Faculty of Electrical Engineering and Technology

DEVELOPMENT OF IOT BASED SYSTEM FOR SMART STREET LIGHT

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Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2023

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

Faculty of Electrical Engineering and Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : DEVELOPMENT OF IOT BASED SYSTEM FOR SMART STREET LIGHT SYSTEM

Sesi Pengajian : 2023/2024

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DEDICATION

To my beloved mother, Maszitta, and father, Shamsul Bahari, and my beloved family,
To my supervisor, Sir Adam Bin Samsudin,
Also my co supervisor, Madam Kamilah Binti Jaffar.
This project is devoted to each and every one of you, as well as to God Almighty, who is my benefactor, my rock, and my wellspring of insight, understanding, and wisdom. I have soared on His wings, and they have been a source of strength for me during this struggle. They have also helped me along the journey to make sure I give it everything I have to complete the tasks I have begun. Blessings from God upon you.

ABSTRACT

The greatest way to reduce electrical power wastage is to build and implement the most cutting-edge IoT street light energy-saving technology. Street light plays a crucial role in maintaining city safety and giving residents a sense of security. However, the cost is rather considerable, and the local governments are responsible for paying it. Making smart street and lighting systems is one of the most crucial things to do right now in order to save a tonne of electrical energy. A paradigm shift in the kinds of devices utilised in lighting technology has occurred recently, however the amount of wasted energy has not decreased significantly. In an urban setting, smart street light is a cost-effective system that combines cutting-edge wireless communication methods, inexpensive LED lights, and extra sensors that regulate light output. Comparing this novel technology to the traditional "ON" and "OFF" switching approach results in significant cost and energy savings. Utilise an automated system in a smart street light system that uses timers and LDR to automatically control the functioning of the street lights. The IR sensors detect people or vehicles entering the road, which causes the light to automatically turn on, similarly when someone exits the road, the lights turn out automatically. By doing this, wasteful electricity consumption at night, when there are no signs of people or cars is avoided.

ABSTRAK

Cara terbaik untuk mengurangkan pembaziran kuasa elektrik ialah membina dan melaksanakan teknologi penjimatan tenaga lampu jalan IoT yang paling canggih. Lampu jalan memainkan peranan penting dalam mengekalkan keselamatan bandar dan memberi penduduk rasa selamat. Walau bagaimanapun, kosnya agak besar, dan kerajaan tempatan bertanggungjawab untuk membayarnya. Membuat sistem jalan dan lampu pintar adalah salah satu perkara yang paling penting untuk dilakukan sekarang untuk menjimatkan satu tan tenaga elektrik. Perubahan paradigma dalam jenis peranti yang digunakan dalam teknologi pencahayaan telah berlaku baru-baru ini, namun jumlah tenaga terbuang tidak berkurangan dengan ketara. Dalam persekitaran bandar, lampu jalan pintar ialah sistem kos efektif yang menggabungkan kaedah komunikasi wayarles termaju, lampu LED yang murah dan penderia tambahan yang mengawal pengeluaran cahaya. Membandingkan teknologi baru ini dengan pendekatan pensuisan "ON" and "OFF" tradisional menghasilkan penjimatan kos dan tenaga yang ketara. Gunakan sistem automatik dalam sistem lampu jalan pintar yang menggunakan pemasa dan LDR untuk mengawal fungsi lampu jalan secara automatik. Penderia IR mengesan orang atau kenderaan yang memasuki jalan, yang menyebabkan lampu menyala secara automatik, begitu juga apabila seseorang keluar dari jalan, lampu akan mati secara automatik. Dengan melakukan ini, penggunaan elektrik yang membazir pada waktu malam, apabila tiada tanda-tanda orang atau kereta dapat dielakkan.

ACKNOWLEDGEMENTS

First of all, I want to thank Allah S.W.T for giving me the opportunity to start my final year project and for helping me complete this difficult and time-consuming project. I would like to sincerely thank my supervisor, co-supervisor, friends, and family. I would want to express my profound gratitude to everyone who has contributed significantly to the accomplishment of this project. Their amazing guidance, support, and encouragement would not have been possible without. I owe a debt of gratitude to Sir Adam Bin Samsudin, my supervisor, and Madam Kamilah Binti Jaffar, my co-supervisor, for their unwavering encouragement, perceptive criticism, and tremendous help throughout this project. Their extensive expertise and steadfast dedication have been invaluable in shaping the course of my studies and inspiring me to reach the pinnacle of achievement. I am appreciative of the University Teknikal Malaysia Melaka team for their instruction and advice, which have improved my knowledge and abilities and enabled me to get over the challenges I encountered while traveling.

I want to sincerely thank my family and friends for their steadfast understanding and support amid the highs and lows of my scholastic journey. Their love and support have been a constant source of strength, strengthening my determination to see my project through to completion.

I would like to thank my research colleagues and colleagues for their insightful discussions and well-considered ideas, which have greatly enhanced the calibre of my work. Finally, I want to express my gratitude to everyone in my immediate neighbourhood for their help and support. This success demonstrates the value of teamwork as well as the sense of camaraderie and support among colleagues. In the end, this thesis is dedicated to my parents, who showed extraordinary vision and steadfast dedication in giving me an education. I dedicate this victory to you both. Glory to Allah. I would want to thank each and every one of you for being an essential part of this adventure.

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CHAPTER 1

INTRODUCTION

1.1 Background

In today's world, electricity is a crucial aspect of daily lives and people heavily rely on it [1]. The street light is crucial and one of a city's biggest energy consumers. Municipal street light expenses can be decreased with an intelligent street light system. The existing technique is comparable to turning on the lights before it gets dark in the evening and shutting them off when it gets light enough outside in the morning [2]. However, when it is absolutely dark out, that is when these lights should really be turned on. In this method, some electricity will be squandered. The apparent difference in "ON" and "OFF" durations on bright and rainy days is one of the main problems with the current street lighting infrastructure. The existing control of the lighting system has also been completely eliminated. As a result of population growth, economic progress, and the tragically limited supply of energy sources, global energy demand is rising at the quickest rate ever. There are still significant energy shortages because the development and expansion of resources cannot keep up with the expanding demand for energy street lights are an important part of any expanding city.

Street lights are always on from dusk to dawn at full power, even when no one is around. These street lights cost millions of dollars every day to provide the necessary electrical energy on a global scale. Traditional incandescent bulbs have ridiculously high maintenance and replacement costs. They use a lot of electricity to operate and emit a lot of heat. All of this increases the need for electricity generation, which results in increased carbon dioxide emissions from power plants. Therefore, this practise damages the earth and contributes to unneeded light pollution. This project is to provide the Internet of Things (IoT) based system for smart street light powered with solar. In isolated rural locations with severe issues with electric power supply, it is possible to methodically assist the pedestrian or vehicle in reaching their destination by integrating all of the street lights with a Smart street light system. Metropolitan areas can also make advantage of this method. An easy and effective remedy to this would be to turn the lights down when it's not busy. If presence is felt, the surrounding lights will always glow brightly and normally. As a result, there would be significant energy savings and decreased running costs for streetlights. IoT enables real-time street light condition monitoring from any place, as well as problem-solving for any processing-related issues.

1.2 Addressing Global Warming Through Smart Street Light System

The serious global problem of global warming calls for coordinated action and creative solutions. By lowering energy use, greenhouse gas emissions, and light pollution, the smart street light system can significantly contribute to the fight against global warming.

The smart street light system may dramatically cut energy use and greenhouse gas emissions by using LED bulbs and digital lighting control. Traditional light bulbs require more frequent replacement and maintenance, whereas LED bulbs use less energy and last longer. Intelligent lighting control enables automatic illumination level adjustments based on the time of day, the weather, and other variables, further enhancing energy economy and lowering light pollution.

Additionally, the intelligent street light system can help to lessen light pollution, which is a significant cause of global warming. The excessive use of artificial light at night, which can disturb wildlife behaviour and affect natural ecosystems, is what leads to light pollution. The smart street lighting system can help lessen light pollution and its effects on the environment by applying intelligent lighting control and reducing the overall quantity of lights.

In order to further increase its energy efficiency and environmental performance, the smart street light system can be connected with other smart technologies, such as sensors. For instance, sensors can be used to modify illumination levels when cars or people are present on the road.

1.3 Problem Statement

It is fairly typical to see the street light on all night, which is a significant energy waster. Every day, there is a comparatively significant power consumption. Compared to the main city streets, certain streets are occasionally empty. Based on the issue, street light was observed in order to enhance the street lighting management system and ensure that the street light can function properly. By implementing this technique, it is possible to reduce both electrical waste and energy consumption. Understanding ways to lower street light power consumption is so crucial. Even though most drivers don't typically consider it, street illumination is crucial in helping to reduce auto accidents. Without sufficient lighting, it is significantly more difficult for drivers to detect possible hazards on the road, traffic signs, other automobiles, pedestrians, and bicyclists. Additionally, dim lighting may exacerbate some driving risks. Installation of streetlights must be useful rather than harmful. Additionally, it can help to lower excessive power use at night, when there aren't any apparent signs of cars.

1.4 Project Objective

The objective of this project is to implemant an IoT based system for smart street light are stated as below:

a) To study the street light system using IoT.

b) To design and develop smart street light that works with motion detection.

c) To determine and analyze the effectiveness for smart street light system for users.

1.5 Scope of Project

By constructing a system of intelligent street lights, the project's execution is focused on lowering maintenance and electricity costs. The effectiveness of deploying smart street lights in comparison to conventional street lights is also studied and contrasted in this study. The Arduino programming language is used for the design's software implementation. On the other hand, the hardware implementation of the street light system is made up of an Arduino, USB converter, an IR sensor, LDR sensors, Solar Panel and LED. In addition to benefiting rural areas, this smart street light installation also assists urban areas. The usage of renewable energy is favourable and useful because as we advance, we need more power.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A new civilization exists today, energy efficiency is acknowledged as a crucial strategy for addressing issues including growing fuel prices, market competition, tighter laws, climate change, and the energy crisis brought on by the depletion of fossil fuel resources. This project typically involves a multi-functional prototype with the ability to automate rather than replace the manual operation of the current street light system. To maintain energy-efficient street light at a lower cost with contemporary development, it aspires to develop and use innovative embedded technology. This research chapter will also incorporate material from further studies, journal articles, and information relevant to this chapter.

2.2 Understanding [Global/Current Issue] in the Literature

Through the research on smart street light systems has recently raised the possibility of privacy issues and data security vulnerabilities. The smart street light system uses sensors and other technology to track and alter lighting levels, which can gather information on local residents' movements and behaviours. The system may be made more effective and efficient with the use of this data, but it also raises questions about data security and privacy.

Another problem is that installing a smart street lighting system might be expensive initially, which can be a barrier for some cities and municipalities, especially those with tight budgets.

2.3 Smart Street Light System

To learn more about the smart street light system, the analyze of several factors that other academics have predicted. This is a description of the work on smart street lights that was done utilizing various components and various algorithms [3]. This was created and put into use by various systems and characteristics. Electricity is a crucial requirement for improving the rural area. The smart system that can decide on the bright control is suggested in this paper. This study provides a novel and cost-effective control lighting system (CLS) for sidewalks and main streets that can lower electrical energy use and CO_2 emissions. High-intensity discharge (HID), a novel type of illumination source, is also included; it can save electricity usage by up to 90%. Figure 2.1 shows a prototype of street light system [3].

Figure 2.1 Smart street lightning system [3]

An infrared sensor (IR sensor) manages street lights, and a Light dependent Resistor sensor (LDR sensor) gauges their brightness. The solar cell serves in this case as a battery. The use of a surveillance camera mounted on street light lights to maintain traffic and monitor the entire system online is the study's most important finding. The internet is used to control the street lights to turn "ON" and "OFF". A camera mounted atop the street lights monitors activity on the roads, and video is kept on the server [4].

Typically, the project is a multi-functional prototype with the potential to replace the manual operation of the outdated street lighting system through the use of self-automation [5]. It aims to develop and implement state-of-the-art embedded systems for maintaining energy-efficient street lighting at lower costs using current technologies. A peculiarity of the street light system is that it uses two sensors, a light dependent resistor (LDR) to determine whether it is day or night, and a passive infrared sensor (IR) to detect movement on the road [6].

Automatic Street Light Control System is a simple yet effective method [7]. In this system, relay makes use of an automatic switch. It eliminates physical labor. This function is really carried out by a sensor known as a Light Dependent Resistor (LDR), which senses light similarly to how the human eye does. The lights are shut off as soon as sunlight is visible to human eyes. A similar strategy is beneficial for reducing energy consumption.

In [8] purpose of the paper project is to detect vehicle movement on highways and turn ON only the block of the street light in front of the vehicle while turning OFF the trailing light to conserve energy. All of the lights on the highways are left on during the night for the vehicles, but a lot of energy is lost when there isn't any traffic.

There are 304 million streetlights in use worldwide as of right now [9]. By 2025, this amount will increase to a total of 352 million street lights. New street lights are being installed to replace the old ones, more energy-efficient Light Emitting Diode (LED) or solid-state light technologies as the light industry goes through a period of upheaval. A "Smart Street Light System" is created when this LED and solid-state light technology is combined and used to communicate simultaneously across a network. Over the next ten years, LED and smart street light will revolutionize cities all over the world. Compared to traditional street light systems, LED has a longer lifespan, lower energy usage, and fewer maintenance costs.

As a more cost-effective option, LEDs are already replacing the conventional streetlights in the majority of developed nations. As part of the "smart city" concept, contemporary nations are concentrating on replacing the current streetlights with "smart" street lights. Cities can further cut costs by using smart street lights to prevent energy waste and maintenance costs.

According to [10] for the city to be safe and for its residents to feel secure, adequate street lighting is a crucial component. However, the cost is rather considerable, and the local governments are responsible for paying it. A paradigm shifts in the kinds of devices utilized in lighting technology has occurred recently, however the amount of wasted energy has not decreased significantly. The central management platform will be in charge of managing the infrastructure for the smart lighting industry's devices, policies, and central operations. The central management platform will be used to define and push all operational policies to the nodes [11].

IR sensors are used in smart street light systems to adjust the timing of traffic lights and monitor traffic density [12]. A comparator receives the sensors' output and digitises it. Using GPS modems, this method can be used to locate neighbouring hospitals and ambulance services. Using LDR and timers, automated systems manage the operation of street lights. When a person or vehicle enters the road, the IR sensors detect it, and the lights automatically turn on. By doing this, wasteful electricity consumption at night, when there are no signs of people or cars, is avoided.

According to [13] it tries to create an intelligent system that can decide whether to turn on, off, or dim lights based on the amount of light present. It includes a solar cell for power supply, a secondary backup DC current, and a surveillance camera to monitor the entire system. All components are simple and cost effective, making it a reliable intelligence system.

2.3.1 Light System

According to [14] the paper depicts the entire circuit that enables the road light to switch to the ON state, and after a certain amount of time, it depicts the growth of a car and half OFF. The primary objective of this traffic light is to automatically turn on and off the lights in accordance with day and night.

Although highway lighting systems are in high demand, their maintenance has significant financial costs as well as unfavorable environmental effects [15]. Because of this, recent studies have looked into potential methods to increase the effectiveness of the current lighting system. The definitive manual for smart highway lighting systems with green energy integration, however, still falls short in terms of quality and thoroughness. Making performance and environmental impact considerations into the planning and development of energy-efficient green roadway lighting systems, the goal of this research is to explore varied processes in the literature. A thorough taxonomy is offered to categories and identify the literature, encompassing core design concepts with their benefits and drawbacks as well as research obstacles. This report also aims to provide readers with a potential framework for bridging the gaps between previous investigations. Researchers and decision-makers who are interested in understanding the advantages of the improved energy efficiency in the highway lighting setup should take note of these findings.

2.4 The Internet of Things (IoT)

One of the most significant 21st-century technologies is IoT. A fresh area of study with significant technical, social, and economic implications is the Internet of Things. Internet connectivity and powerful data processing capabilities are being coupled with consumer goods, durable goods, transportation equipment, automobiles and trucks, industrial and utility components, sensors, and other ordinary objects in a way that promises to transform how people work, live, and play.

2.4.1 Street Light using IoT

Smart street light using IoT are suggested using solar energy to power an intelligent street light to easily reduce the amount of electricity utilized in urban areas [16]. The photovoltaic system collects energy and transfers it to the LEDs in the street lighting. When the sun light is not detected by the sensors because LEDs will automatically turn on once the rechargeable battery has enough energy from the photovoltaic system to power them. PIR sensor is installed and used to the level of light. Light intensity and also regulates moving objects close to the light in this article [3]. This system makes use of both light and photoelectric sensors. The complete intelligent system can run on artificial energy sources. PIR and LDR sensors detect human activity and the level of light in a certain region and the information sent across the wireless link to the EB section.

The system that this paper proposes offers a way to save electricity, the combination of an IR transmitter and receiver is used to identify vehicles [4]. When a vehicle or item moves away, the sensor sends information to the microcontroller, which turns the device “ON”, and when that happens, the light turns “OFF” and may be accessed online. To regulate the street light, a smart street light system is being developed. The idea put out in this paper is that the Internet of Things will lessen the need for human labor and energy conservation while maximizing the use of the energy that is saved. To save even more energy, LED bulbs have taken the place of conventional HID lamps.

Development of IoT system it strives to leverage the newest, modern technology to support the enhancements for city management and the populace, with a primary focus on sustaining the smart city vision [17]. According to this report [18] demonstrates how to design an embedded system with an emphasis on the requirement for an automated street light system. In this case, the piezoelectric sensor takes the place of the IR sensor to detect the motion of the object on the road. The microcontroller msp230 is the brain that directs the procedure. It offers a way to regulate both the amount of light and traffic on the roads. As sensing devices, photoelectric and light sensors are employed. To recognise motion on the road, this device uses a piezoelectric sensor.

To conserve energy by minimizing both personnel and electricity waste, saving energy can be used for a variety of things, including home and commercial uses [19]. People prefer to live sophisticated lives with all the amenities in today's modern environment [9]. Scientific and technological advances are being made swiftly to meet the aforementioned needs. With the aid of cutting-edge technology, Internet of Things plays a vital role in automating a range of industries, including health monitoring, traffic control, agricultural irrigation, street lights, and classrooms. Street lights are now manually controlled, which wastes a lot of energy internationally and needs to be changed. In this study, we examined how IoT is being used to design smart street lights for the present. Addressing the world's energy issue and increasing the use of street lighting are essential. Figure 2.2 show a prototype of light system using IoT [19].

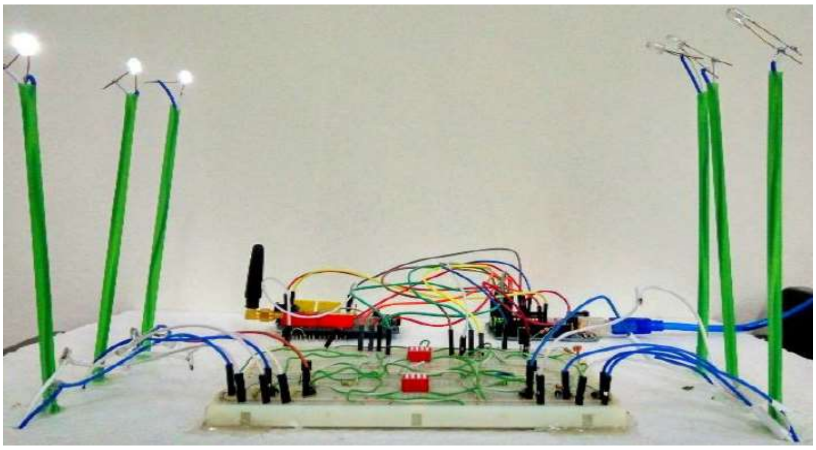

Figure 2.2 Smart street light using IoT [19]

An IoT framework-based energy-efficient smart and intelligent street road lighting system that consists of an IoT sensor-based smart electric pole with a controller for adjusting LED lamps [20] . Using wireless sensor networks and Internet of Things technologies to design a smart street light management system to respond to the national green lighting policy [21]. The system gathers data from the street lamp's environment in real time and uploads it to a platform for cloud monitoring. This paper also do the research regarding using IoT system to discusses the architecture of a smart street lighting system based on NB-IoT technology [22].

2.5 Alternative energy source

Due to the uncontrollable GHG emissions from petrol and the increasing prices of fossil fuels, renewable energy sources are playing a vital role as an alternative source to reduce energy use in various sectors. The widespread use of alternative energy sources can help to mitigate the issues brought on by the concentration of too much CO_2 in the earth's atmosphere.

2.5.1 Solar system

Compared to other energy sources that rely on fossil fuels like oil, coal, and gas, solar energy is still a relatively young technology. Given that highways receive a lot of intense sunshine, there is a significant chance to use this energy to power lampposts at night. There are, however, very few studies that deal with the energy-efficient design of pure solar illumination systems. According [23] it is advised to take into account solar as a substitute energy source for illumination in all types of outdoor lighting systems, including street, highway, and remote area lighting systems. The difficulty in using solar energy comes from how effectively it is transmitted electrically, a problem that is unquestionably managed by the quality of photovoltaic modules and solar charge controllers. The primary topics of discussion about the development of solar-powered lighting systems revolve around the charge controller. For instance, the microprocessor based Maximum Power Point Tracking (MPPT) control system is installed to boost the energy efficiency of solar highway lighting [24].

2.5.2 Rechargeable Battery

A throwaway or primary battery, which is delivered fully charged and discarded after usage, is different from a rechargeable battery in that it can be recharged multiple times. The creation of pollution-free energy generation systems is crucial.

Figure 2.3 Rechargeble Battery

2.6 Hardware Components

Researches on hardware components used to develop the IoT based system for smart street light develop will be discussed in this section. The parts comprise an Arduino IDE node MCU, an LDR sensor, an IR sensor, a power light emitting component, and a relay board.

2.6.1 Arduino Microcontroller

One of the controllers made by the Arduino firm and frequently used as a controller to make electronic projects is the Arduino microcontroller. In addition, it serves as both a physical programmable circuit and an Arduino component. The C++ programming language can be used to read the Arduino microcontroller. Because there is no need to add additional code to the hardware device, it might simplify the process. There are variety Arduino are available in the market that have shown in figure below.

Figure 2.4 Arduino Uno

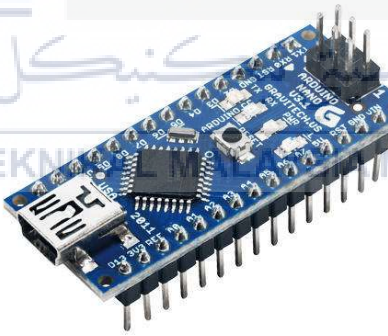

Figure 2.5 Arduino Nano

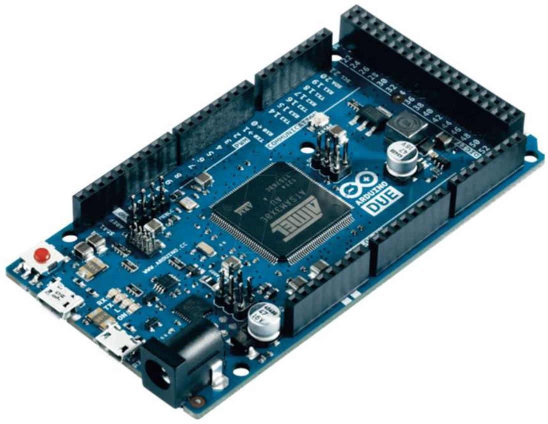

Figure 2.6 Arduino DUE

Figure 2.7 Arduino Leonardo

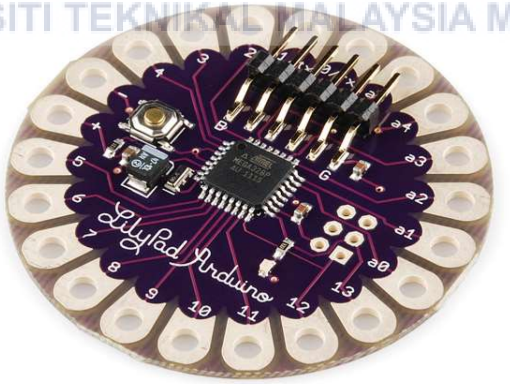

Figure 2.8 LilyPad Arduino

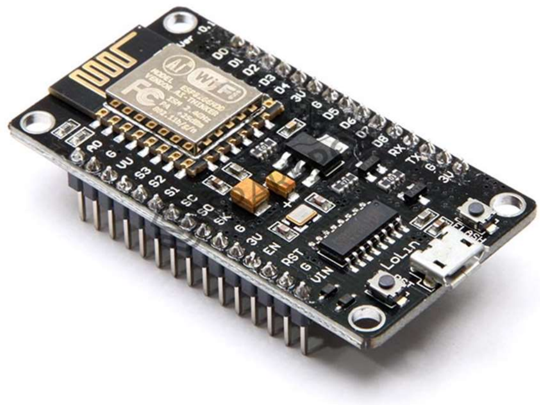

Figure 2.9 Arduno Node MCU

2.6.2 Light Dependent Resistor Sensor

An LDR or photo resistor is a type of light-sensitive device whose resistance is dependent on the electromagnetic radiation that is incident. sometimes known as photo conductors, photo conducting cells, or just photocells. LDR sensors are made of extremely durable semiconductor materials. There are numerous different methods to display an LDR; the picture below shows one of the more common ones. That it is getting light is indicated by the arrow. Electrons in the semiconductor material's valence band are stimulated to move into the conduction band when light strikes the device.

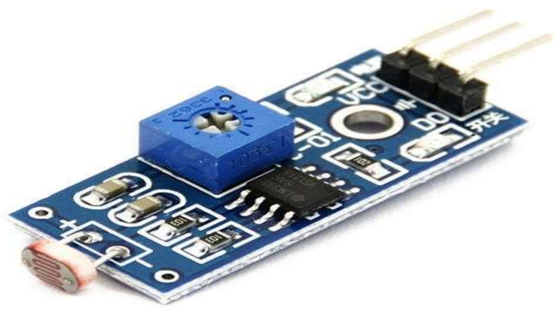

Figure 2.10 Light dependent resistor

2.6.3 IR sensor

Infrared radiation is used by an electrical device known as an infrared sensor (IR sensor) to detect emit particular features of its environment. It can also determine the temperature of an object and detect motion. Infrared wavelengths are invisible to the human eye. A region of the electromagnetic spectrum called infrared radiation has wavelengths that are longer than those of visible light but shorter than those of microwaves.

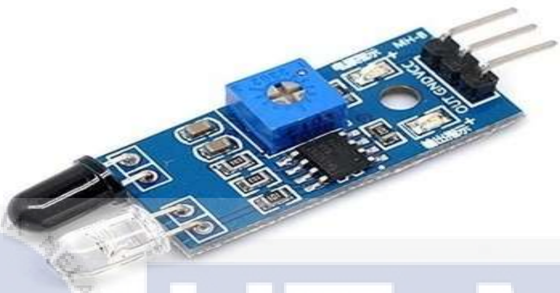

Figure 2.11 IR sensor

2.6.4 Power Light Emitting Diode

One LED with a power more than 0.5W is considered a high-power LED light source. Many manufacturers today employ low power LEDs, however they require a large number of LEDs and have a faster rate of light decay. Therefore, it is fashionable to employ high-power LED sources for business illumination.

Figure 2.12 Power Light Emitting Device

2.6.5 Relay

Computer boards known as relay boards have a variety of relays and switches on them that are used to regulate the voltage supply. Relays are electrical switches that may be turned “ON” or “ OFF”, allowing current to flow or not. Relays can be controlled by low voltages, such as the 5V supplied by the NodeMCU pins. Due to their relative simplicity, extended lifespan, and excellent dependability that has been demonstrated, relays are utilised in numerous applications. Low voltage application and high voltage application are the two main functions of relays. They are designed to minimise arcing in high voltage applications but prioritise reducing noise in low voltage applications.

Figure 2.13 Relay Board

2.7 Summary

Given that the goal of the street lighting system is to ensure that everyone can access the road safely. The ideal solution must, however, also be reasonably priced, energy-efficient, and light pollution-free. Experience and knowledge are necessary to ensure that all of these objectives are realized. Accessibility can be enhanced and surroundings where individuals feel safe and comfortable can be created with the help of proper lighting. Street lighting benefits must always be weighed against the expense of the infrastructure, upkeep, and energy use. The chosen fittings must be strong, easy to install, energy-efficient, and maintenance-free for optimum outcomes.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is thought to be a crucial component in project execution. The design of the IoT based smart street light will be covered in this part. Additionally, a detailed explanation of the project development process will be provided. The goal of any technique is to finish the job and ensure that things according to plan. The project work plan will include covering Gantt charts and flowchart. The description offers information about the hardware and software setup to develop the smart street light design.

3.2 Selecting and Evaluating Tools for a Sustainable Development

It is crucial to carefully select and evaluate the tools and technologies that will be used when building and executing a smart street light system using IoT. This entails a variety of methodological concerns, including analyzing the precision and dependability of sensors, the compatibility of various tools and software, and the project's effects on the environment. It's also critical to think about the project's social and economic ramifications, such as making sure the street lighting system is user-friendly and weighing the advantages and disadvantages of various tool choices. There are a number of methods that can be applied to support these methodological considerations, including life cycle assessments to assess the project's environmental effects, using open source software to promote transparency and accessibility, and conducting field tests to assess sensor accuracy. Researchers and practitioners may guarantee the effectiveness, sustainability, and impact of their projects by carefully choosing and analyzing the technologies they use for smart street light system projects.

3.3 Experimental Setup

An IoT-based smart street light is shown in this study. The street light system in this project will regulate when the street light is expected to turn "ON" when necessary and "OFF" when not. Street lighting currently uses a significant amount of electricity worldwide since it is switched on when it becomes dark and off when it gets light. The biggest energy waste in the world needs to be changed. When people and cars approach, the lights turn “ON” when nobody is around, they turn “OFF” or use less energy. Since our intelligent street lamps will switch on when they approach, both pedestrians and drivers of moving cars will find it convenient to move around.

3.3.1 Project Layout

This section will outline the development of an IoT based system for smart street lighting. The signal for the LED lamp to switch on and glow brightly will be sent as soon as the IR sensor and LDR sensor identify the presence of a vehicle. The IR sensor and LDR sensor will wait if the vehicle is not there, and the LED lamp will continue to operate at a low intensity. The IR sensor and LDR sensor will only be active at night or when it is cloudy, therefore during the day the LED lamp will be in an “OFF” state. The figure below are show the example of the prototype of IoT system based street light system by [13].

Figure 3.1 Prototype of the IoT based system for smart street light [13]

3.3.2 Circuit diagram

The figure below show the circuit diagram of IoT system in this project based smart street light system is mainly coinsits of LDR sensor, IR sensor, LEDs, and Arduino nodeMCU ESP32

In this instance, the LDR sensor is utilised to determine whether it is day or night. The LDR sensor must be linked similarly to a potentiometer since it produces changing resistance depending on the amount of light that strikes it. The LDR sensor has two connections, one end to 5V and the other to a fixed resistance that is further connected to ground. According to the circuit design, the NodeMCU's single ADC pin (A0) is linked to a place where a fixed resistance and one end of an LDR sensor meet. Due to the varied resistance the LDR sensor exhibits, fluctuating voltage will be produced at A0 in accordance with the amount of light hitting the LDR. To determine whether a person is crossing the street or not, IR sensors are utilised. It recognises any nearby obstacles or motion. When an item, such as a human, animal, or vehicle, comes in contact with the IR rays being transmitted by the transmitter, they are reflected back. The receiver diode will pick up the reflected beam and confirm the object's presence by glowing the relevant LED. Since the street light will only come on if someone is in the street, this strategy will significantly reduce the amount of electricity used. Three pins make up an IR sensor, two of which are used for VCC and ground and one for an output pin. If an object is present, the IR sensor's output increases. This connection is connected to a NodeMCU pin so that anytime an IR sensor detects a person crossing the street, the street light is activated. The circuit diagram for this project designed with Fritzing software is shown in Figure 3.2.

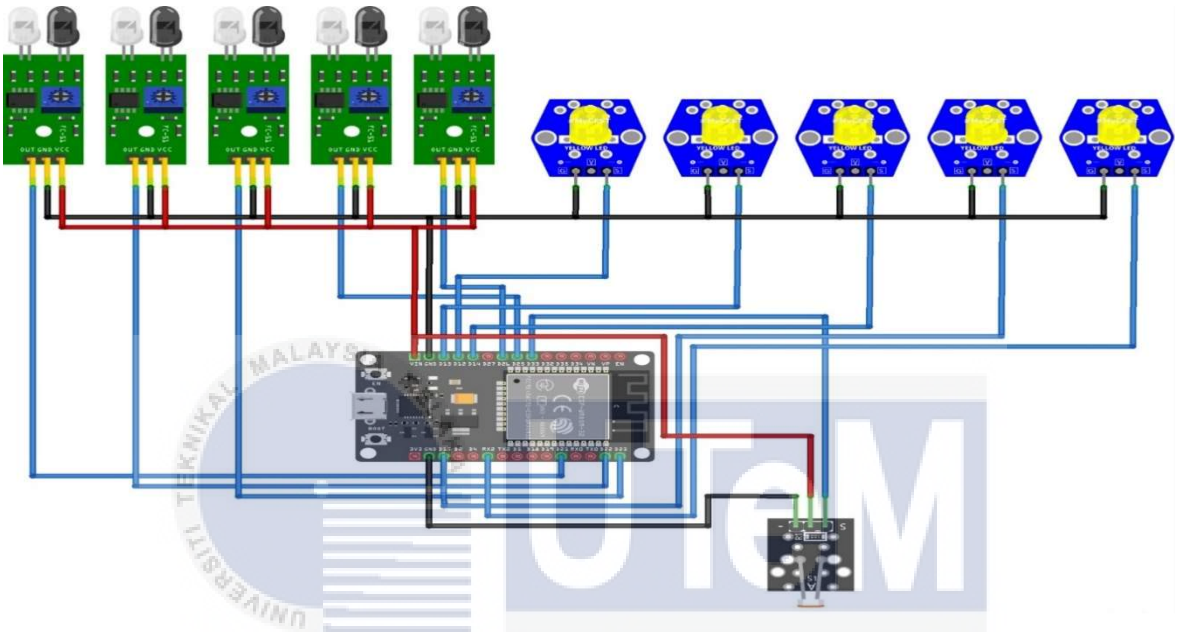

Figure 3.2 Circuit Diagram

3.3.3 Block diagram

Figure 3.3 in this section displays the project's block diagram. Both input and output are present. The power supply, which comes from the solar board, is the input component used. Additionally employed in this project as input components were the IR sensor and LDR sensor. The input and output processes for this project will be run by the Arduino node mcu as the primary process. The output is an LED bulb, which may either be “ON” “OFF” depending on the signal received from the Arduino.

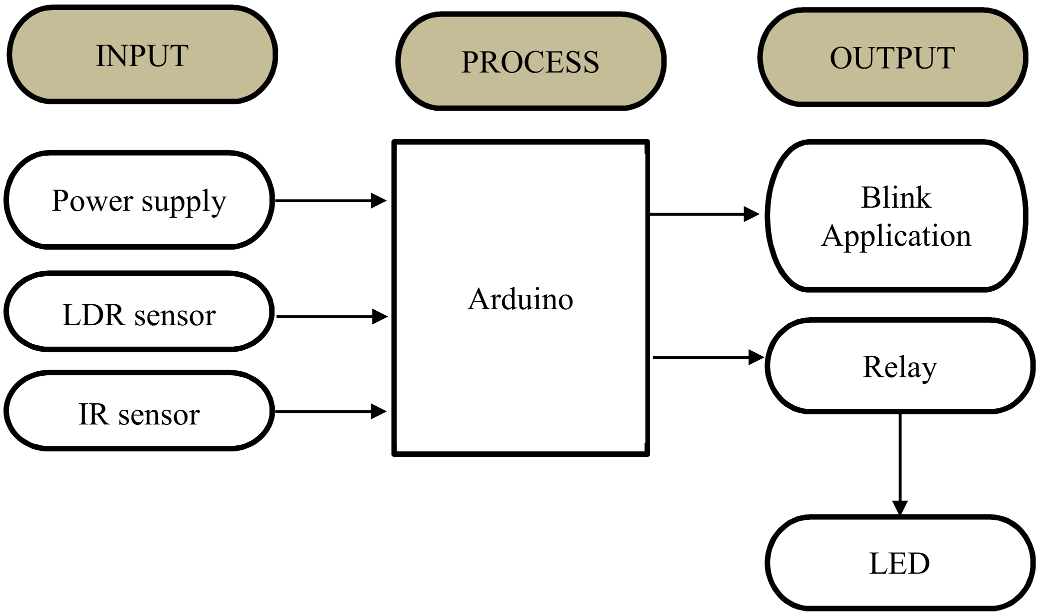

Figure 3.3 Block diagram of street light system

3.3.4 Project flowchart

The project flowchart for the IoT based system for smart street lights is shown in the figure below. The system will be prepared once solar power has been generated for the power source. Depending on whether it is daytime or night, the presence of vehicles will be recognised. The LED lamp will be important throughout the daytime. When a vehicle is there at night, the IR sensor and LDR sensor will react and turn on the LED lamp, which will then glow brightly. If no vehicle is present, the LED lamp will be off state.

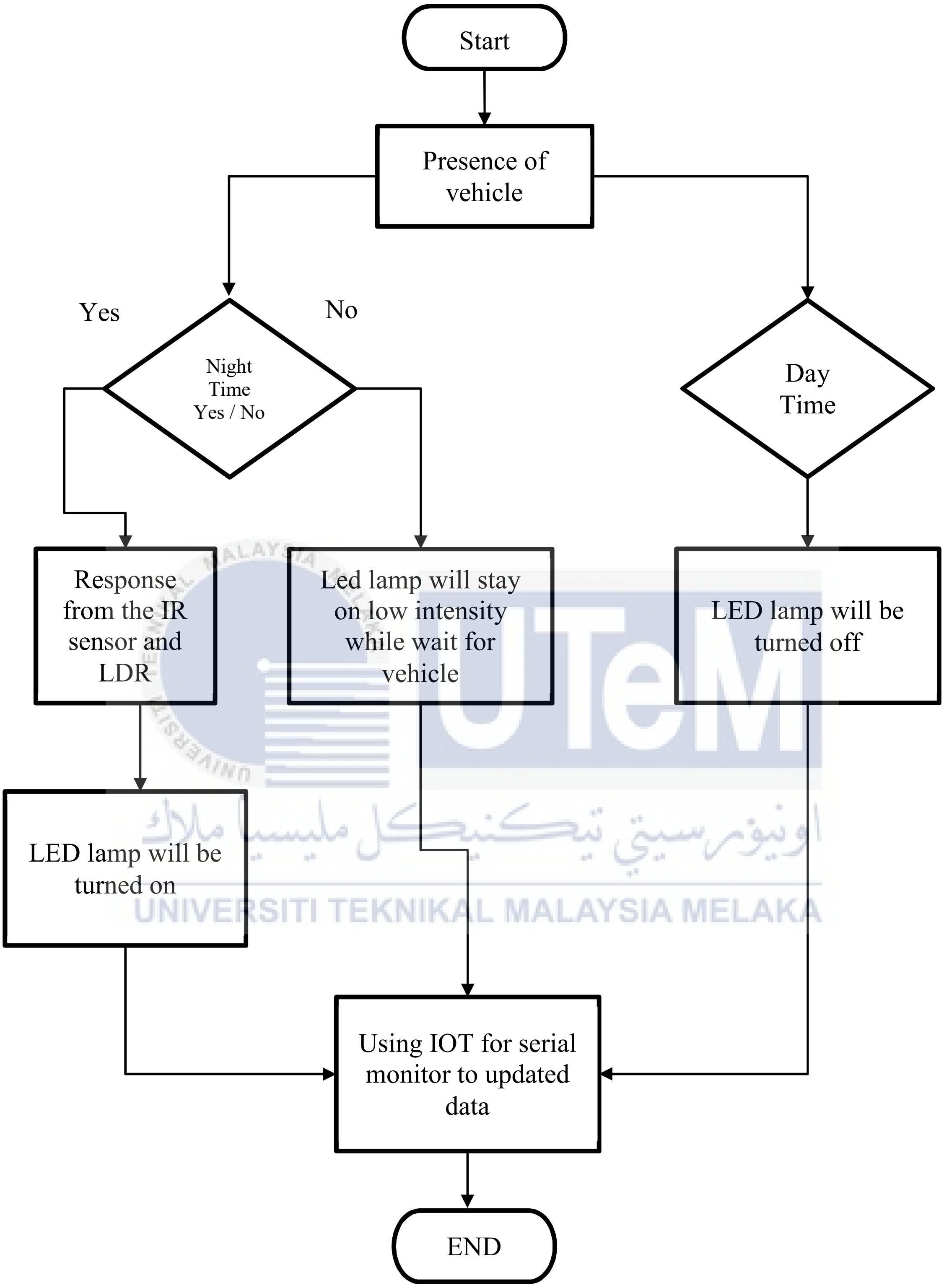

Figure 3.4 Program flowchart for this project

3.4 Equipment

The elements that went into creating the Internet of Things-based solution for smart street lights.

3.4.1 Arduino Node MCU

Open-source prototype board designs are available for the open-source firmware known as Node MCU. "NodeMCU" is a combination of the words "node" and "MCU" (micro-controller unit). In a strict sense, "NodeMCU" only refers to the firmware and not the related development kits. The designs for the prototyping boards and firmware are also open source. The Nodemcu ESP8266 are being using for smart street light sytem for IoT based system.

Figure 3.5 Arduino Node MCU ESP 32

3.4.2 Light Dependant Resistor

The most common uses for photo resistors, often referred to as light dependent resistors (LDR), are to detect the presence or absence of light or to gauge the intensity of the light. An LDR is a type of sensor that can be used to detect light. The analogue input pin on the Arduino is linked to the LDR because it emits an analogue voltage. Connect a relay in series with every street light, which will take instructions from the LDR on how to turn the lights “ON” and “OFF” and can create an automatic street light.

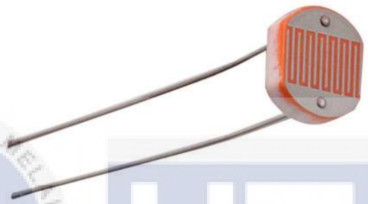

Figure 3.6 Light Dependent Resistor

3.4.3 Interfacing IR sensor

An electronic gadget called an infrared sensor emits radiation to detect environmental factors. In addition to detecting motion, it can measure an object's heat. An infrared LED serves as the emitter, while an infrared photo diode, sensitive to infrared light of the same wavelength as that emitted by the LED, serves as the detector. When infrared light strikes the photodiode, the output voltage and resistances adjust in direct proportion to the intensity of the infrared light received.

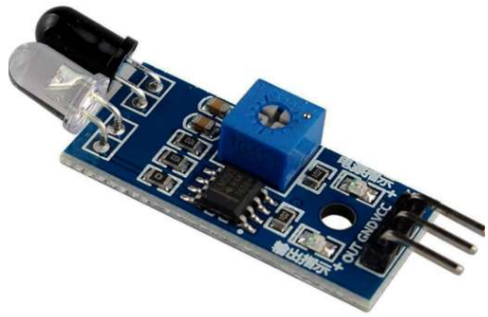

Figure 3.7 IR sensor

3.4.4 Power Light Emitting Device

LEDs are semiconductor light sources used in optoelectronic, luminance, and indication systems. When electrons and holes unite again, they release photons. The anode (+) and cathode (-) are the two terminals. To drive the LED, low input voltage or PWM are employed.

3.4.5 Relay

The microcontroller is connected to a relay to control the electrical power supply to the street lights. The relay acts as a switch to turn the light “ON” and “OFF” based on the control signal received from the microcontroller.

3.4.6 Blynk Interface

With the help of the flexible and user-friendly smartphone application, manufacturers and developers can effortlessly manage and keep an eye on their Internet of Things (IoT) projects. Blynk's user-friendly interface makes it easy for users to develop bespoke dashboards, or "Blynk apps," that communicate with a range of Internet of Things devices.

Numerous hardware platforms are supported by the programme, including well-known microcontrollers like Arduino, Raspberry Pi, and ESP8266/ESP32. Widgets are interactive graphical interfaces that users may create to visualise data, operate connected devices, and obtain real-time updates. Building Internet of Things apps is made easier with Blynk's drag-and-drop feature and large widget library. It also makes cloud-based collaboration easier, enabling users to oversee and manage their projects remotely from any location with an internet connection. Blynk offers a quick and easy way to create interactive and connected projects without requiring a lot of programming knowledge, whether being an IoT enthusiast or a professional developer.

For this project are being using Blynk application to remotely control and monitor street light in smart street light system. The Blynk program is being used for this project to control the LED output and lights. The street light's intensity has been adjusted using the high and low indicators. The duration of the LED's "ON" when the IR sensor detects the presence of a vehicle is set using the indication in line three. Figure 3.8 below are show the blynk application that being used for this project.

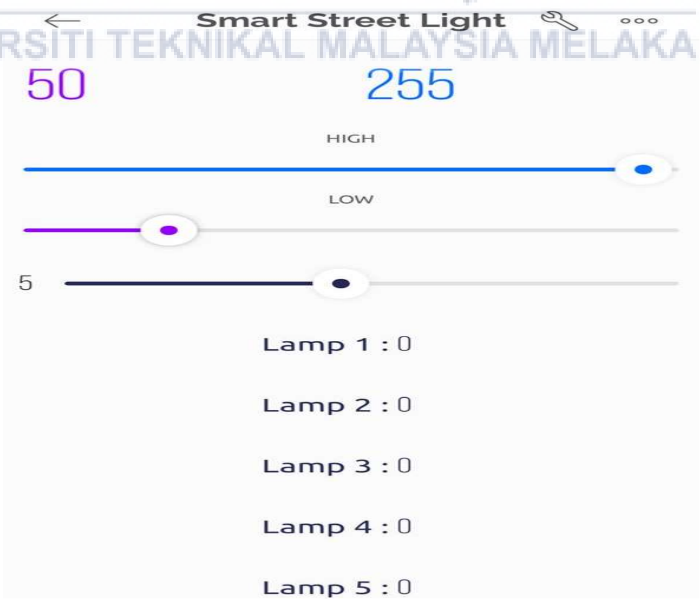

Figure 3.8 Blynk Application

3.4.7 Arduino IDE

A vital resource for makers, amateurs, and experts exploring the realm of embedded electronics and microcontroller programming is the Arduino Integrated Development Environment (IDE). An easy-to-use platform for creating, developing, and uploading code to Arduino microcontroller boards is offered by this open-source software, which was developed by the Arduino. Particularly well-known for being user-friendly for novices and providing robust functionality for more experienced users is the Arduino IDE. Its user-friendly interface allows it to handle both C and C++ programming languages. It also offers a large library of pre-written code, or sketches, which makes it easier to construct a variety of projects. From simple blinking LED projects to complex Internet of Things applications, the Arduino IDE has become the go-to environment for realising a wide range of electronic breakthroughs thanks to its real-time feedback through the Serial Monitor and easy connection with a number of Arduino-compatible boards. Figure below show the picture of the Arduino IDE interface.

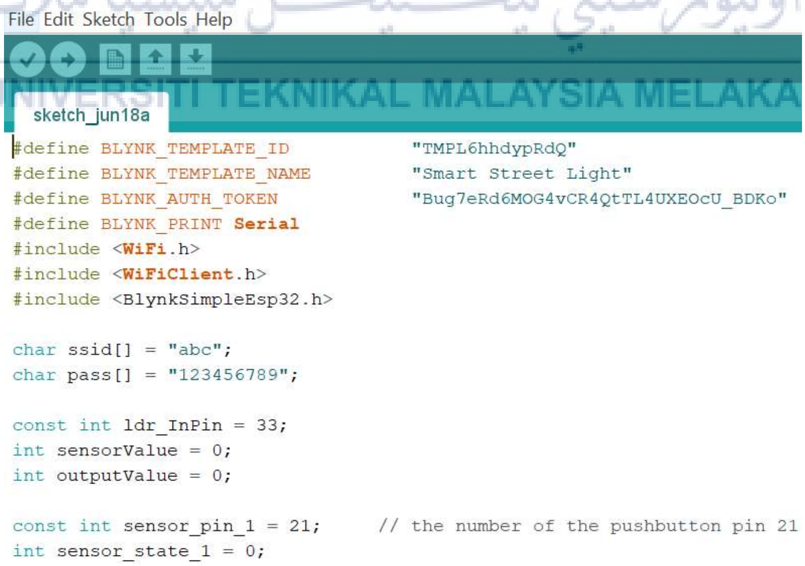

Figure 3.9 Arduino IDE interface

3.4.8 Power Supply

An electrical power source is referred to as the "power supply." Power supply unit are objects or systems that provide energy electrical or otherwise to output loads. They lower the signal's amplitude and convert AC signals to DC signals. For this project will use the power supply from solar system and rechargeable battery.

3.4.8.1 Polycrystalline Solar Panel

A photovoltaic panel that uses polycrystalline silicon solar cells is known as a polycrystalline solar panel as shown in figure 3.10 below. These solar cells have a less uniform crystal structure than monocrystalline ones since they are created by melting many silicon pieces together. Multiple grain boundaries and a unique blue colour that distinguish polycrystalline solar panels from monocrystalline ones. This solar panel are a well-liked option in the solar business because of its affordability and comparatively high efficiency. Solar energy may be converted into useful electrical power using polycrystalline panels which are well renowned for its capacity to generate electricity from sunlight. This panel are appropriate for a variety of uses including industrial-sized solar power facilities as well as residential and commercial installations. Despite having somewhat lower efficiency than monocrystalline panels, polycrystalline solar panels are nevertheless an appealing alternative for people looking to harvest solar energy and lessen the reliance on conventional power sources because of its affordable price. The specification of the solar panel is shown in table 3.1 below.

Figure 3.10 Solar Panel

Table 3.1 Technical Specification of Solar Panel

Type	**Polycrystalline**
Power Maximum	5W
Tolerance	+- 5%
Vmp	12V
Imp	0.42A
Voc	14.5V
Isc	0.45A
Maximum System Voltage	750V
Size	275mm x 180mm x 17mm

This is a 5W polycrystalline solar panel with a tolerance of ±5% that is intended for flexible energy collection. This panel performs dependably while operating at a maximum power voltage (Vmp) of 12V and a matching current (Imp) of 0.42A. It has a short-circuit current (Isc) of 0.45A and an open-circuit voltage (Voc) of 14.5V. It guarantees system compatibility with a maximum system voltage of 750V. The solar panel's small size (275 x

180 x 17 mm) allows it to be used in a variety of ways while combining efficiency and flexibility in the use of solar energy. compatibility with a maximum system voltage of 750V. The solar panel's small size (275 x 180 x 17 mm) allows it to be used in a variety of ways while combining efficiency and flexibility in the use of solar energy.

3.5 Summary

This chapter presents the proposed methodology in order to develop a new, effective and integrated for smart street light system. The primary focus of the proposed methodology is to sure that objective can be archieve by doing this project. The methods also intended to focused on lowering maintenance and electricity costs.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and analysis on the development of IoT based system for smart street light. The project's goals were to discover a way to conserve power and lessen the negative consequences of the existing lighting system. The first step in this project is to set up the system's inputs and outputs for controlling the lights. Assembling the instructions and producing the system to control the street lights is the first task to complete in this project. The discussion for this project is about to compare the electric costing when using iot street light with exciting street light.

4.2 Results and Analysis

This section will display the findings and analysis obtained from the project, which involved creating an Internet of Things-based smart street light system. The results of this study allow users to compare the effectiveness of smart street light systems for users by comparing them to conventional lighting, and also reveal that smart street lights can function with motion sensing.

4.2.1 Prototype

Figure below show the complete prototype of IoT based system for smart street light. There are Arduino Node MCU ESP32, IR sensor, LDR sensor and LED. The solar panel are being used to generate the power of the system.

Figure 4.1 Prototype of the project

4.2.2 Result of the project with blynk application

This part will go through how the smart street light sytem based on Iot system should work in various scenario in real life. Table 4.1 below displays the anticapated outcome based on variety of scenario.

Table 4.1 Result for this project

No.	Scenario	Result
1.	When the day time.	IR sensor and LDR will not operate. LED lamp will be off state. Figure 4.2 show the output result during day time. There are no value detect for LED lamps.
2.	When night time but no presence of vehicle.	IR sensor will wait for the respond and LDR will give signal to LED lamp to

		turn on the light at low intensity. Figure 4.3 show the output result.
3.	When night time and sensor 1 detect presence of vehicle.	IR sensor 1 will respond and give signal to LED lamp to turn on the light at high intensity for lamp 1 but other lamp will be at low intensity. Figure 4.4 show the output result.
4.	When night time and presence of vehicle.	IR sensor will respond and give signal to LED lamp to turn on the light at high intensity. Figure 4.5 show the output result.

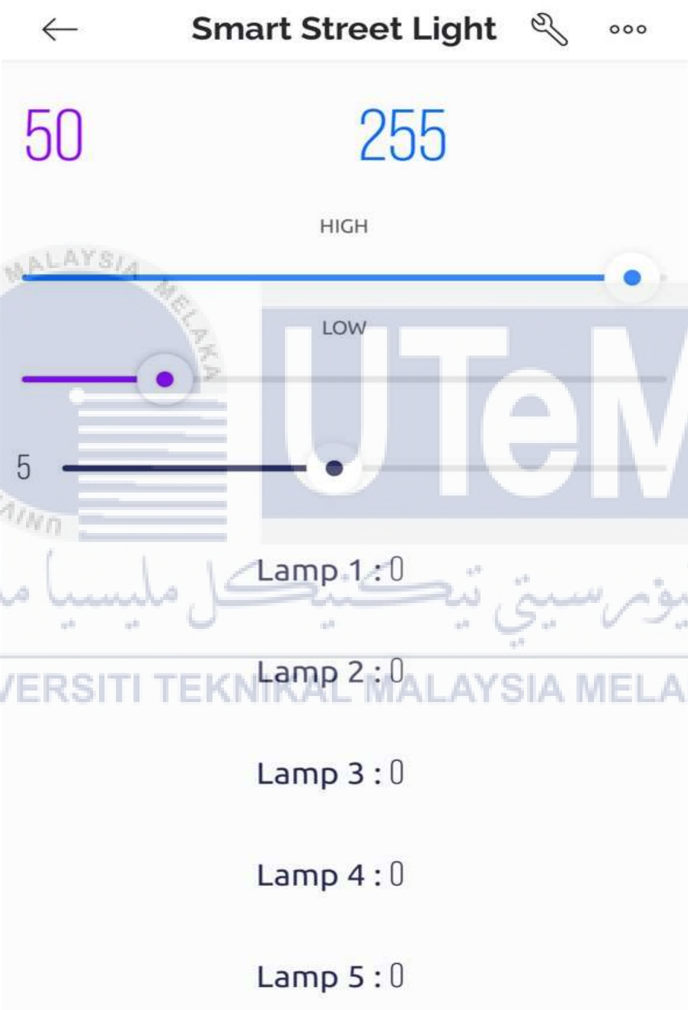

Figure 4.2 Result output day time in Blynk

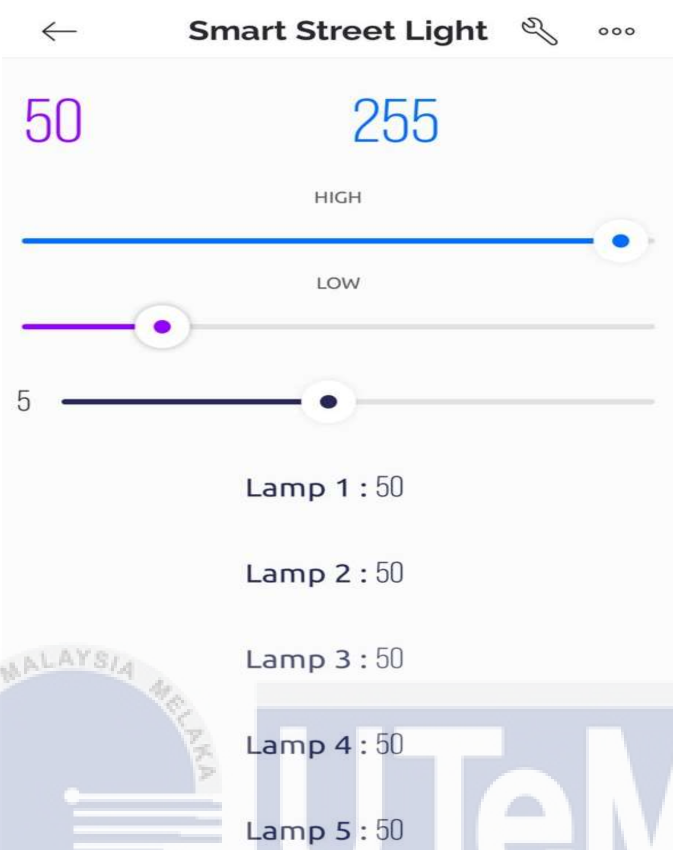

Figure 4.3 Result output during night time and no presence of vehicle

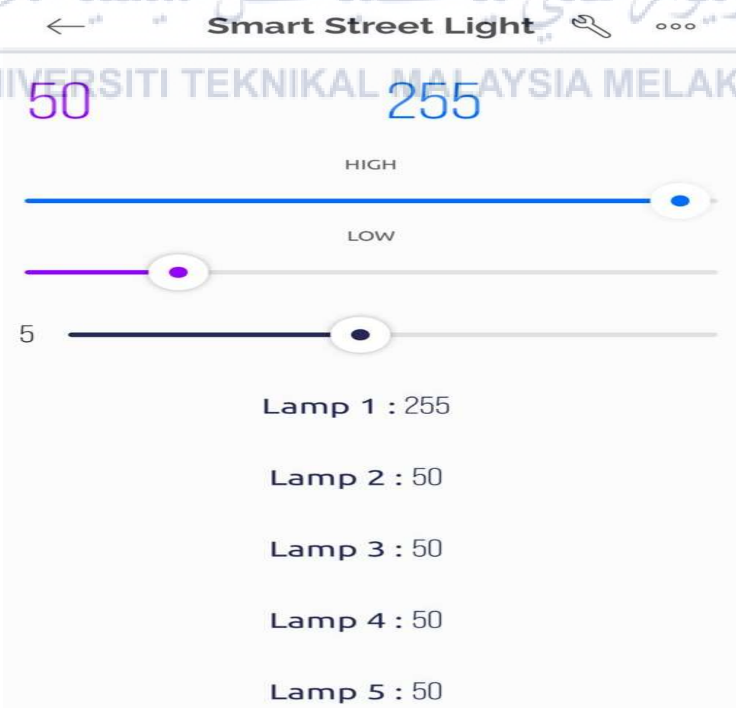

Figure 4.4 Result output during night time and sensor 1 detect the presence of vehicle

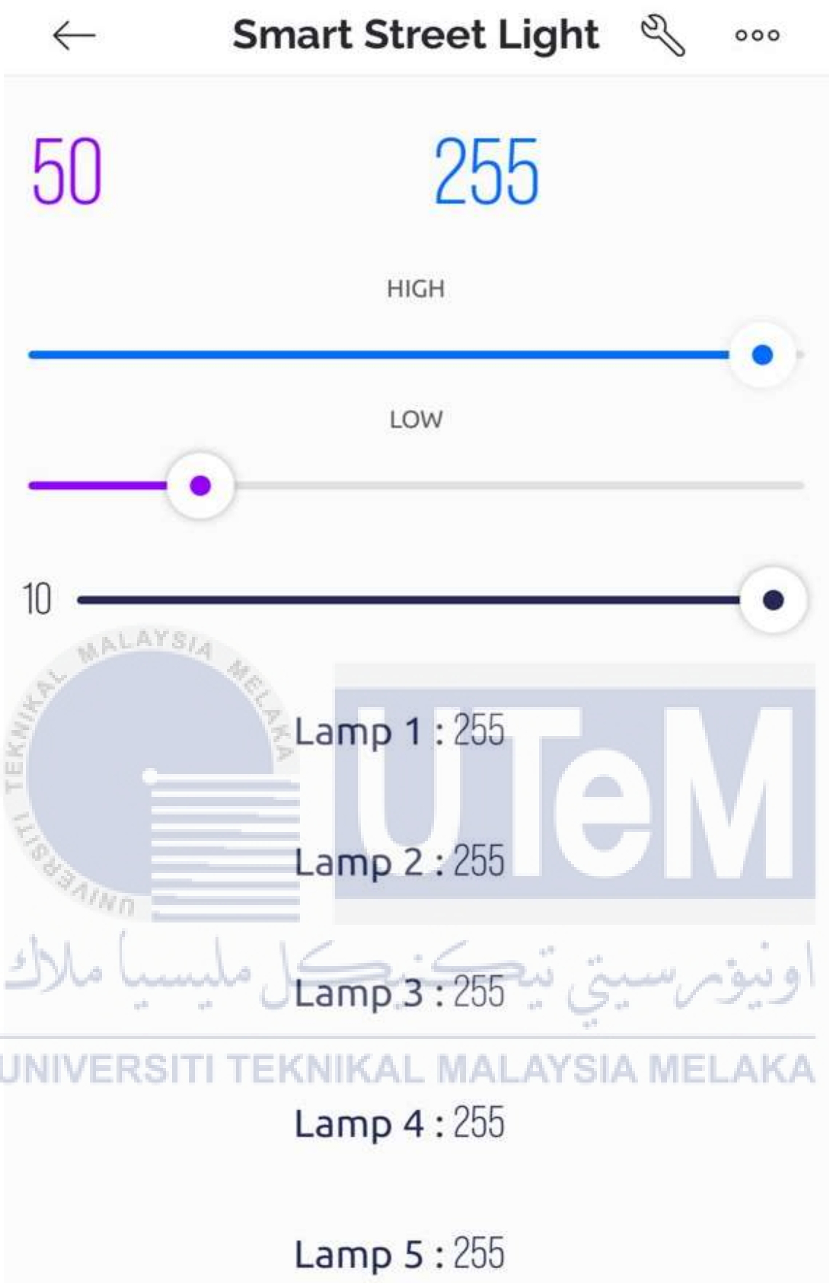

Figure 4.5 Result output during night time and sensor 1 detect the presence of vehicle

4.2.2.1 Observation and Outcomes

For a comparative study it is a necessarily to take the following assumptions. Firstly, assumptions is the street light is turn "ON" from 6pm to 6am. Next, it is consume 1kwh power for a period of t hour when it glows with its maximum intensity 255, so that one street light consumes maximum 12kwh in a day and the number of street light are 5.

Table 4.2 Analysis scenario of the street light

Type of street light	Power Consumption
Conventional	12 kwh x 5 light = 60kwh
Smart Street Light Case 1: (Let 10 vehicle is in motion during night)	10 car x 5 light and each light are turn on 10 sec. Low intensity of 5 light is 30% = 30% x 5 x 12kwh = 18 kwh 10 car x 5 light x 0.06kwh = 3 kwh Total power saved = 60kWh – 3kwh – 18 kwh =39 kwh
Smart Street Light Case 2: (Let no vehicle is in motion during night)	Low intensity of 5 light is 30% = 30% x 5 x 12kwh = 18 kwh Total power saved = 60kWh – 18 kwh =42 kwh

The analysis data for the scenario with the project prototype is displayed in the figure 4.6. The issue is predicated on the idea that conventional street lights use more energy than smart street lights. The goal of the analysis is to determine how practical and efficient smart street lighting is in comparison to traditional street lighting in today's world. As a result, if smart street lights are used globally, we can interpret or indicate that so much energy can be save.

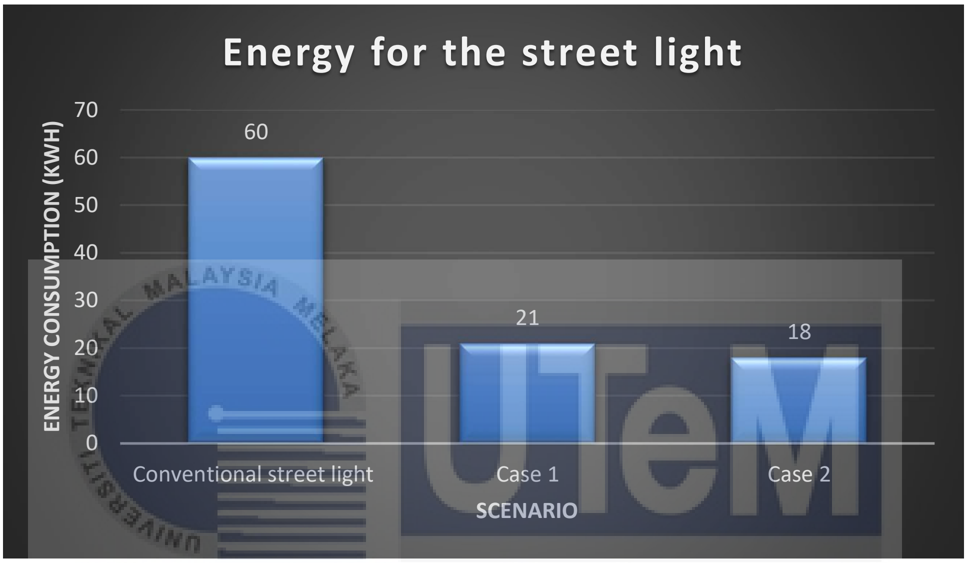

Figure 4.6 Energy consumption of the different type of street light

4.2.3 Analysis with solar

The Open Circuit Voltage, Short Circuit Current and Power values of the solar panel for 1-day data collection day using multimeter are displayed in the Table 4.3 and figure below.

Table 4.3 Data analysis for solar panel

TIME	VOLTAGE (V)	CURRENT (A)	POWER (Watt)
8.00 am	13.15	0.04	0.003
10.00 am	13.17	0.08	0.006
12.00 pm	13.83	0.26	0.018
2.00 pm	13.99	0.43	0.03
4.00 pm	13.95	0.24	0.02
6.00 pm	13.18	0.07	0.005

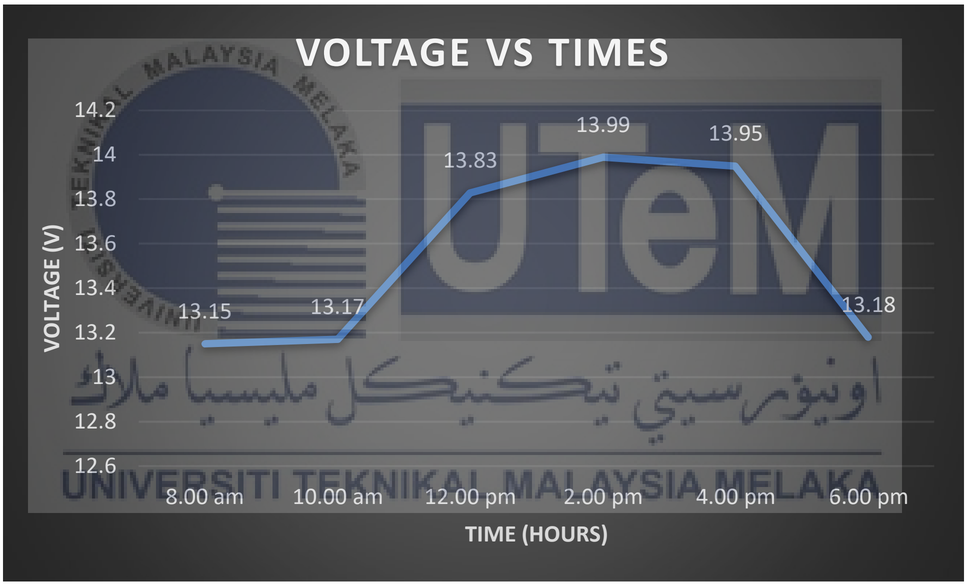

Figure 4.7 Result voltage and time for solar panel

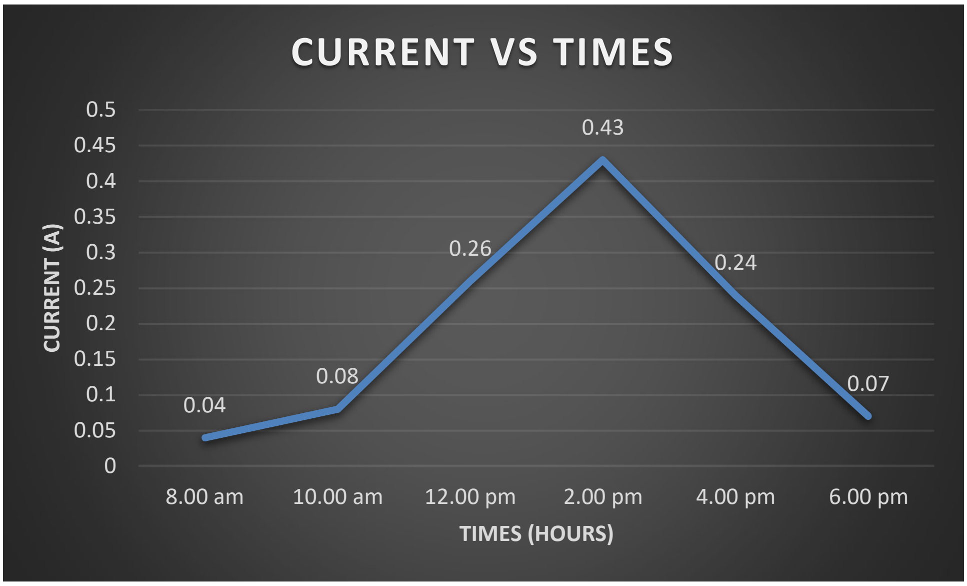

Figure 4.8 Result current and time for solar panel

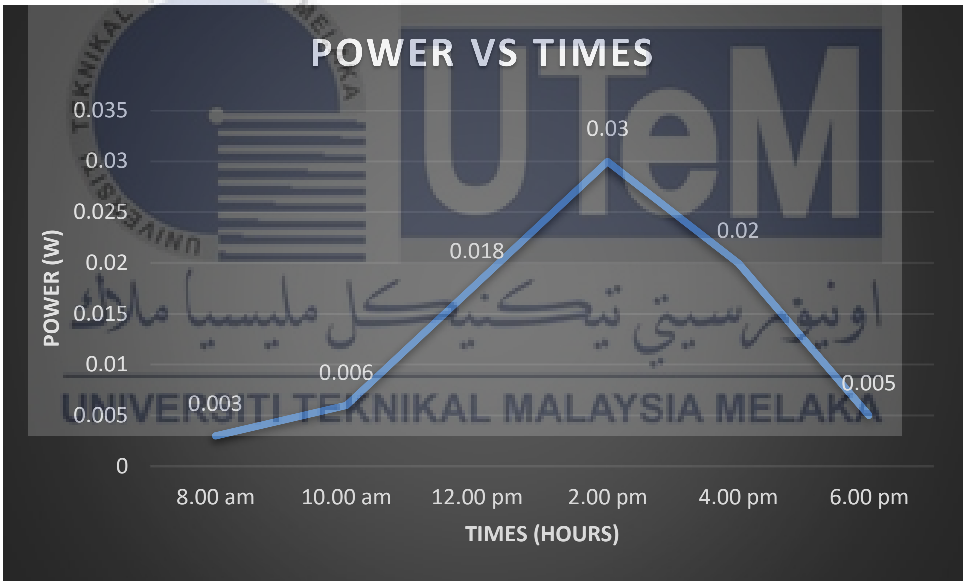

Figure 4.9 Result current and time for solar panel

4.2.3.1 Discussion and analysis of solar panel

The results shown in the above figure were obtained in a single day and were repeated every two hours to determine the voltage, current, and power values when charging in direct sunshine. After charging, solar panels receive a value between 13 and 14 V, according to the data in Table 4.3. The street light in this prototype project is turned "ON" by using only 5 volts from the source. Using a USB converter, the solar panel's 13 volt output will be step down to 5 volts at the project site in order to charge the battery.

The data analysis indicates that one of the energy sources that can be used to provide street light electricity is solar power. Smart street lights require a power source that can provide power continuously, but solar panels are also a practical option since they use renewable natural energy to power the lights. The solar panel can supply the street light with electricity in a single day. As solar panels create power from sunshine, they are less expensive to use than direct power supplies, which currently require more energy to operate.

4.3 Summary

This chapter presented case studies to demonstrate applicability of the proposed system wide for smart street light system based on IoT system. The case study is based on the detection motion when the presence of vehicle. When compared to the conventional system, the suggested method is simpler to set up and operate and requires less maintenance. This further reduces the need for human involvement, and only in the event of a malfunction will a physical visit to the street light location be necessary. Automated systems are more efficient than manual processes. These prototype can also be reprogrammed to suit our needs. The result that obtained in Blynk Application can be use for future work. Additionally, this prototype uses a solar panel for power generation, which is an excellent way to reduce the cost or usage of electricity.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This chapter will give a concise summary of the conclusion. The conclusion essentially serves as a project recap. On the other hand, suggestions and ideas for future enhancement will be provided in this section. In this project report, the "IoT based system for Smart Street Light System" is studied in detail. This report includes information about the project's design, operation, and implementation.

In accordance with expectations, the circuit turns on and off the road lights. LDR sensor determines whether it is day or night. The vehicle's motion is detected by the lR sensor. The Arduino UNO has successfully controlled the traffic lights. The lights will turn ON in the areas of the motions as directed by the controller. In addition, the road light system's drawback of relying on a photoelectric sensor has been overcome by using a timing controller. This control circuit can finally be used as a section of a lengthy highway connecting urban and rural locations. The project's findings confirm the hypothesis that the Smart Street Light circuit would reduce power usage. This project's final result is that the circuit is quite effective and can be employed in streets.

5.2 Future Works

The recommendation for future works are given below:

a) A user can turn the lights on and off at a specific moment. In this project, the LDR sensor is utilized to sense the system's light intensity and switch on the lights based on that intensity. Instead of utilizing a sensor, we can also program the system to turn the lights on and off at a fixed time.

b) If we use superior sensors, meaning that the resistance of the sensors does not change significantly when the temperature changes, we can get an exact output from the sensors for detecting the light intensity. If we want to manage the lights in any garage, retail centre, or home lighting system, we may use the same approach. As a result, this technique can be used in a variety of situations where wireless technology is required to switch any electrical item.

c) The off-peak dimming system can be implemented to advance the project. The lights will emit diminishing lights when there is no movement of traffic or people on the street, and they will glow properly when there is. This will result in a little rise in energy consumption and a decrease in system costs, raising the system's efficiency.

d) Advanced Data Analytics and Sensors by installation of cutting-edge sensors to monitor the environment, such as weather, noise levels, and air quality, in order to build a more complete smart city infrastructure. using machine learning algorithms to evaluate sensor data in order to facilitate predictive maintenance and improved municipal planning decision-making.

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APPENDICES

Appendix A Coding of this project using Arduino IDE.

```
#define BLYNK_TEMPLATE_ID           "TMPL6hhdypRdQ"
#define BLYNK_TEMPLATE_NAME         "Smart Street Light"
#define BLYNK_AUTH_TOKEN            "Bug7eRd6MOG4vCR4QtTL4UXEOcU_BDKo"
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

char ssid[] = "abc";
char pass[] = "123456789";

const int ldr_InPin = 33;
int sensorValue = 0;
int outputValue = 0;

const int sensor_pin_1 = 21;     // the number of the pushbutton pin 21 = 12, 22 =13,23 = 14,25 = 15,  :
int sensor_state_1 = 0;

const int sensor_pin_2 = 22;
int sensor_state_2 = 0;

const int sensor_pin_3 = 23;
int sensor_state_3 = 0;

const int sensor_pin_4 = 25;
int sensor_state_4 = 0;


const int sensor_pin_5 = 26;
int sensor_state_5 = 0;

const int led_state_1 =  12;
const int led_state_2 =  13;
const int led_state_3 =  14;
const int led_state_4 =  15;
const int led_state_5 =  16;

int high = 255;
int low = 60;

int timer_set = 1;

int state_1 = LOW;
unsigned long previousMillis_1 = 0;
long interval_1 = timer_set*1000;

int state_2 = LOW;
unsigned long previousMillis_2 = 0;
long interval_2 = timer_set*1000;

int state_3 = LOW;
unsigned long previousMillis_3 = 0;
long interval_3 = timer_set*1000;

int state 4 = LOW;
```

```
unsigned long previousMillis_4 = 0;
long interval_4 = timer_set*1000;

int state_5 = LOW;
unsigned long previousMillis_5 = 0;
long interval_5 = timer_set*1000;

int flag_1 = 0;
int flag_2 = 0;
int flag_3 = 0;
int flag_4 = 0;
int flag_5 = 0;

int lock = 1;

void setup()
{
  Serial.begin(115200);
  pinMode(sensor_pin_1, INPUT);
  pinMode(sensor_pin_2, INPUT);
  pinMode(sensor_pin_3, INPUT);
  pinMode(sensor_pin_4, INPUT);
  pinMode(sensor_pin_5, INPUT);

  pinMode(led_state_1, OUTPUT);
  pinMode(led_state_2, OUTPUT);
  pinMode(led_state_3, OUTPUT);

  pinMode(led_state_4, OUTPUT);
  pinMode(led_state_5, OUTPUT);

  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  starts();

  analogWrite(led_state_1, low);
  analogWrite(led_state_2, low);
  analogWrite(led_state_3, low);
  analogWrite(led_state_4, low);
  analogWrite(led_state_5, low);
}

void loop()
{
  Blynk.run();

  ldr();

  Blynk.virtualWrite(V0,high);
  Blynk.virtualWrite(V1,low);

  interval_1 = timer_set*1000;
  interval_2 = timer_set*1000;
  interval_3 = timer_set*1000;
  interval_4 = timer_set*1000;
```

```
interval_5 = timer_set*1000;

if(lock == 1)
{
  timer_1();
  timer_2();
  timer_3();
  timer_4();
  timer_5();

  sensor_state_1 = digitalRead(sensor_pin_1);
  if (sensor_state_1 == LOW)
  {
    flag_1 = 1;
  }

  //-----------------------------------------------

  sensor_state_2 = digitalRead(sensor_pin_2);
  if (sensor_state_2 == LOW)
  {
    flag_2 = 1;
  }


  //-----------------------------------------------

  //-----------------------------------------------

  sensor_state_3 = digitalRead(sensor_pin_3);
  if (sensor_state_3 == LOW)
  {
    flag_3 = 1;
  }

  //-----------------------------------------------

  sensor_state_4 = digitalRead(sensor_pin_4);
  if (sensor_state_4 == LOW)
  {
    flag_4 = 1;
  }

  //-----------------------------------------------

  sensor_state_5 = digitalRead(sensor_pin_5);
  if (sensor_state_5 == LOW)
  {
    flag_5 = 1;
  }

  //-----------------------------------------------
}
```

```
  else
  {
    analogWrite(led_state_1, 0);
    analogWrite(led_state_2, 0);
    analogWrite(led_state_3, 0);
    analogWrite(led_state_4, 0);
    analogWrite(led_state_5, 0);
  }

  delay(2);
}

BLYNK_WRITE(V2)
{
  int data1 = param.asInt();
  low = data1;
}

BLYNK_WRITE(V3)
{
  int data2 = param.asInt();
  high = data2;
}

BLYNK_WRITE(V4)
{
  int data3 = param.asInt();

   timer_set = data3;
}

void timer_1()
{
 if(flag_1 == 1)
 {
  unsigned long currentMillis_1 = millis();
  if (currentMillis_1 - previousMillis_1 >= interval_1)
  {
    previousMillis_1 = currentMillis_1;
    if (state_1 == LOW)
    {
      analogWrite(led_state_1, high);
      state_1 = HIGH;
      Serial.println("1");
    }
    else
    {
      analogWrite(led_state_1, low);

      previousMillis_1 = 0;
      currentMillis_1 = 0;
      flag_1 = 0;

      state_1 = LOW;
      Serial.println("2");
```

```
      }
    }
  }
}

void timer_2()
{
 if(flag_2 == 1)
 {
  unsigned long currentMillis_2 = millis();
  if (currentMillis_2 - previousMillis_2 >= interval_2)
  {
    previousMillis_2 = currentMillis_2;
    if (state_2 == LOW)
    {
      analogWrite(led_state_2, high);
      state_2 = HIGH;
      Serial.println("1");
    }
    else
    {
      analogWrite(led_state_2, low);

      previousMillis_2 = 0;
      currentMillis_2 = 0;
      flag_2 = 0;

      state_2 = LOW;
      Serial.println("2");
    }
  }
 }
}

void timer_3()
{
 if(flag_3 == 1)
 {
  unsigned long currentMillis_3 = millis();
  if (currentMillis_3 - previousMillis_3 >= interval_3)
  {
    previousMillis_3 = currentMillis_3;
    if (state_3 == LOW)
    {
      analogWrite(led_state_3, high);
      state_3 = HIGH;
      Serial.println("1");
    }
    else
    {
      analogWrite(led_state_3, low);

      previousMillis_3 = 0;
      currentMillis_3 = 0;
```

```
        flag_3 = 0;

        state_3 = LOW;
        Serial.println("2");
      }
    }
  }
}

void timer_4()
{
 if(flag_4 == 1)
 {
  unsigned long currentMillis_4 = millis();
  if (currentMillis_4 - previousMillis_4 >= interval_4)
  {
    previousMillis_4 = currentMillis_4;
    if (state_4 == LOW)
    {
      analogWrite(led_state_4, high);
      state_4 = HIGH;
      Serial.println("1");
    }
    else
    {
      analogWrite(led_state_4, low);

      previousMillis_4 = 0;
      currentMillis_4 = 0;
      flag_4 = 0;

      state_4 = LOW;
      Serial.println("2");
    }
  }
 }
}

void timer_5()
{
 if(flag_5 == 1)
 {
  unsigned long currentMillis_5 = millis();
  if (currentMillis_5 - previousMillis_5 >= interval_5)
  {
    previousMillis_5 = currentMillis_5;
    if (state_5 == LOW)
    {
      analogWrite(led_state_5, high);
      state_5 = HIGH;
      Serial.println("1");
    }
    else
    {
```

```
      analogWrite(led_state_5, low);

      previousMillis_5 = 0;
      currentMillis_5 = 0;
      flag_5 = 0;

      state_5 = LOW;
      Serial.println("2");
     }
    }
  }
}

void ldr()
{
  sensorValue = analogRead(ldr_InPin);
  outputValue = map(sensorValue, 0, 400, 0, 100);

  Serial.print("sensor = ");
  Serial.print(sensorValue);
  Serial.print("\t output = ");
  Serial.println(outputValue);

  if(outputValue < 10 && lock == 0)
  {
    lock = 1;
    analogWrite(led_state_1, low);

    analogWrite(led_state_2, low);
    analogWrite(led_state_3, low);
    analogWrite(led_state_4, low);
    analogWrite(led_state_5, low);
  }
  else if(outputValue >= 10 && lock == 1)
  {
    lock = 0;
  }
}

void starts()
{
  digitalWrite(led_state_1,HIGH);
  digitalWrite(led_state_2,HIGH);
  digitalWrite(led_state_3,HIGH);
  digitalWrite(led_state_4,HIGH);
  digitalWrite(led_state_5,HIGH);
  delay(100);
  digitalWrite(led_state_1,LOW);
  digitalWrite(led_state_2,LOW);
  digitalWrite(led_state_3,LOW);
  digitalWrite(led_state_4,LOW);
  digitalWrite(led_state_5,LOW);
  delay(100);
  digitalWrite(led_state_1,HIGH);
  digitalWrite(led_state_2,HIGH);
```

```
digitalWrite(led_state_3,HIGH);
digitalWrite(led_state_4,HIGH);
digitalWrite(led_state_5,HIGH);
delay(100);
digitalWrite(led_state_1,LOW);
digitalWrite(led_state_2,LOW);
digitalWrite(led_state_3,LOW);
digitalWrite(led_state_4,LOW);
digitalWrite(led_state_5,LOW);
delay(100);
digitalWrite(led_state_1,HIGH);
digitalWrite(led_state_2,HIGH);
digitalWrite(led_state_3,HIGH);
digitalWrite(led_state_4,HIGH);
digitalWrite(led_state_5,HIGH);
delay(100);
digitalWrite(led_state_1,LOW);
digitalWrite(led_state_2,LOW);
digitalWrite(led_state_3,LOW);
digitalWrite(led_state_4,LOW);
digitalWrite(led_state_5,LOW);
delay(100);
digitalWrite(led_state_1,HIGH);
digitalWrite(led_state_2,HIGH);
digitalWrite(led_state_3,HIGH);
digitalWrite(led_state_4,HIGH);
digitalWrite(led_state_5,HIGH);

  delay(100);
  digitalWrite(led_state_1,LOW);
  digitalWrite(led_state_2,LOW);
  digitalWrite(led_state_3,LOW);
  digitalWrite(led_state_4,LOW);
  digitalWrite(led_state_5,LOW);
  delay(100);
}
```

Appendix B Costing of this project.

No	Component	Unit	Price per unit (RM)	Price (RM)
1	ESP32 + SAEICD	1	45	45
2	Light Dependent Resistor	4	5	20
3	Interfacing IR sensor	2	2	4
4	Solar Panel 5W 18V	1	45	45
5	Battery 7.4v + Charger	1	35	35
6	USB Converter	1	5	5
7	Switch on/off	1	2	2
8	Wire 3 core 1 meter	3	10	30
9	PVC box 11x6	1	15	15
Total Cost				201