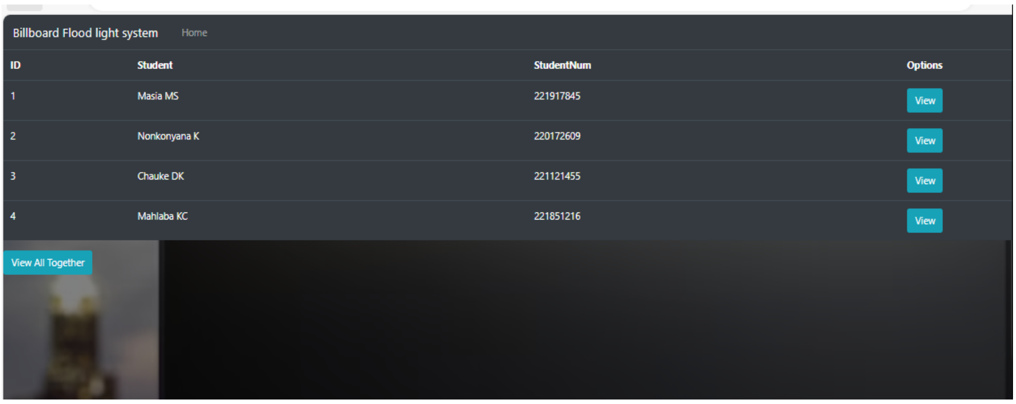

Figure 22: Admin view

Admins have access to all data from each node, while other users can only view their own nodes and configure the light intensity.

4.4.2.1 Data Visualization

For flask webserver to receive data, ESP32 Wi-Fi capabilities are used. The ESP32 Wroom 32 Wi-Fi is enabled as shown in figure 14 to connect the microcontroller to the host as this allows data to be sent through Wi-Fi.

```

#include <WiFi.h>
#include <HTTPClient.h>

const char* ssid = "WiFi SSID";                 // WiFi SSID
const char* password = "WiFi password";                  //WiFi password
const char* serverUrl = "http://192.168.0.124:8080/data";  //  Flask server URL

```

Figure 101: ESP32 WI-FI connect

Viewing of the data is achieved by using python flask webserver. The webserver enables receiving data which is synchronized with the ESP32 Wroom 32 readings. The following figure below shows integration of python and flask, declaring ldrValue received from ESP32.

```
@app.route('/data', methods=['POST'])
def receive_data():
    global latest_ldr_value
    try:
        data = request.get_json()
        if data is None:
            return jsonify({"status": "error", "message": "Invalid JSON data"}), 400

        latest_ldr_value = data.get('ldr_value')
        print(f"Received LDR value: {latest_ldr_value}")
        return jsonify({"status": "success", "ldr_value": latest_ldr_value}), 200
    except Exception as e:
        print(f"Error: {e}")
        return jsonify({"status": "error", "message": "An error occurred"}), 500

@app.route('/latest', methods=['GET'])
def latest():
    return jsonify({"ldr_value": latest_ldr_value}), 200

if __name__ == '__main__':
    app.run(host='0.0.0.0', port=8080)
```

Figure 24: Python framework

After all the integration of python flask, website and ESP32 the view option can be used for the actual LDR light intensity with real time.

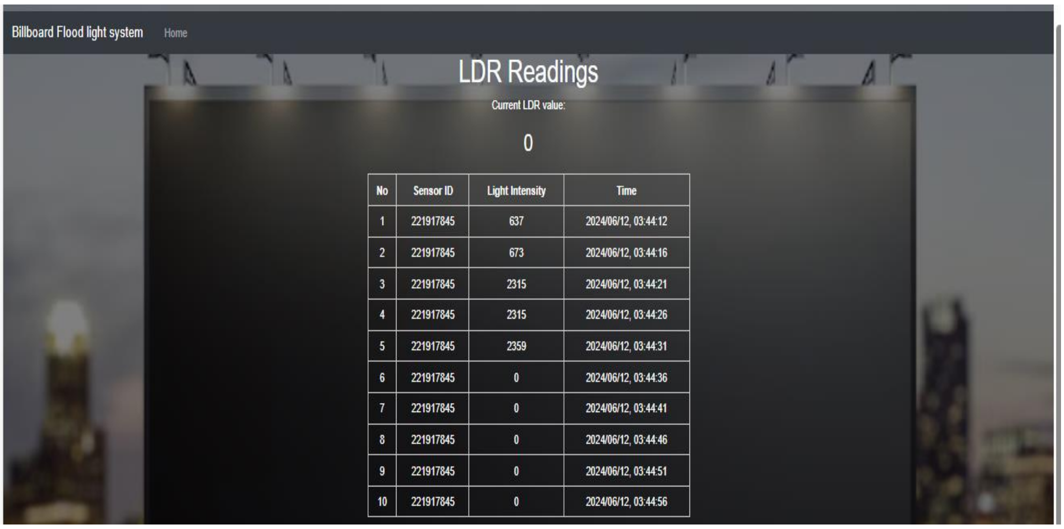

Figure 25: light intensity reading

The figure shows the viewing page in which the light intensity readings are displayed in the form of table. It also include the real time at which the LDR reading from ESP32 is sent to the website then saved to the database.

4.4.2.1 Data saving

The received data is saved in MYSQL database for efficient monitoring. The table to which the data is saved is created which stores the data to MYSQL as the ESP32 is transferring.

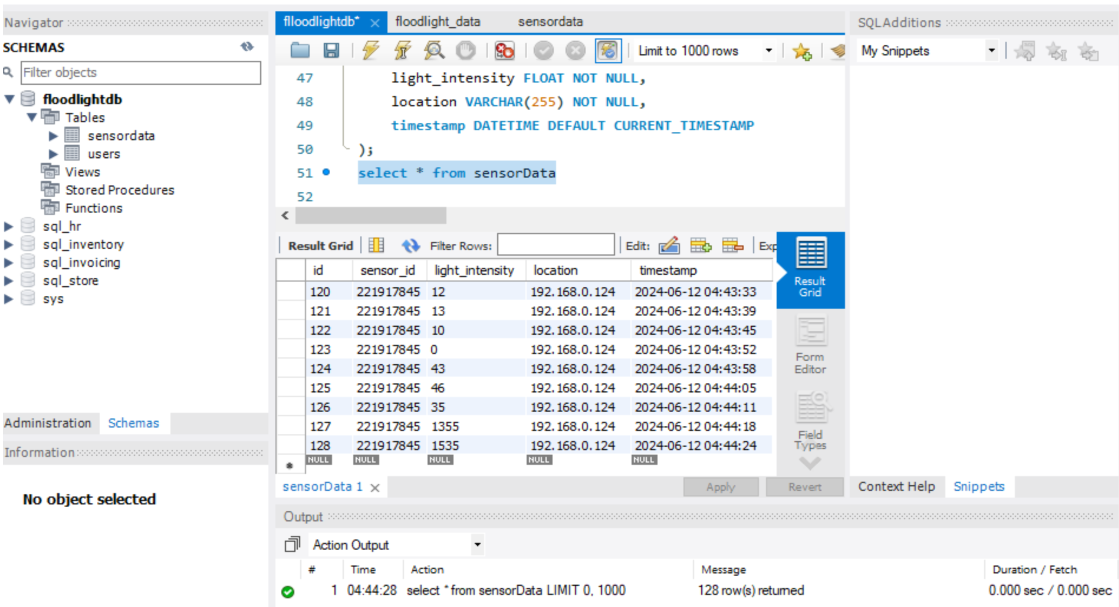

Figure 26: MYSQL data save

With data received saved in MYSQL it allows technicians to view and view data at any given time. The database stores the sensor ID, light intensity at a given time, and states the location of where LDR is reading from.

4.5 Software Flowchart

The software flowchart focuses on the definite algorithm involved in processing the data received from the ESP32 microcontroller and save it to the Database.

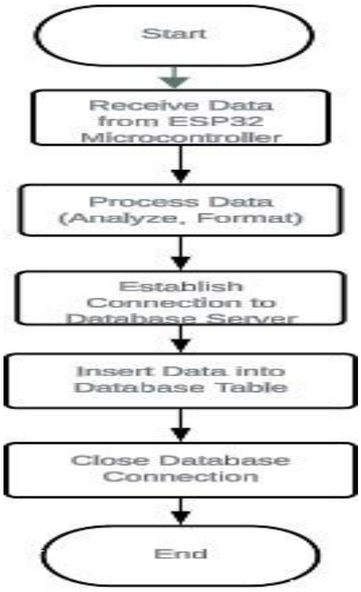

Figure 27: Software flowchart

First, it starts with obtaining data from ESP32 followed by its subsequent handling and analysis within the software environment. Then, there is an established connection with database server for saving processed data to appropriate table of a database. When finished inserting data, it disconnects from the database server resulting in termination of the software flowchart. This brief summation captures key

4.3.2 Conclusion

In summary, the web development section of the project focuses on creating an intuitive and secure interface for both admins and students. The website is designed to offer seamless navigation, ensuring that users can easily access different sections and features.

Secure login mechanisms are implemented to protect user data and restrict access appropriately, with robust session management and encrypted password handling. Additionally, user-friendly forms facilitate data entry and updates, ensuring data integrity and seamless interaction with the database. By prioritizing ease of use, security, and efficient data management, the website provides a reliable platform for monitoring and managing floodlight data effectively.

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

The project has achieved monitoring of billboard floodlights with the use of LDR sensor. Efficient readings of the LDR were achieved which helped control the floodlights due to a threshold set within the hardware part of the project. Problems such as establishing the WI-FI connection to the webserver were encountered but solved by identifying port and IP address of the host. Due to time the project could not have more functionalities which would have been better for viewings. An improved sensor would be very efficient for the project.

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Appendix

- Data sheet for ESP32 BOARD

Name	No.	Type	Function
GND	1	P	Ground
3V3	2	P	Power supply.
EN	3	I	Chip-enable signal. Active high.
SENSOR_VP	4	I	GPIO36, SENSOR_VP, ADC_H, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	I	GPIO39, SENSOR_VN, ADC1_CH3, ADC_H, RTC_GPIO3
IO34	6	I	GPIO34, ADC1_CH6, RTC_GPIO4
IO35	7	I	GPIO35, ADC1_CH7, RTC_GPIO5
IO32	8	I/O	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	10	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV