ANALYSIS AND DEVELOPMENT OF A WIRELESS TRAFFIC LIGHT FOR PEDESTRIAN CROSSING

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ANALYSIS AND DEVELOPMENT OF WIRELESS TRAFFIC LIGHT FOR PEDESTRIAN CROSSING

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This report submitted in partial fulfilment of the requirements for the Degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering

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DECLARATION

I declare that this report entitled "Analysis and Development of Wireless Traffic Light for Pedestrian Crossing" is the result of my own work except for quotes as cited in the references.

Signature :

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Date : 14 JUNE 2021

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature :

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Date : 14 JUNE 2021

DEDICATION

Special dedication to my beloved family, supervisor, lecturers and fellow friends

ABSTRACT

Traffic signals for pedestrian crossing are crucial in ensuring safety for the public, especially in urban streets. A pedestrian crossing requires a control unit connected through underground cables between traffic and a pedestrian signalling device. Due to the infrastructure and maintenance cost of a conventional pedestrian crossing is high, alternative techniques to improvise the system is required by the municipal. The wireless traffic light for pedestrian crossing can reduce the costly infrastructure needed in future implementation as this involves no cutting of roads and underground cables. Hence the reduces maintenance cost. A reliable and stable wireless connection between traffic signalling poles is a mandatory feature in ensuring timely signals. A mesh network of wirelessly connected devices to a traffic controller can provide different traffic sequences by demand as a conventional pedestrian crossing light. The proposed wireless traffic light for pedestrian crossing can vary as per traffic conditions and by user demand.

ABSTRAK

Isyarat lalu lintas untuk lintasan pejalan kaki adalah komponen penting dalam memastikan keselamatan bagi orang ramai, terutama di jalan-jalan bandar. Persimpangan pejalan kaki memerlukan unit kawalan yang dihubungkan melalui kabel bawah tanah antara lalu lintas dan alat isyarat pejalan kaki. Oleh kerana kos infrastruktur dan penyelenggaraan penyeberangan pejalan kaki konvensional tinggi, teknik alternatif untuk memperbaiki sistem diperlukan oleh pihak perbandaran. Lampu isyarat tanpa wayar untuk lintasan pejalan kaki dapat mengurangkan infrastruktur mahal yang diperlukan dalam pelaksanaan masa depan kerana ini tidak memerlukan pemotongan jalan dan kabel bawah tanah. Oleh itu mengurangkan kos penyelenggaraan. Dengan sambungan tanpa wayar yang boleh dipercayai dan stabil antara lalu lintas, tiang isyarat adalah ciri wajib dalam memastikan isyarat tepat pada masanya. Rangkaian jaringan peranti yang disambungkan tanpa wayar ke pengawal lalu lintas dapat memberikan urutan lalu lintas yang berbeza berdasarkan permintaan sebagai lampu penyeberangan pejalan kaki konvensional. Lampu isyarat tanpa wayar yang dicadangkan untuk pejalan kaki boleh berbeza mengikut keadaan lalu lintas dan mengikut permintaan pengguna.

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Now I send my apologies to Mr. Adie and Dr. Siva Kumar Subramaniam for the mistake and inconvenience I had to create. The friendly working environment had greatly helped me through my bachelor’s degree Project smoothly. Once again, I would like to thank everyone for giving me such a wonderful learning experience and wish everyone all the best in the future.

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LIST OF SYMBOLS AND ABBREVIATION

PLC	:	Programmable Logic Control
LoRa	:	Long Range Communication
CSS	:	Chirp Spread Spectrum
M2M	:	Machine to Machine
IoT	:	Internet of Things
Wi-Fi	:	Wireless Fidelity
WLAN	:	Wireless Local Area Network
WPAN	:	Wireless Personal Area Network
FSK	:	Frequency Shifting Keying
SNR	:	Signal-to-Noise Ratio
WTL	:	Wireless Traffic Light

IEEE	:	Institute of Electrical and Electronics Engineers
LR-WPAN	:	Low-Rate Wireless Personal Area Network
FLC	:	Fuzzy Logic Control
LoRaWAN	:	Long Range Wide Area Network
DSS	:	Decision Support System
EEPROM	:	Erasable Programmable Read-Only Memory
SRAM	:	Static Random-Access Memory
GSM	:	Global System for Mobile Communications
PER	:	Packet Error Rate
SF	:	Spreading Factors
LR-WPAN	:	Low-Rate, Wireless Personal Area Network
CPU	:	Central Processing Unit
BW	:	Bandwidth
SF	:	Spreading Factor
CR	:	Code Rate
RSSI	:	Received Signal Strength Indicator

AI	:	Artificial Intelligence
UTeM	:	University Technical Malaysia Melaka
SSH	:	Secure Shell
DHCP		Dynamic Host Configuration Protocol
LAN		Local Area Network
USB		Universal Serial Bus
SSID		Service Set Identifier
PCB		Printed Circuit Board
UV		Ultraviolet
CAD		Computer aided drafting

CHAPTER 1

INTRODUCTION

This chapter will discuss this project's brief, Problem Statement, Project Objectives, Scope of work, Methodology, and Thesis Plan.

1.1 Introduction

The traffic light is a system that monitoring vehicle and pedestrian traffic. The pedestrian traffic light is a device for controlling pedestrians. If the button is pressed, the traffic light will show red color and let the pedestrian crossing the road. They must be programmed to adapt to outside environments to interact and transfer the signal between them in any environment. For this to be completed, the traffic signal model necessities regulator gadgets to react to the environment. Such as ultrasonic, ultrasound, Programmable Logic Control (PLC), and many more microcontroller technology can be used.

Wireless Traffic Light for Pedestrian Crossing is a system that combined software and hardware project. This project system will use a wireless technique, which is Long Range Communication (LoRa). LoRa is a spread spectrum modulation method got from chirp spread spectrum (CSS) Technology. LoRa is a Wireless Technology created to empower low data rate communication over a long-range by sensors and actuators for Machine to Machine (M2M) and Internet of Things (IoT) applications. A bidirectional communication technique is a use in communicating the signal, starting with one traffic signal next [1].

In this project, LoRa will be transmitted the signal to the other LoRa system of devices to interface and communicate with the two traffic lights. At that point, the traffic signal model will work as the traffic signal's present function and it is utilizing the wireless technology method. The proposed system would remain the current traffic light system and functionality, but there is no wire used for connecting the traffic lights in this project. In this project, the software is Arduino IDE, and this software is used as a computer code compiler. There are two devices included in this project. LoRa Sensor Node and LoRa Gateway. The sensor node powered up by a battery and made up of the Arduino UNO, Lora Module, and Push Button, as shown in Figure 1.1.

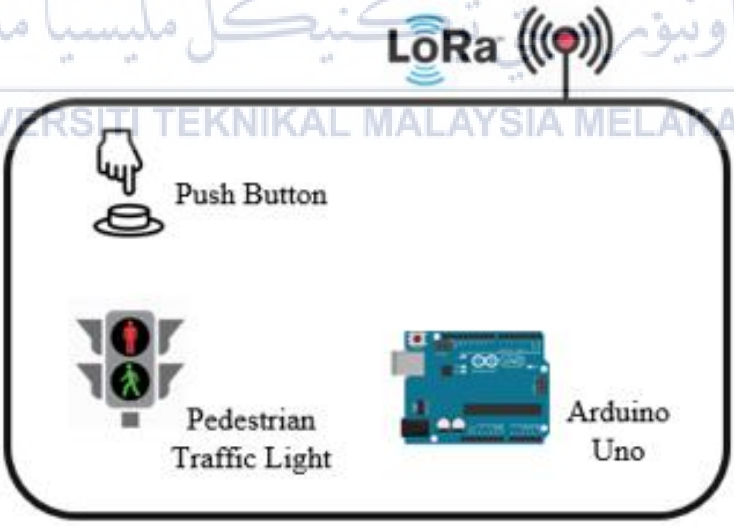


Figure 1.1: Sensor Node

The gateway used is Dragino LoRa LG01P and will be located at the data centre, as shown in Figure 1.2. In this project, the LoRa gateway is important because the transmitted data must be received in the same transceiver language. The information is translated and sent to the cloud using an ethernet cable or Wireless Fidelity (Wi-Fi) connection. The data is then decrypted using an ethernet cable or Wi-Fi link and sent to the cloud.

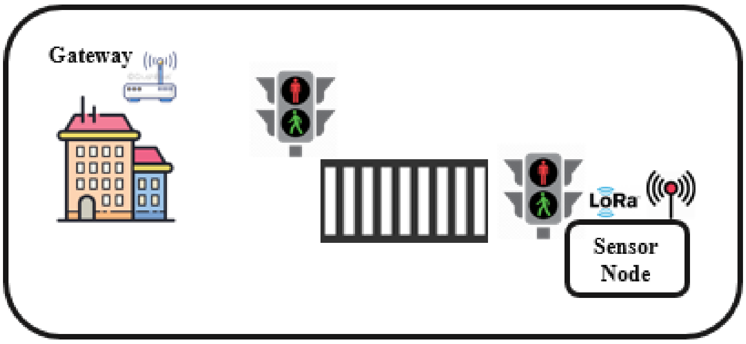


Figure 1.2: Sensor Node and Gateway Located

1.2 Problem Statement

In Malaysia, there are too many cases of road accidents faced by construction workers. According to the Official Website Department of Occupational Health and Safety [2], a flagman was hit by lightning while performing his job dealing with the traffic. Another case on this page is that a construction worker accomplished rod cutting works for the new installation traffic lights. Abruptly, a car, though to be driven fast, came from behind and attacked the construction worker. The victim was thrown as far as 30 meters away and died at the place where it happened. Below is the Table of National Occupational Accident & Fatality Rate [3].

Table 1.1 : National Occupational Accident & Fatality Rate[3]

YEAR	2014	2015	2016	2017	2018
Accident Rate	3100	2810	2880	2930	2400
Fatality Rate	421000	484000	484000	490000	414000

The infrastructure and maintenance of traffic lights are very costly. The current traffic signal system utilizes wire to impart the sign starting with one traffic signal then onto the next. Since the communication utilizes wire as the correspondence channel, it will increase the development cost and increment wire use. Besides, the laying of power cables involving earthworks shows in Figure 1.3 will entail a big budget for construction costs.

Figure 1.3: Cutting and Dig the road.

Moreover, the road has been resurfaced after the cables installed, as shown in Figure 1.4. It is committed to resurfacing quality standard and must ensure that the traffic light never fail. Moreover, the light would cost taxpayers if the traffic light location is far from the power source.

Figure 1.4: 2" Gi Pipe Cultivation

The conventional traffic signal controller system utilizes the Programmable Logic Controller (PLC). The issue is the expense of the regulator set is costly. Moreover, the PLC framework needs different segments, for example, the Central Processing Unit (CPU) and I/O card, to help the framework. PLC likewise requires the 24VDC to work, and it makes the power cost costly.

1.3 Objective

i. To design and develop a Wireless Traffic Light for Pedestrian Crossing to establish communication between sensor nodes and gateways that can transmit data over a WiFi network (ThingSpeak).

ii. To determine how performance of a LoRa network (range, signal quality and stability) is affected by placement in Wireless Traffic Light for Pedestrian Crossing.

1.4 Scope of Project

This project's key objective is to develop IoT technology in a wireless system using LoRa communication tools. This project will include a study and analysis of network setups such as mesh topology, the wireless system's communication range, timely response, and sustainability. This system will reduce workforce cost as it can be remote maintenance via the monitor. A microcontroller will be used to transmit and receive information data for this system. The microcontroller will be connected to an open-source IoT platform to visualize the traffic light signalling poles connection to ensure the traffic light operates successfully. The communication of two pedestrian traffic signals is via wireless by utilizing LoRa Communication.

This project also focuses on construct a model of two pedestrian traffic lights. As shown in Figure 1.5, this project will choose a push button or sensor as the input. Next, for the process, the part Control Unit will be selected for this project. Last but not least, the output will display the standard wireless traffic light for pedestrian crossing.

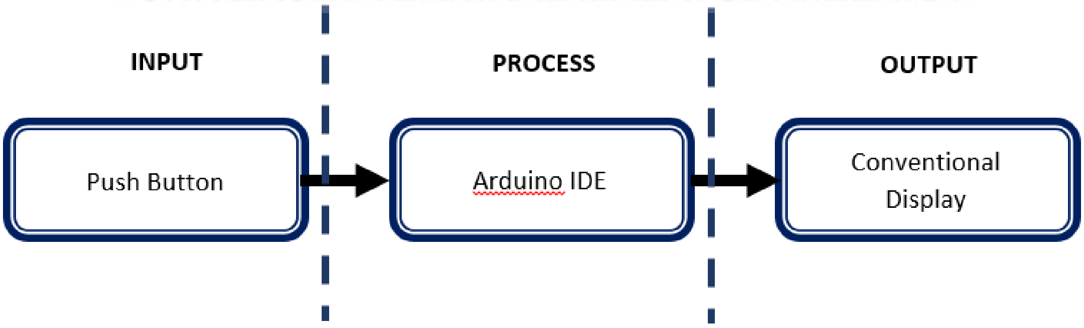


Figure 1.5: Block Diagram Scope of Work

Besides, the development of this system proved on the real environment to analyse the capability of LoRa in terms of latency, power consumption and any related parameter. The range of study is 200m to 1 km. It is important to have this test because it helps figure out the suitable parameter of LoRa.

1.5 Thesis Plan

This final year project thesis consists of five chapters to elaborate on the development of Wireless Pedestrian Traffic Light system, which is beginning with Introduction, Background Study, Methodology, Result, Discussion and Conclusion

Chapter 1 presents the entire project that comprises background studies, problem statement related to the project, objective, and scope of work. This part incorporates the essential operation and all the necessity of this project.

Chapter 2 is about the literature review relevant to this project, which discusses the historical analysis of the previous project and all the material philosophy and design of the new traffic light model.

Chapter 3 explained the research methodology where the process of the flow of The project, the hardware and software used in this project, discussing how the project operates systematically with appropriate planning.

Chapter 4 concentrates on reviewing and discussing the resulting gain from the project's analysis, comparing the results obtained with the previous result from the literature review.

Chapter 5 is about the conclusion after completion of this project and also the suggestion for future work.

CHAPTER 2

BACKGROUND STUDY

This chapter is about the previous study related to this project. These studies are the method of obtained reference and all information regarding the project development. The main concern includes the theoretical, methodology, and analysis that can help support this Wireless Pedestrian Traffic Light project.

2.1 Wireless Technology

Wireless Technology hugely affects our lives by encouraging pervasive processing. It offers imperative assistance, to give some examples, for smart homes, savvy urban communities, smart grids, and the Internet of Things. This makes mobility possible for audio, video, and data traffic. The need for thousands of cables was removed by interconnecting several separate, most often tiny devices. However, as opposed to the corresponding wired channel, far more distortions and environmental disturbances are faced due to the existence of wireless communications. These disruptions are due to heat, pollution, and physical barriers in the transmission path, such as houses, cars, trees, and mountains [4].

The Wi-Fi Alliance has envisaged Wireless Fidelity (Wi-Fi) as a single, internationally accepted standard for high-speed local area wireless networking. Based on IEEE 802.11

standards [5], the term Wi-Fi hand out Wireless Local Area Network (WLAN) technology [6]. Wi-Fi is access or edge-network technologies. This suggests that they offer the last-kilometre wireline network options. Both depend on comparable organization associations and transmission support infrastructure past the last kilometre [7].

ZigBee is a well-known wireless mesh networking industry standard for integrating sensors, diagnostics, and control frameworks. The connection in a Wireless Personal Area Network (WPAN), for example, has been referred to as the "Internet of things (IoT)." This device is also an open device, with a global, packet-based protocol designed to provide an easy to use design for safe, dependable, Low Power Wireless Networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards guidelines that can eliminate costly and perhaps hazardous cabling in industrial control applications [8].

Long-Range Communication (LoRa) is the actual layer or modulation layer used to establish the long-range communication link. LoRa extremely productive adjustment for accomplishing low power because many legacy wireless systems use Frequency Shifting Keying (FSK) modulation as the physical layer [9]. LoRa processing gain is presented in the RF channel by duplicating the information signal with a spreading code or chip arrangement. By increasing the chip rate, we increment the frequency part of the complete sign spectrum. As such, the absolute sign's energy is presently spread over a more extensive range of frequencies, permitting the receiver to recognize a sign with a lower signal-to-noise ratio (SNR) [10] .

2.2 Past Work Project of Wireless Traffic Light (WTL)

In this section, describe all the past work of the WTL project that has been done before by using different wireless technologies to operate the WTL in the smartest way.

2.2.1 Smart Traffic Light Control System by using ZigBee Wireless Communication.

Intelligent System for Traffic Light development comprises a traffic light controller that deals with the traffic signals of a "+" intersection of mono-directional streets. The framework is complemented by the convenient controller for emergency vehicles abandoned in busy time gridlock. Secure communication utilizing the ZigBee wireless gadget initiates the traffic ace controller into crisis mode and gives an open route before the slowed down crisis vehicle crosses the intersection [11]. As appear in Figure 2.1 of intelligent traffic light control, the designed system connects to a junction of 4 mono-directional roads in the front of "+".

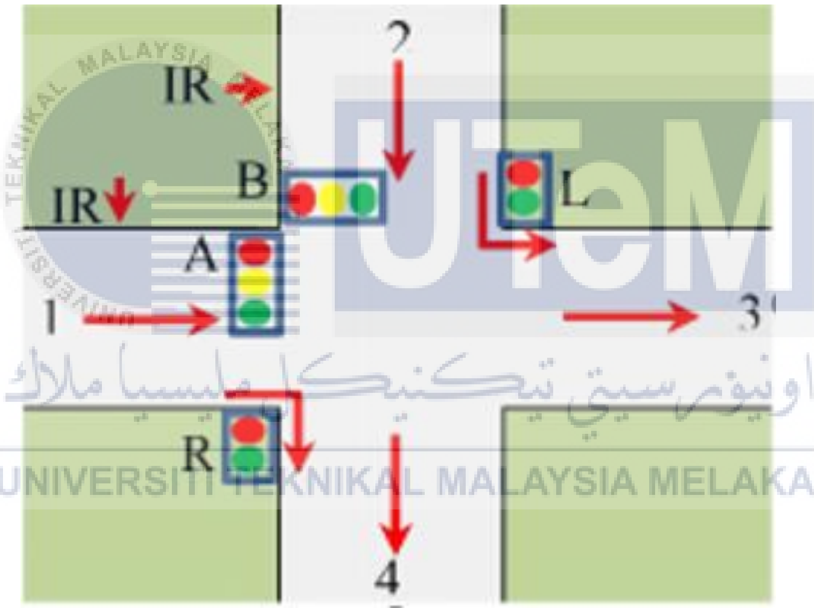


Figure 2.1: Intersection of 4 Monodirectional roads[11]

The disposition of vehicles changes between the streets contemplates the intersection of walkers. Table 2.1 represents the traffic signals' conditions marked B,A,R and L during the two arrangement modes. The phrase adopted is made up of three regions: traffic lights, color lights, and states. For instance, A-G ON assigns that the green light of the traffic signals enlightened. Stage 1 of the main design compares to the initiation of the green light of the traffic signal and traffic R where the vehicles leaving at street one cross the convergence. Stage

2 concurs with the notice for stop position where just the yellow light of the traffic signals is turning on for 5 seconds. during this arrangement, the red lights of the traffic signal B and L are ON. In the subsequent setup, the enlightenment of the light is turned around [11].

Table 2.1: Traffic Light Configurations[11].

First Configuration		Second Configuration	
Phase 1	Phase 2	Phase 1	Phase 2
A-G ON A-Y OFF A-R OFF	A-G OFF A-Y ON A-R OFF	A-G OFF A-Y OFF A-R ON	A-G OFF A-Y OFF A-R ON
B-G OFF B-Y OFF B-R ON	B-G OFF B-Y OFF B-R ON	B-G ON B-Y OFF B-R OFF	B-G OFF B-Y ON B-R OFF
R-G ON R-R OFF	R-G ON R-ROFF	R-G OFF R-RON	R-G OFF R-RON
L-G OFF L-R ON	L-G OFF L-R ON	L-G ON L-R OFF	L-G ON L-R OFF

A ZigBee module is a device that communicates through a wireless network. It employed the IEEE 802.15.4 protocol, which ensures data delivery and integrity in its whole. Media Access is a unique feature that ensures that two network nodes do not broadcast at the same time, resulting in data collisions and communication failures. Addressing is a strategy for ensuring that only the intended node accesses the received data, permitting data to be transmitted from one place to another or from one location to several points by broadcasting to all network nodes. Error Detection is a method of validating data received at the node [12].

2.2.2 Smart Traffic Light Control System by using Remote Control Wireless Communication

The remote control uses to send the command from an operating officer to the main control, as shown in Figure 2.2. A wireless traffic light controller makes a traffic policeman easily and effectively control a road junction with wireless remote control. There is a two-mode system, which is manual mode and automatic mode. The manual mode allows the traffic light control to be manually changed by the traffic policeman by pressing the button to emit a green light signal in the direction of the street. [13].

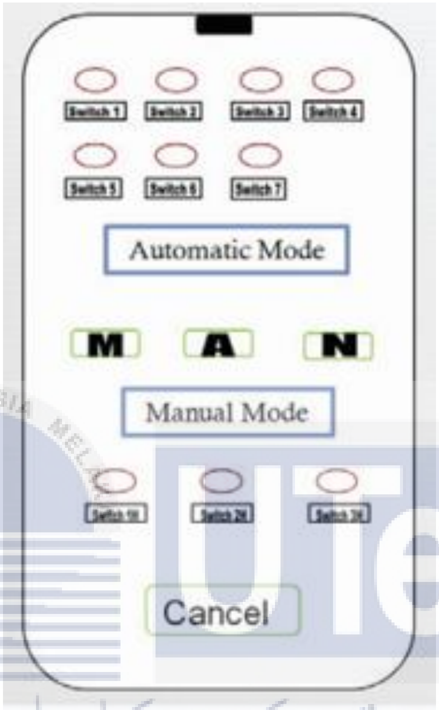


Figure 2.2: Remote Control [13].

The remote will respond by utilizing the Hall impacts sensor to check the pressing button's bearing on the distance concerning the remote's locations and direction. Give a control sign to the leading body of the traffic light controller. The traffic light controller boards will change the light sequence as indicated by the pre-set examples and time delay in programmed mode. The traffic policeman can change the path whenever by utilizing the remote control. The system helps the policeman control the intersection by himself and change the states of the traffic flow progressively [13]. The block diagram of the system shown in Figure 2.4 consists of three main parts.

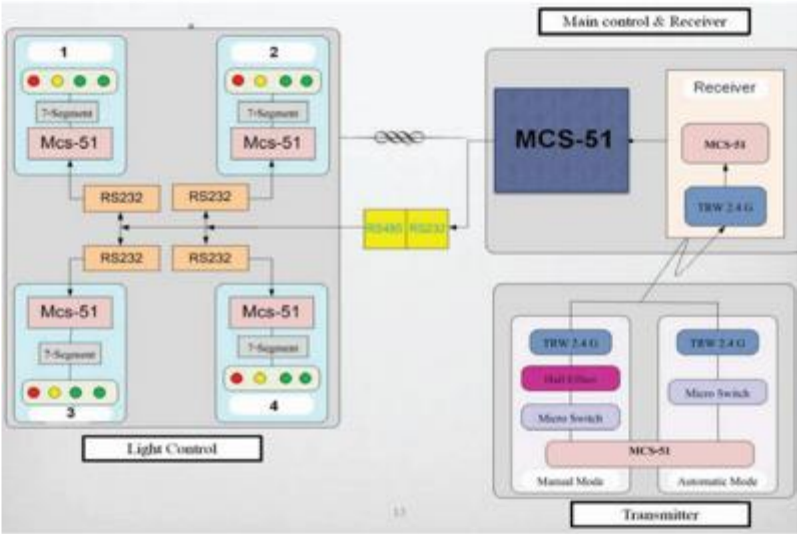


Figure 2.3: Block Diagram Project System [13].

2.2.3 Smart Traffic Light Control System by using Fuzzy Logic Controller

A fuzzy logic controlling the traffic flow system utilizing fuzzy innovation can change the human thinking process into an algorithm utilizing mathematical models. Usage of genuine principles like how traffic policemen would think to oversee traffic light lights should be possible by fuzzy on the off chance that rules [14].

The traffic light controllers should change the process duration of the green light sign contingent on the measure of vehicles showing up, which would boost the traffic flow and control the standard holding uptime. The assistance of an experience creates the contributions of the fuzzy signal control system. The fuzzy rule-based system derives input actions from given inputs by constructing if-then rules representing the relation among the linguistic variables [14].

As a rule, a fuzzy traffic light controller, as appeared in Figure 2.4, will improve the traffic protection in the intersection, the use of the convergence at its most extreme level and limit the deferrals. In a traffic light system, the red light demonstrates the vehicles showing up to be halted, the green light shows the vehicles showing up to be permitted, and the yellow light shows the switch over of red light or green light [14].

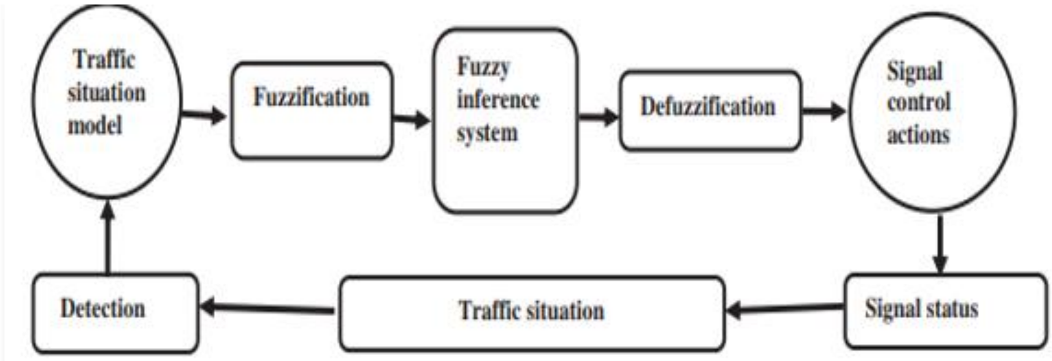


Figure 2.4: Fuzzy Traffic Signal Controller [14].

2.2.4 Smart Traffic Light Control System by using Programmable Logic Controller (PLC)

A Programmable Logic Controller PLC is a device used to control and automate complex systems. They use programmable memories for storing instructions provided by the user who can implement logic functions and sequential, time, counting, and arithmetic operations. PLCs function by inspecting their inputs and, depending on their status and the functions created by the user, they switch outputs [15].

In other words, a programmable controller is an industrial computer specialized in real-time applications. PLCs usually contain a processor, a power source, in-out modules, output modules, and a unique, dedicated module [16]. The interface is created with the program Easy Builder. In order to develop it, one needs to know all the right labels for the ladder scheme, inputs and outputs used, as shown in Figure 2.5.

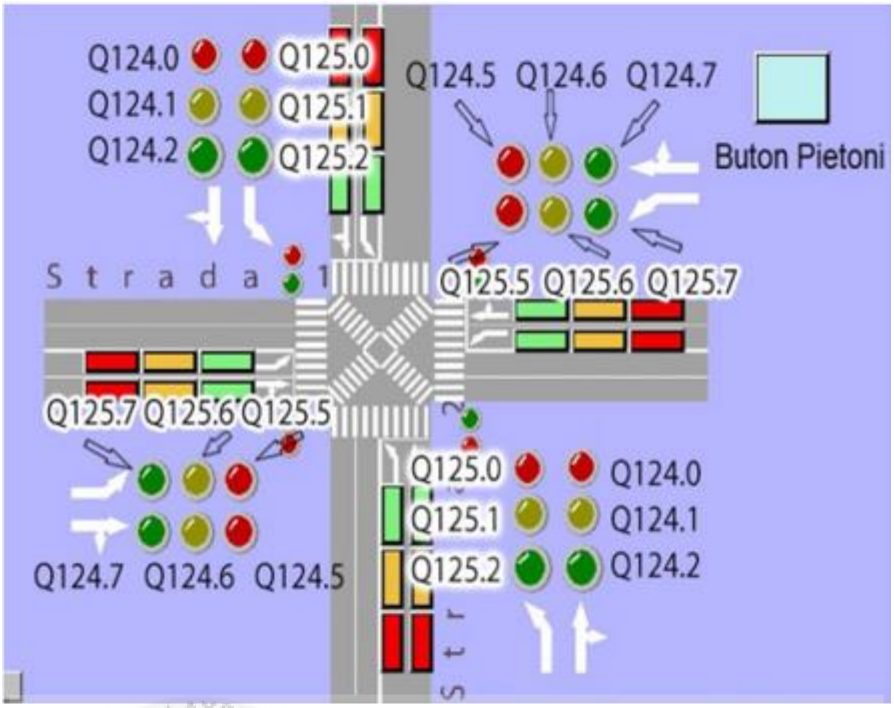


Figure 2.5: Association of the streetlight lamps with outputs Q of the PLC [15]

In another study, a PLC-based traffic light control system was built, and software was used to execute autonomous traffic light control. The program replaced the original relay wiring in the system, and the PLC's hardware and software resources were utilised wisely. The traffic light signal system was shown using two seven-segment digital tubes in countdown order, while the hardware wiring and PLC ladder diagram were thoroughly detailed. [17]. The wiring diagram, as shown in Figure 2.6.

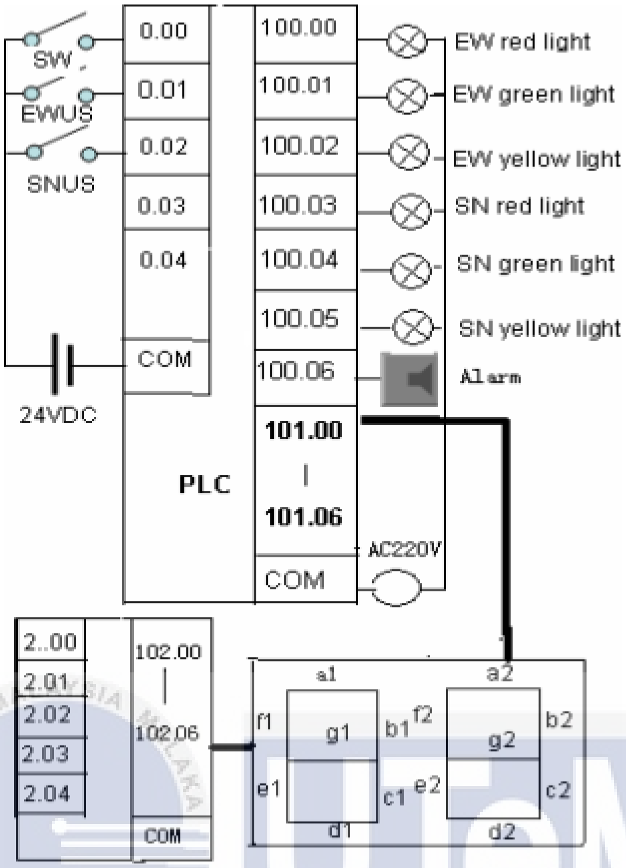


Figure 2.6: Circuit diagram of the controlling system [17].

2.2.5 Smart Traffic Light Control System by Using Raspberry Pi

A traffic control system based on IoT is created, with signal timings updated depending on vehicle counting. A WI-FI transceiver module is included in this system. It sends the vehicle count from the present traffic light to the next traffic signal. It adjusts the signals of the following signal based on the traffic density of the preceding signal. The system is built around the Raspberry Pi and Arduino. Traffic video image processing is done in MATLAB with Simulink assistance. The raspberry pi is in charge of the entire vehicle counts. [18]. The operation of these studies shown in the block diagram shows in Figure 2.7.

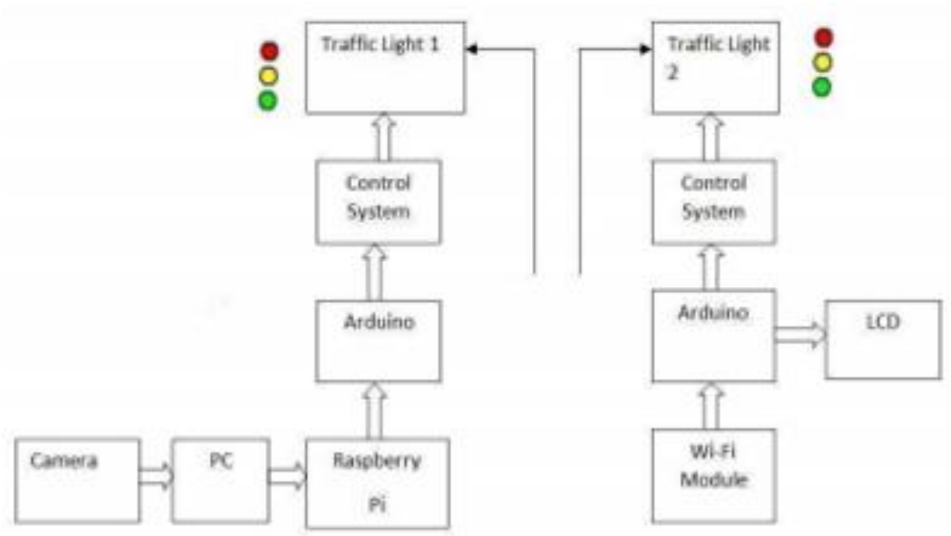


Figure 2.7: Block Diagram of the system [18]

The Raspberry Pi is a little computer with multiple ports to which the Camera, Speaker, and so on are connected. Image processing is carried out on the Raspberry Pi using OpenCV and Python. The Webcam's highest resolution is 1280x720, with a processed picture resolution of 680x680 and a Line of Sight (LOS) of 600 - 1200. The operational range of the camera is 40cm to 130cm, while the range of the Raspberry Pi camera is 50cm to 400cm. The audio command is broadcast over the speaker when a sign or traffic light is recognized. [19].

2.3 Past Work Project of WTL by Using LoRa Technology

This section describes all the past work of the WTL project that has been done before by using the LoRa Technology controller to operate the WTL in the smartest way.

2.3.1 Smart Traffic Light for Congestion Monitoring using Long Range Wide Area Network (LoRaWAN)

Traffic light congestion ordinarily happens in metropolitan territories where the quantity of vehicles is an excessive number of out and about. This issue drives the requirement for development and gives adequate arrangements paying little mind to this issue. A smart system that will screen this clog level at the traffic signal will be another choice to supersede the old structure, which isn't common-sense any more. Actualizing the IoT innovation will give the full favourable position to observing and making a congestion design dependent on sensor readings. Different sensors arrangements for every path will give a gigantic advantage in recognizing vehicles and increasing the precision in gathering information.

The sensor position of Smart Traffic light of congestion checking utilizing LoRa appeared in Figure 2.8. Every path will be executed with various sensors for more proficiency and exactness. The information will assemble and show the number of congestions on every path. At that point, an appropriate algorithm for running normally will be executed. This project will give data on which path has a higher level of congestion.

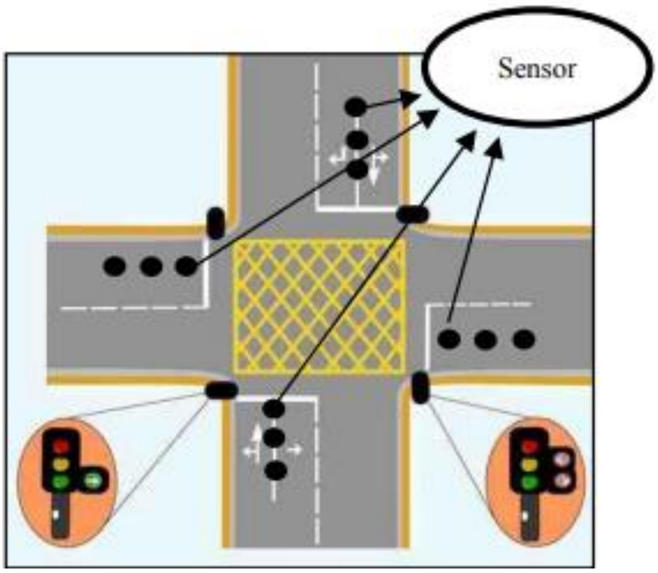


Figure 2.8: Multiple sensors placement [20].

The Smart Traffic light design for congestion observation utilizing LoRaWAN, as appeared in Figure 2.9, will be a distinction in the traffic light monitoring system. The different sensors that place along the path and beginning toward the stopping point to the rear of the traffic signal intersection.

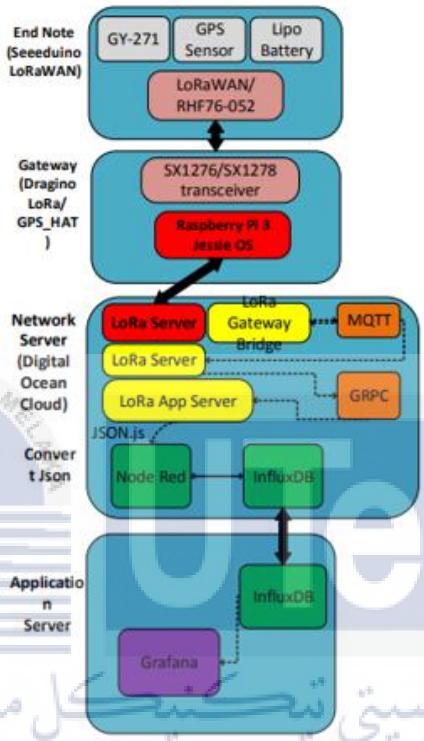


Figure 2.9: Smart Traffic light for congestion monitoring using LoRa

2.3.2 IoT based Automated Traffic Light Control System for Emergency Vehicles using LoRa.

There is a serious issue of Emergency Vehicles being stuck at intersections due to traffic congestion or scheduled traffic signal. This may result in the Emergency Vehicle may remain in a statutory position. Otherwise, if the emergency vehicle ever tries to override the signal, it may result in an accident or traffic congestion. The system is designed to find a cost efficient and accurate solution to save lives. Siren of the approaching emergency vehicle is priory sensed by using smart objects. The traffic lane in which the emergency vehicle is approaching is made free by halting the traffic in other lanes of the intersection [21]. The system architecture is shown in Figure 2.10.

Figure 2.10: System Architecture

The black box at the intersection indicates the junction controller which hosts the Decision Support System (DSS). All the smart objects are connected to the DSS via LoRa transceivers. A sound detection sensor is present along with the Decision Support System in the Junction controller to confirm the departure of the Emergency vehicle. The smart object consists of Sensors, Camera, Storage, Processing unit, and Communication device [21]. Decision Support System is a processing unit with an actuator, as shown in Figure 2.11.

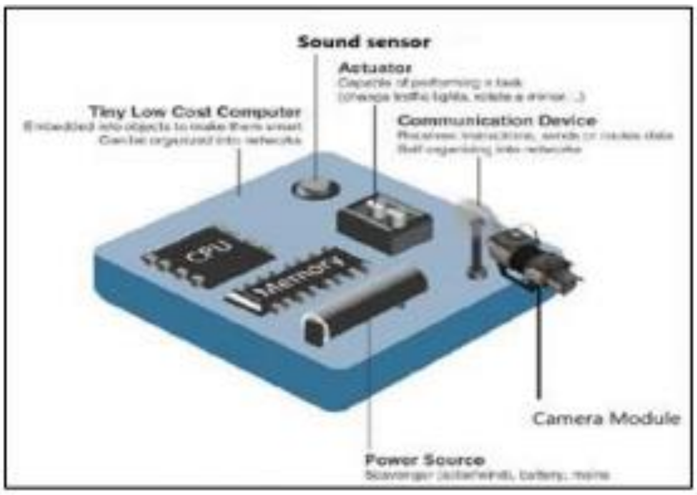


Figure 2.11: Smart Object

2.3.3 Intelligent Street Light by using LoRa.

The streetlights of a city provide better traffic conditions, a safer pedestrian environment, and a great improvement in the city's tourist and commercial architectural performance. This project aims to build a smart street light prototype that provides the consumer with lamp level management and feedback on results. [22].

As illustrated in Figure 2.12, this device functions in a master-slave arrangement, with each street light acting as a slave and the LoRa Gateway acting as the master. When an impediment crosses the streetlight (SLAVE), the ultrasonic sensor detects the obstacle and increases the brightness of that specific street light. This also delivers RF packets to forthcoming street lights. As a result, the brightness of the street light chain will gradually grow. Then it will return to regular mode.

Furthermore, the master may control each street light separately by sending instructions to a certain slave. The master is connected to the internet to allow users to control street lights remotely. Thus, the Master gateway can connect and control a large number of street lights.

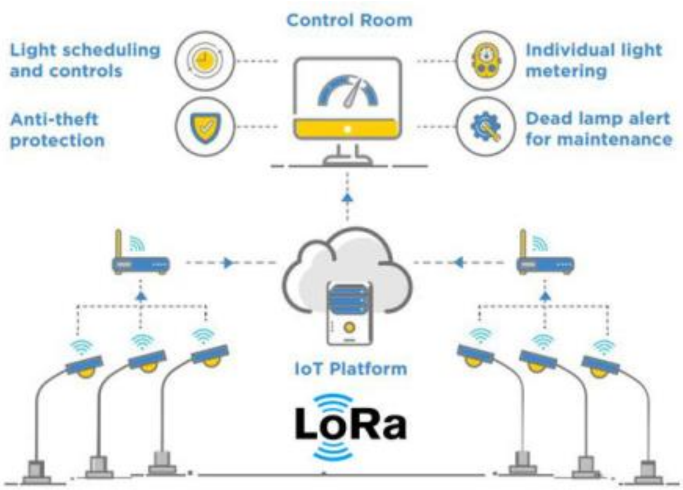


Figure 2.12: intelligent Street Light System [22]

2.4 Comparison Between Wireless Technologies

The most serious elements to be examined under coexistence Bluetooth Low Energy (BLE), Wi-Fi, Lora, and ZigBee devices are included. The specifications, as shown in Table 2.2, interpret from different wireless technologies [23].

Table 2.2 Specification of different Wireless Technologies [23].

Technology	Standard	Frequency	Range	Typical Transfer Radio
ZigBee	IEEE 208.15.4	2.4 GHz	10 meters - 100 meters	250 kbps
LoRaWAN	LoRaWAN	433 MHz,688 MHz, and 915 MHz	2 KM -15 KM	300 bps – 50 kbps
Wireless Fidelity (WiFi)	802.11n	2.4 GHz and 5 GHz	50 meters	150 Mbps – 200 Mbps
Bluetooth Low Energy (BLE)	IEEE 802.15.1	2.4 GHz (ISM)	50 meters – 150 meters (Smart/LE)	1 Mbps (Smart/LE)

According to the wireless technology, the network size for Zigbee approximately up to 65,000 nodes. Bluetooth is eight nodes per network, while Wi-Fi approximately 8000 nodes network size. The most bigger network size is the LoRa gateway has a very high capacity and capability to receive a message from a very high volume of End Node [24]. This illustration of network size comparison shown in Figure 2.13.

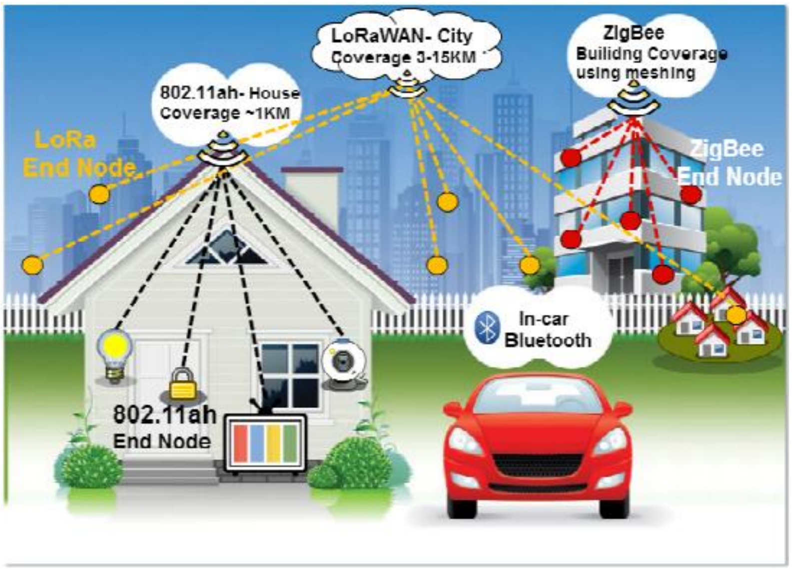


Figure 2.13: The Influence Wireless Technologies Range

The plan of the sensors, as indicated by the wireless technology and their separate application, is introduced in Figure 2.14. Organizing nodes are seen that will fill in as an extension between three of the examined technologies LoRa, Wi-Fi, ZigBee, and Bluetooth [23].

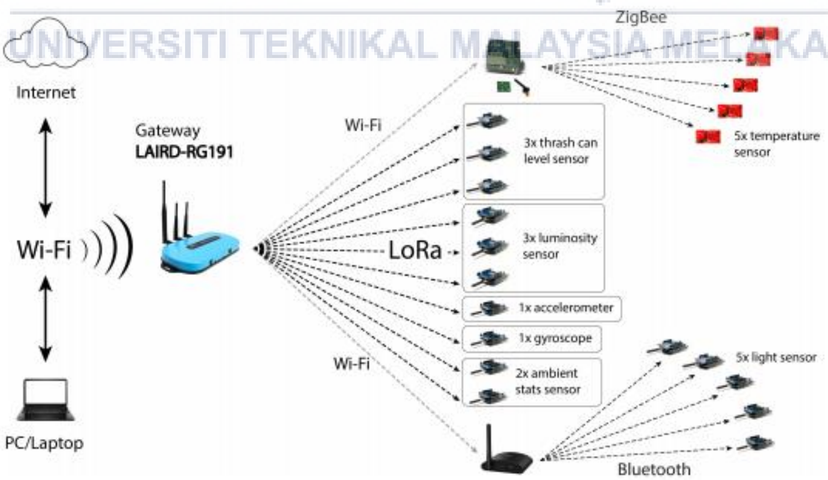


Figure 2.14: Network sensors under each technology

The power consumption of some wireless communication technologies addressed in this study in the range coverage range, as may be seen in Figure 2.15. In contrast to Bluetooth/LE and Wi-Fi networks, it demonstrates that LoRa has the greatest range with the least amount of power usage [25]. Wi-Fi and Bluetooth attain very fast data speeds, but their energy consumption is significant and their range is limited. All smartphone users are all too aware of this energy need. The main telecommunications companies' base stations deliver high data rates and very extended ranges, but this requires a significant amount of energy. As a result, power supply is usually a critical planning issue in such setups.

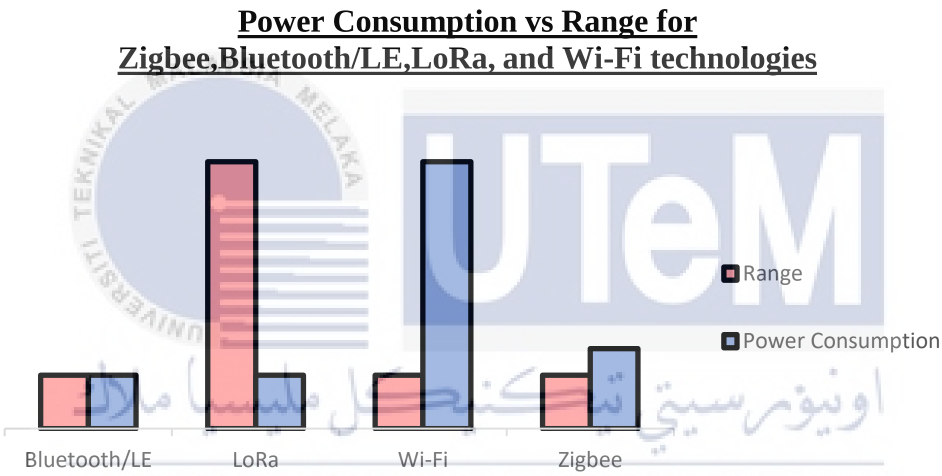


Figure 2.15: Power Consumption vs. Range for Bluetooth/LE, LoRaWan, and Wi-Fi technologies

LoRa Gateway has long-range communication compared to other networking systems, such as Wi-Fi, Bluetooth, NFC, and every other communication service. Even though the Global System for Mobile Communications (GSM) has the more extended territory, it incorporates membership expenses that are not LoRa is for nothing out of pocket. LoRa burns-through less power and energy during operations.

LPWAN (Low-Power Wide-Area Networks) standard of LoRa Technology proposes the compromise of cutting down the data to the impairment of longer communication ranges.

Figure 2.16 presents a relationship between the conventions of wireless communication. LoRa technology ensures incredibly huge communication distances for low data bandwidth.

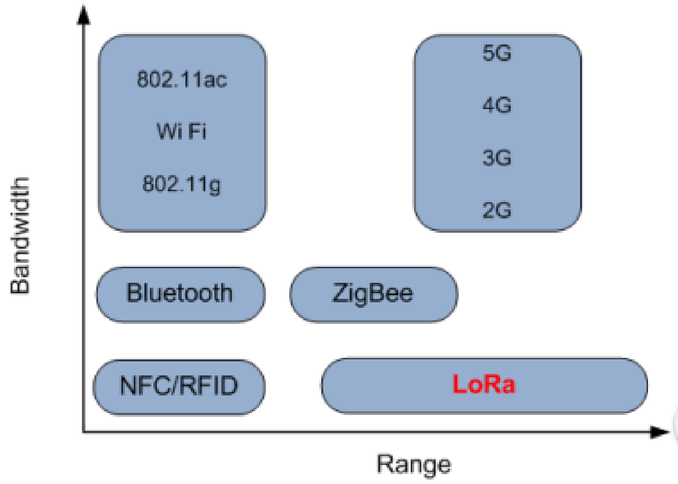


Figure 2.16: Wireless communication protocols comparison [26].

As a result, the standard is appropriate for applications where a limited amount of information is sent and the data obtained from sensors does not vary over time. The ERP (Effective Emitted Power) of a LoRa Device is limited to 25 mW in the European frequency band of 867-869 MHz. This policy is mandated because the communication channel bandwidth is decreasing [26].

This obstruction results in a data transport rate of 300 bps to 5.5 kbps. Another important factor is the obligation cycle, which should be less than 1%. These points of view slowed the transmission rate even more. The module is recommended for more effective communication transmission of information from the sensor to the gateway. LoRaWAN is the convention used at the layer where LoRa modulation is used. The fundamental advantage of using this modulation is that it increases the affectability of the receiver [26].

2.5 Long-Range Communication (LoRa)

LoRa technology is a long-distance communication, low-energy consumption, low-bitrate wireless telecommunication system created as a solution for the (IoT) end-devices utilizing LoRa across a solitary wireless bounce to impart to the gateways, associated with the Internet of Things interface and transfer information data between end-devices and a central network server. [27].

2.5.1 Typical LoRaWAN

A LoRaWAN network is typically a star-of-stars architecture comprised of at least one gateway, end-device, and a LoRaWAN Network Server. Figure 2.17 presents the essential topology of a LoRaWAN network. The end-devices are the node liable for gathering information or activating and creating LoRaWAN packets. The gateway is in charge of receiving LoRaWAN packets and transmitting them to the LoRaWAN Network Server over an IP-based network. It only works on the physical layer, unable to decode packets and determine their contents. The LoRaWAN Network Server is an abbreviation for a more contemporary component composed of three major components: a Network Server, an Application Server, and the Join Server [28].

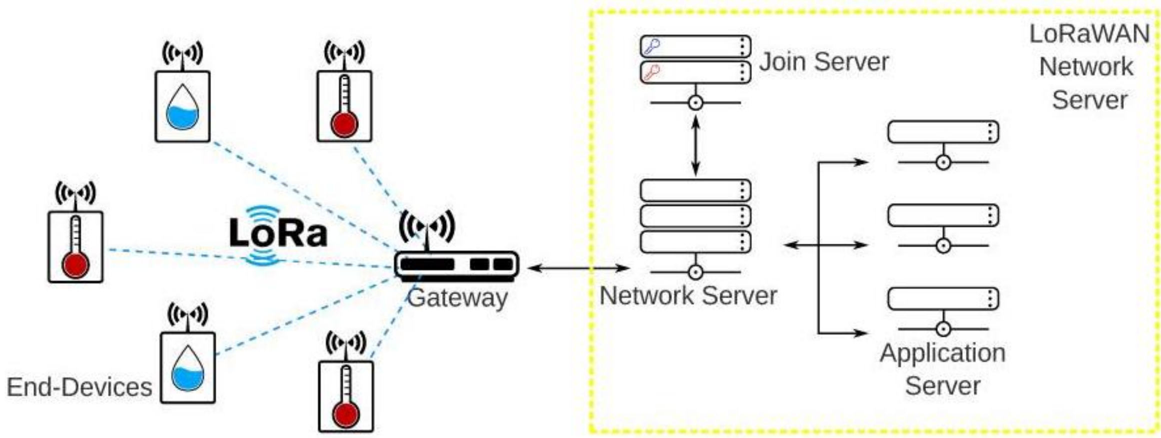


Figure 2.17 Typical LoRaWAN Network [28].

2.5.2 LoRa Classes

The end-device send their information to at least one gateways, and the gateways forward the message to the Network Server. No correspondence between end-devices is permitted in the default normalization. The end-device, as appeared in Figure 2.18, follow one of the three potential classes of activity [28].

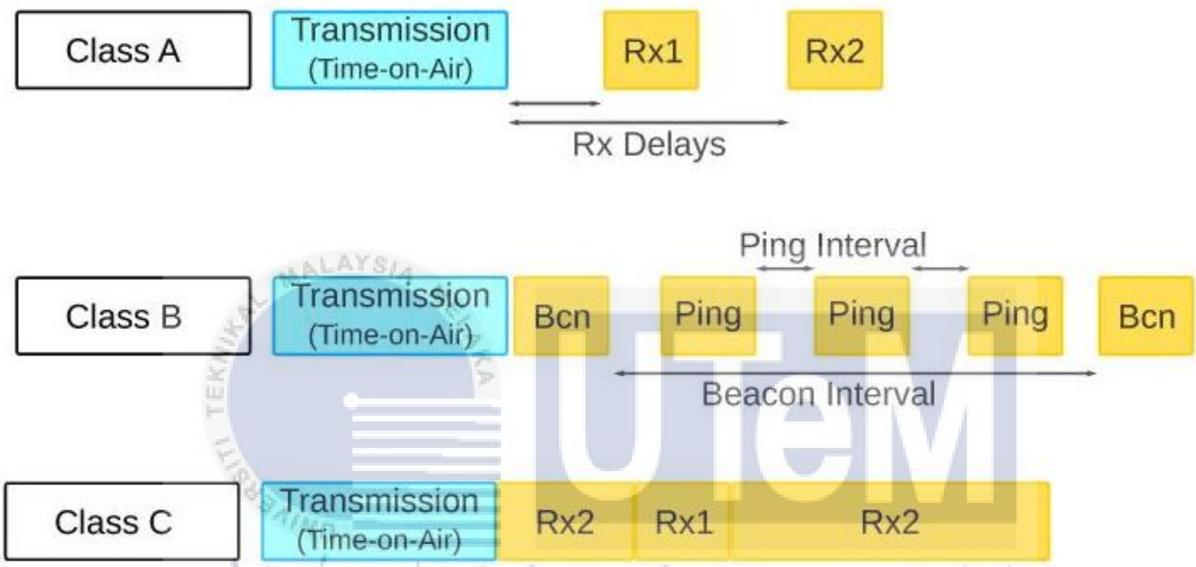


Figure 2.18: LoRa Classes.

2.5.3 Network Topology

The addition of an intermediary system changes the topology of the LoRaWAN network from star-of-stars to some new options. To understand better, it is necessary to contextualize the relay and router nodes in a mesh network topology. Figure 2.19 depicts a broader view of the various mesh LoRaWAN network prospects based on the mesh network concept [28].

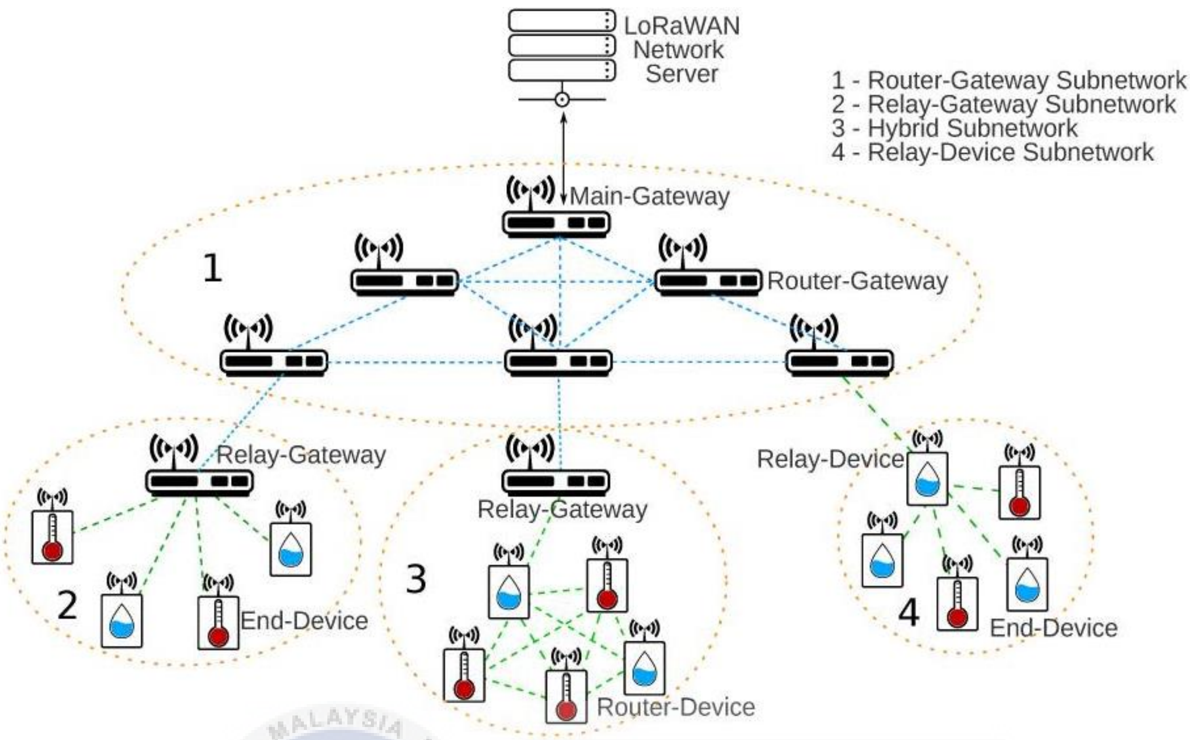


Figure 2.19: Star to Star Topology

2.5.4 LoRa Formula

A few parameters are accessible for the customization of the LoRa regulation Bandwidth (BW), Spreading Factor (SF), and Code Rate (CR). LoRa utilizes an offbeat meaning of the spreading factor as the logarithm, in base 2, the quantity of chirps per symbol. For straightforwardness, These parameters impact the successful bit rate of the modulation, its protection from impedance noise and its simplicity of decoding. The bandwidth is the main parameter of the LoRa modulation [27].

A LoRa symbol is made out of 2 SF chirps, which cover the whole frequency band. It begins with a progression of upward chirps. At the point when the most extreme frequency of the band is reached, the frequency wraps over, and the increase in frequency starts again from the base frequency[27]. An illustration of a LoRa transmission in the frequency variety over the long run appeared in Figure 2.20. The situation of this brokenness in frequency is encoded in the data communicated as there are 2 SF chirps in a symbol that can viably encode SF bit of data the information taken from [29].

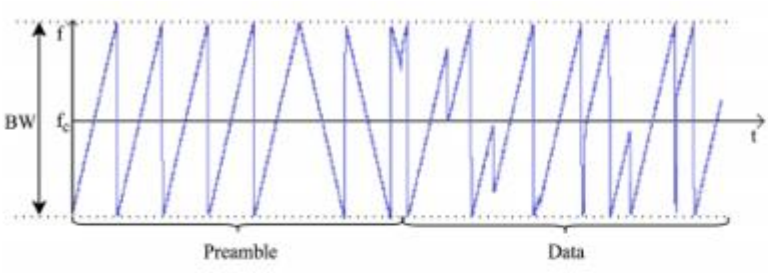


Figure 2.20: Frequency variation over time of a sample signal emitted by a LoRa transmitter [29].

Furthermore, because the symbol rate and bit rate at a particular spreading factor are proportional to the frequency bandwidth, double the bandwidth appropriately doubles the transmission rate. This is translated in Equation (2.1), which ties a symbol's span (TS) to the bandwidth and the spreading factor.

$$TS = \frac{2SF}{BW}$$

Equation (2.1)

LoRa incorporates a forward mistake amendment code. The code rate (CR) approaches 4/(4 + n), with n ∈ {1, 2, 3, 4}. Considering, just as the way that SF bits of information are transmitted per symbol, Equation (2.2) permits one to register the valuable bit rate (Rb).

$$Rb = SF \ X \ \frac{BW}{2SF} \ X \ CR$$

Equation (2.2)

These parameters likewise impact decoder affectability. As a rule, an expansion of bandwidth lowers the receiver affectability, though an ascent in the spreading factor increases the receiver affectability. Diminishing the code rate decreases the Packet Error Rate (PER) within sight of short explosions of impedance [27]. LoRa recipient affectability in dBm at various data transmissions and spreading factors shows in Table 2.2 [30].

Table 2.3: LoRa receiver sensitivity(dBm) different BW and SF [30].

BW \ SF	7	8	9	10	11	12
125KHZ	-123	-126	-129	-132	-133	-136
250KHZ	-120	-123	-125	-128	-130	-133
500KHZ	-116	-119	-122	-125	-128	-130

LoRa employs six spreading factors (SF7–SF12) to optimize the data rate/range trade-off. A higher spreading factor provides for a greater range at the price of a lower data rate, and vice versa. Depending on the spreading factor and channel bandwidth, the LoRa data rate ranges between 300 bps and 50 kbps. [31].

2.5.5 LoRa Specification

The LoRaWAN specification, as shown in Table 2.4, vary significantly per area due to varied regional spectrum allocations and regulatory requirements The LoRaWAN definition for Europe and North America is specified, however the technical committee is currently working on other areas. Entering the LoRa Alliance as a contributor partner and collaborating in the working group can provide considerable benefits to organizations seeking solutions for the Asian market.

Table 2.4: Regional Summary of LoRa

	Europe	North America	China	Korea	Japan	Malaysia
Frequency Band	867 MHz – 869 MHz	902MHz - 928MHz	470MHz - 510MHz	920MHz - 510MHz	920MHz - 925MHz	433MHz - 435MHz Or 915MHz - 924MHz
Channel	10	64+8+8	In definition by Technical Committee	In definition by Technical Committee	In definition by Technical Committee	In definition by Technical Committee
Channel BW Up	125/250KHz	125/500KHz				
Channel BW Down	125KHz	500KHz				
TX Power Up	+14dBm	20dBm typ (+30dBm allowed)				
TX Power Down	+14dBm	+27dBm				
SF Up	7-12	7-10				
Data Rate	250bps-50bps	980bps-21.9kbps				
Link Budget Up	155dB	154dB				
Link Budget Down	155dB	157dB				

CHAPTER 3

METHODOLOGY

This chapter will discuss the method used to conduct and establish this Wireless Traffic Light for Pedestrian Crossing system. Throughout the chapter, this section describes the project plan, design, development, and analysis process the chapter.

3.1 Introduction

This Wireless Traffic Light for Pedestrian Crossing consists of two main devices, which are the sensor node and the gateway. It's composed of a push button for the sensor node. The push button is attached to the LoRa module in order to transmit the data and the combination of the LoRa module and sensor circuit is called a sensor node. A lithium battery is used to power up the sensor as LoRa uses low power to operate. The hardware part is integrated with the software part, which is interfacing with the internet platform. The complete process is shown in Figure 3.1.

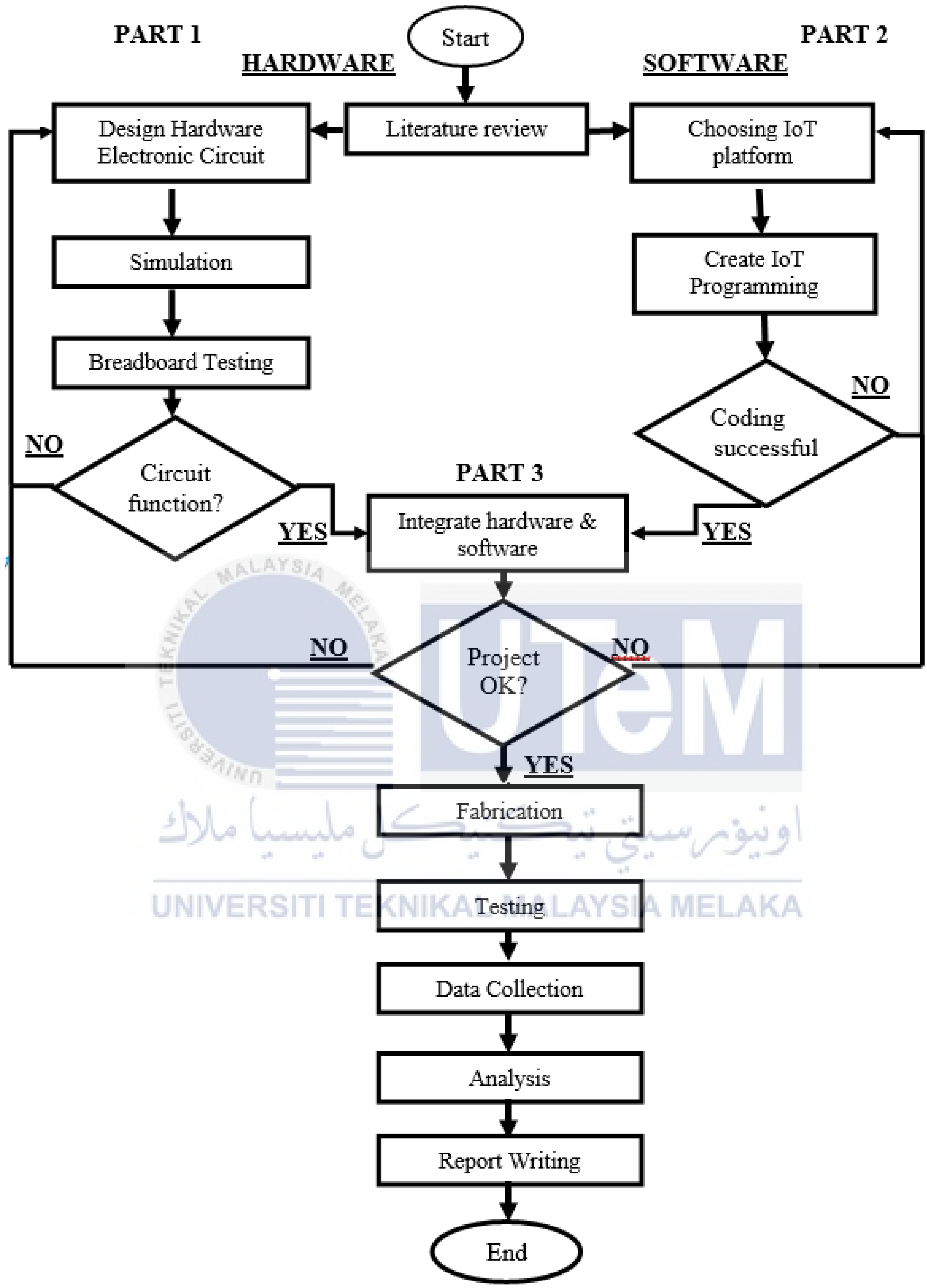


Figure 3.1: Flowchart of the methodology of the project.

For part 1, the proper analysis will be carried out on the shortcomings of the current traffic light for the pedestrian crossing system. This analysis would involve design hardware electronic components that can be added to the device, such as the controller and the wireless network. A simulation design will be done by using designing software such as Proteus. After that, do testing on the breadboard to make sure the circuit function.

For part 2, start with choosing the open-source IoT platforms such as ThingSpeak. After that, create the IoT programming coding. Then, continue to the method of linking the controller to the cloud to capture and view the data obtained from the microcontroller.

Upon completion, part 3 will be done. A phase of the development process, such as fabricating and testing the hardware components, will continue indefinitely. Then, data collection and do analysis. Lastly, writing the full report for this project.

3.2 Project Planning

This project started after made a meeting with the supervisor to discuss and brief the project. After that, the proper analysis was carried out on the shortcomings of the current traffic light for the pedestrian crossing system in order to analyse the problem and the appropriate solution using the current technology. This research analysis is done through reading journals, articles, and any related past studies.

Besides reading the journal and article, Jabatan Kerja Raya (JKR) Melaka is also the source of information to get all the information about the traffic light in Melaka. During the interview, there are so many questions asked, as shown in Figure 3.2. to Mohd Fithrie Bin Hisnin which is Electrical Engineer in JKR Melaka.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TRAFFIC LIGHT IN MALACCA (SURVEY FORM)

NAME	MOHD FITHRIE BIN HISNIN
POSITION	JURUTERA ELEKTRIK J41 CAWANGAN KEJURUTERAAN ELEKTRIK
ORGANIZATION	JKR MELAKA

1. What are the problems that are often happened regarding traffic light?

Traffic Light have no problem,

2. What is the estimated cost for maintenance and construction of the pedestrian traffic light?

new construction Rm 60K - 70K depends on the system used. (Android, apple, windows)

3. Usually, what causes of the traffic light damage?

* raining
* overload current or over voltage from mb
* Insect disorders (ants)(bee, lizard)

4. How often are traffic lights maintained within a year?

yearly maintenance, breakdown maintenance when accident occur

5. Suggestion/Comment

* human detector in Pedestrian crossing Traffic Light.

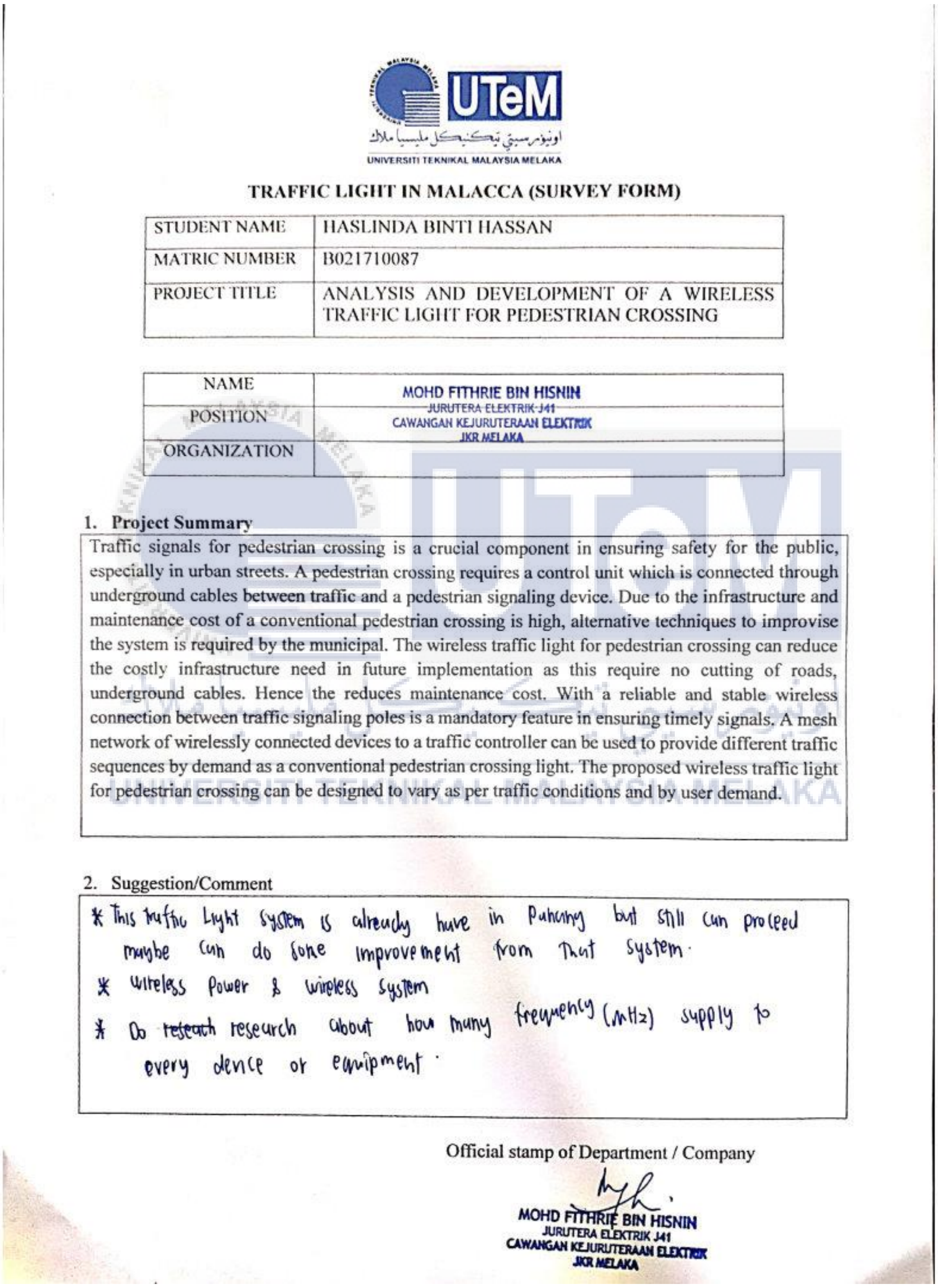
Official stamp of Department / Company

MOHD FITHRIE BIN HISNIN
JURUTERA ELEKTRIK J41
CAWANGAN KEJURUTERAAN ELEKTRIK
JKR MELAKA

2/12/2020

Figure 3.2: Survey Form

Instead of asking the question to Mohd Fithrie about the traffic light in Melaka, in this interview session also ask the opinion and advice about this project. The survey form, as shown in Figure 3.3.



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TRAFFIC LIGHT IN MALACCA (SURVEY FORM)

STUDENT NAME	HASLINDA BINTI HASSAN
MATRIC NUMBER	B021710087
PROJECT TITLE	ANALYSIS AND DEVELOPMENT OF A WIRELESS TRAFFIC LIGHT FOR PEDESTRIAN CROSSING

NAME	MOHD FITHRIE BIN HISNIN
POSITION	JURUTERA ELEKTRIK J41
ORGANIZATION	CAWANGAN KEJURUTERAAN ELEKTRIK JKR MELAKA

1. **Project Summary**

Traffic signals for pedestrian crossing is a crucial component in ensuring safety for the public, especially in urban streets. A pedestrian crossing requires a control unit which is connected through underground cables between traffic and a pedestrian signaling device. Due to the infrastructure and maintenance cost of a conventional pedestrian crossing is high, alternative techniques to improve the system is required by the municipal. The wireless traffic light for pedestrian crossing can reduce the costly infrastructure need in future implementation as this require no cutting of roads, underground cables. Hence the reduces maintenance cost. With a reliable and stable wireless connection between traffic signaling poles is a mandatory feature in ensuring timely signals. A mesh network of wirelessly connected devices to a traffic controller can be used to provide different traffic sequences by demand as a conventional pedestrian crossing light. The proposed wireless traffic light for pedestrian crossing can be designed to vary as per traffic conditions and by user demand.

2. Suggestion/Comment

* This traffic Light system is already have in Pahang but still can proceed maybe can do some improvement from that system.
* Wireless Power & wireless system
* Do ~~reseach~~ research about how many frequency (MHz) supply to every device or equipment.

Official stamp of Department / Company

MOHD FITHRIE BIN HISNIN
JURUTERA ELEKTRIK J41
CAWANGAN KEJURUTERAAN ELEKTRIK
JKR MELAKA

Figure 3.3: Survey Form

3.3 Hardware Development

Hardware development of this project consist of the process of constructing the sensor node and gateway. It includes the circuit designing, circuit testing, circuit troubleshooting, and PCB development. Several software was used during this development to allow the controller to operate and communicate as intended. In this project there are some hardware components used. The hardware component used are 2 pieces Arduino controller, 2 pieces LoRa Shield, 2 pieces LM 2596 DC-DC Switching Regulator, Push Button, Red Light, and Green Light.

3.3.1 SX127x LoRa Shield

As indicated in Figure 3.4, the SX127x LoRa Shield will be combined with an Arduino Shield; this technology is based on an open-source library. This Shield enables data transmission over incredibly long distances at modest data rates. It enables ultra-long-range spread spectrum transmission and great interference immunity while consuming the least amount of power.

Figure 3.4: SX127x LoRa Shield

3.3.2 Arduino UNO

In this project, Arduino UNO as shown in Figure 3.5 is used to communicate with LoRa module, which transmit data input from user and send to LoRa module then connect to another LoRa module and operate the wireless traffic light for pedestrian crossing.

Figure 3.5: Arduino UNO R3

3.3.3 LM 2596 DC-DC Buck Converter Adjustable Step-Down Module

The DC-DC module is used to lower the input voltage and provide a consistent 5 volt output voltage. The LM2596 switching voltage regulator, as illustrated in Figure 3.6, is utilized to regulate the voltage here. The LM2596 regulator is a monolithic integrated circuit that is appropriate for the quick and convenient design of a stepdown switching regulator in this project. It can drive a 3 A load with outstanding line speed and load regulation.

Figure 3.6: LM 2596 DC-DC Buck Converter Adjustable Step-Down Module

3.3.4 Hardware Circuit Connection

In this project, the hardware part is divided into two. First is Transmitter Part as shown in Figure 3.7 which is include LoRa Shield, Arduino Uno, LM 2596 and Push Button.

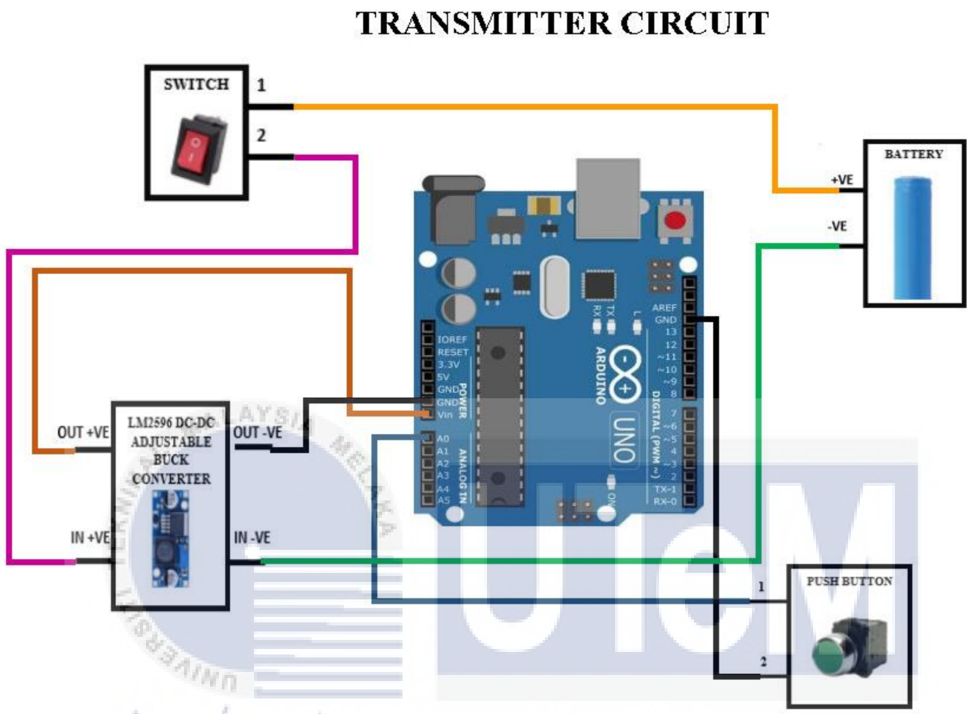


Figure 3.7: Transmitter Circuit

The second part is Receiver Part as shown in Figure 3.8 which include LoRa Shield, Arduino Uno, LM 2596, 18560 Rechargeable Battery, Amplifier Circuit to give more power to the LED, Timer, Red Light, and Green Light of Pedestrian Traffic Light.

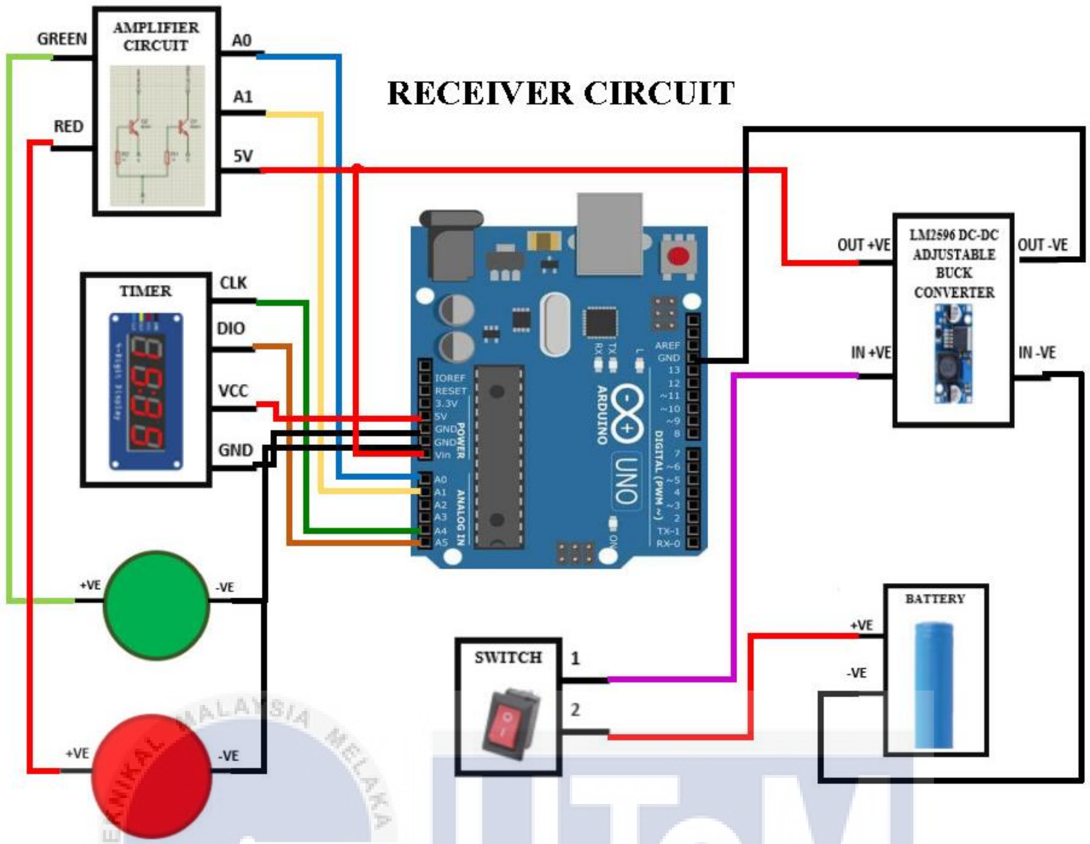


Figure 3.8: Receiver Circuit

3.3.5 Fabrication Process

The process of converting a circuit board design into a physical structure based on the parameters supplied in the design package is known as PCB manufacturing. Several strategies are used to generate this physical appearance. The first way is to create the PCB layout, as illustrated in Figures 3.9 and 3.10, using CAD (Computer assisted drawing) software such as PROTEUS.

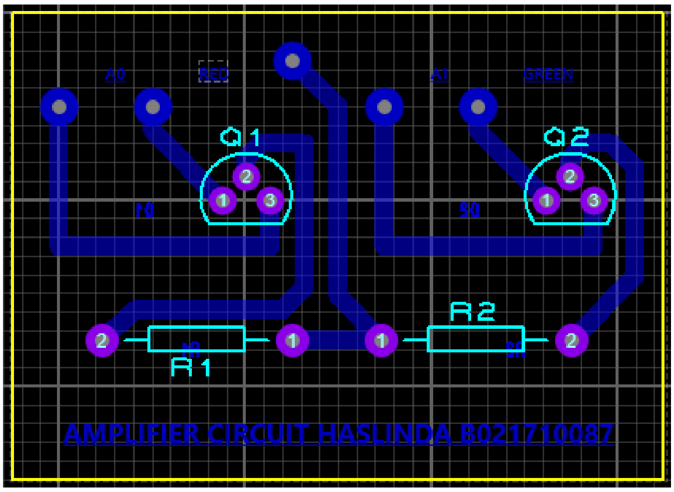


Figure 3.9: Amplifier Circuit Layout of PCB

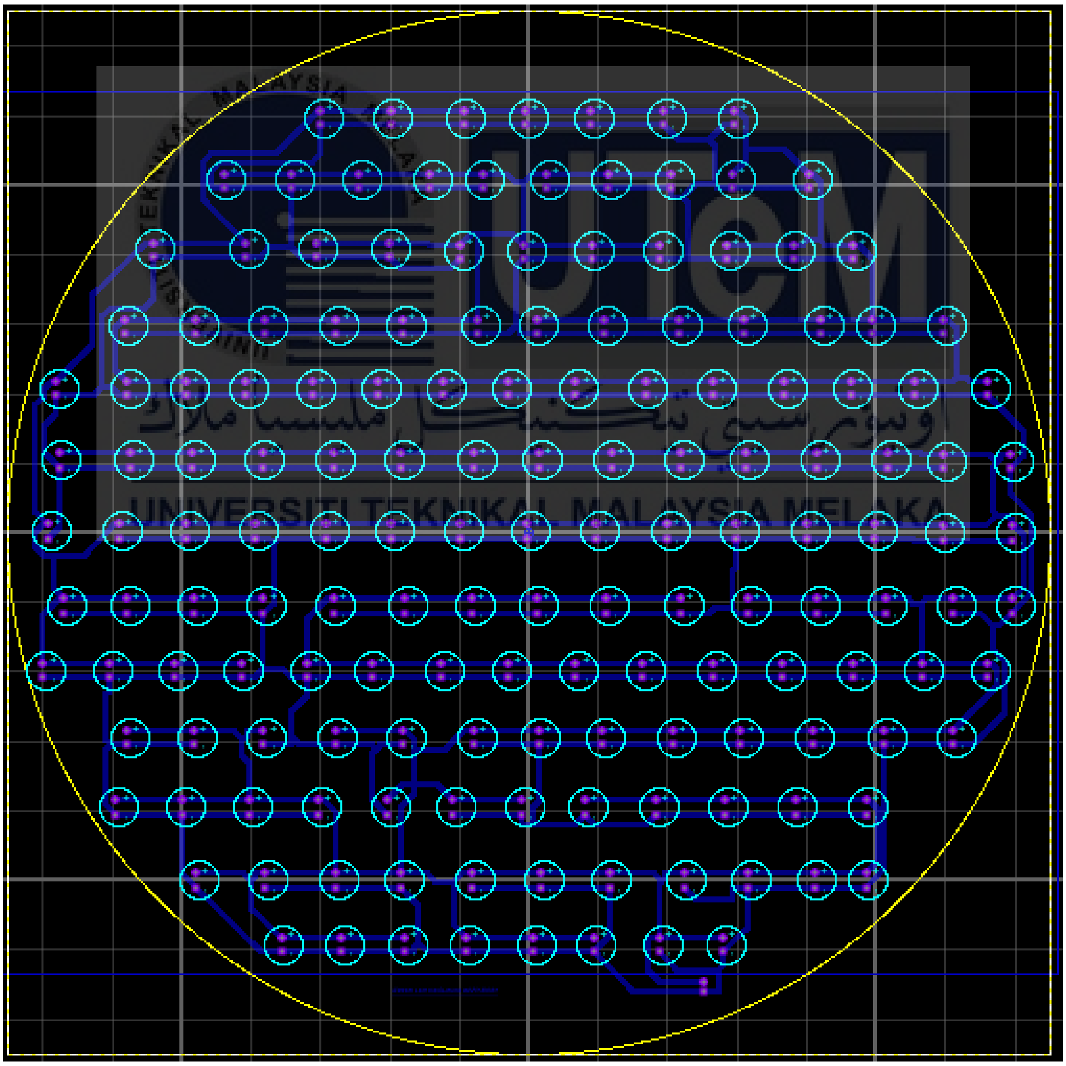


Figure 3.10: Red and Green LED Circuit Layout of PCB

In a dark room, the photo-lith film is exposed to yellow light in the presence of trace paper and developed to make a negative film of the PCB design. as shown in Figure 3.11 and Figure 3.12. Use only Amber Light throughout this process.

Figure 3.11: Laminating photo-lith film

Figure 3.12: Negative development of the circuit (Dark Room Process)

As illustrated in Figure 3.13, the Copper Clad + Film pair is subjected to Ultra Violet Rays in the UV Chamber during the developing PCB process. As a result, after developing the UV Exposed Copper Clad sheet, the exposed section (the black tracks / lines of the circuit in the PCB design shown in Figures 3.9 and 3.10) becomes rougher than the other section that was not exposed to ultra violet.

Figure 3.13: PCB Ultra Violet Rays in the UV Chamber

After the board has been exposed, it goes to developing process as shown in Figure 3.14 dry film resist developer act as solvent agent to dissolves the unexposed part of the dry film resist.

Figure 3.14: Dry Film Resist Developer Process

The part which the ultraviolet rays lashed does not dissolves in the developer. The part which the ultraviolet rays did not lash dissolve in the developer and the copper foil appears. The exposed resist left as the mask pattern on the top of the copper board. This mask pattern does not dissolve in the etchant as shown in Figure 3.15. The board should be fully developed in 120 seconds. The develop time, are changes with the size of the printed board, the area which dissolves the resist.

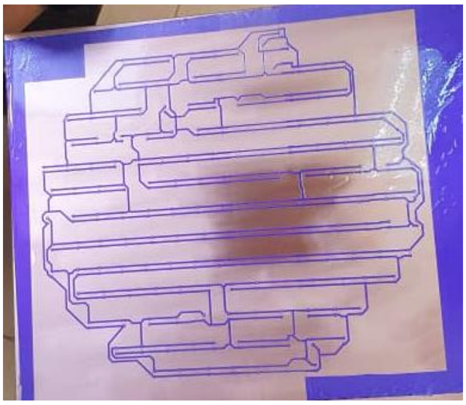


Figure 3.15: The Results of Developing Process

The etching process, seen in Figure 3.16, is the procedure that leaves the Etched Circuit Board with the needed design printed on it in the form of Copper Tracks. As in the previous phase, the copper clad sheet has the PCB design printed on it using blue ink. So, now that the sheet has been dipped in Ferric Chloride solution, the section of the PCB that is covered with blue ink remains unchanged, while the section that does not have blue ink is dissolved in a solution of ferric chloride after experiencing a chemical reaction.

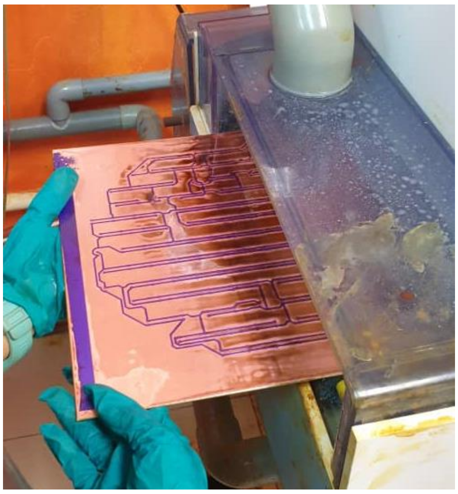


Figure 3.16: Etching Process

After done the etching process, wash the PCB with water, till the dye color is removed as shown in Figure 3.17.

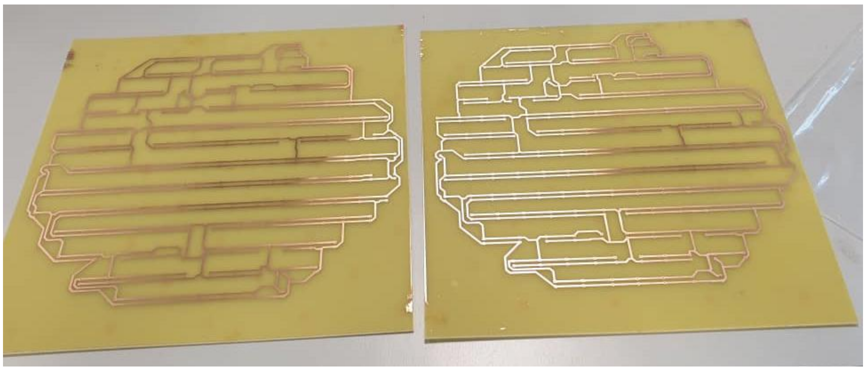


Figure 3.17: The Result of Etching Process

After the board has been etched, it goes to drilling the holes for PCB. The PCB drilling process as shown in Figure 3.18 must be properly executed because even a minor inaccuracy might result in a significant loss the drilling process is regarded as the most crucial and time-consuming aspect of printed circuit board production.

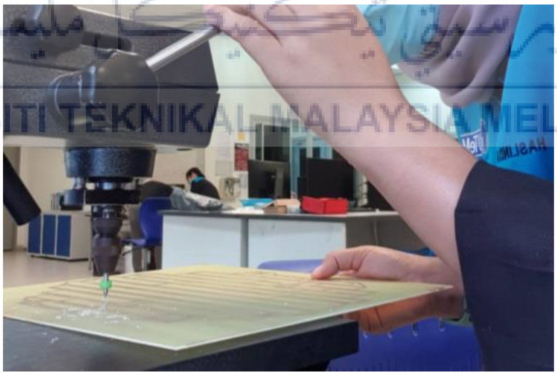


Figure 3.18: Drilling Process

The most important process in the electronic industry is soldering process as shown in Figure 3.19 and Figure 3.20. Soldering is a joining method that uses solder to link different types of electronics component type of metals together. Solder is a metal alloy typically composed of tin and lead that is melted using a hot iron. To generate a strong electrical connection, the iron is heated to temperatures exceeding 380 degrees Fahrenheit and then cooled.

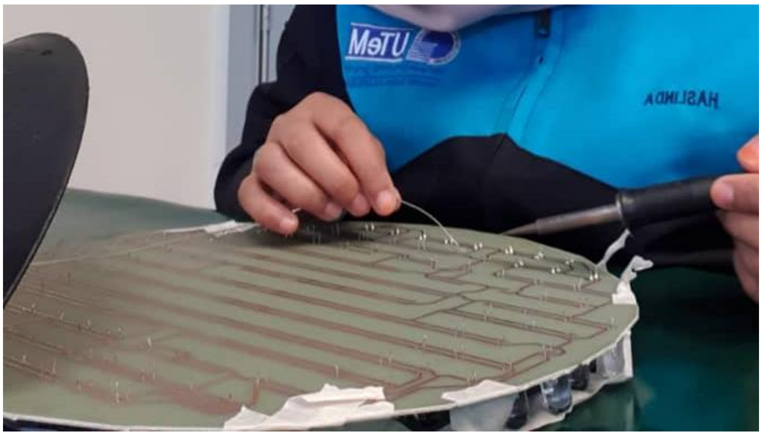


Figure 3.19: Soldering Process

Figure 3.20: Result of Soldering Process

3.4 Software

The Arduino IDE Software was used to program the function of the control system in this project. The first step in creating the appropriate code for this project is to create the project flowchart. A flowchart is made up of a series of instructions that are connected together by arrows to demonstrate the order in which they must be carried out. Each instruction is placed in its own box depending on the instruction, the boxes take on a variety of forms.

3.4.1 Project Flowchart

Project flowcharts, such as the one shown in Figure 3.21, are frequently used to define in detail algorithms that will be executed by a computer. When a computer performs an algorithm, it is said to execute the algorithm. Running and execution are two terms that are used interchangeably.

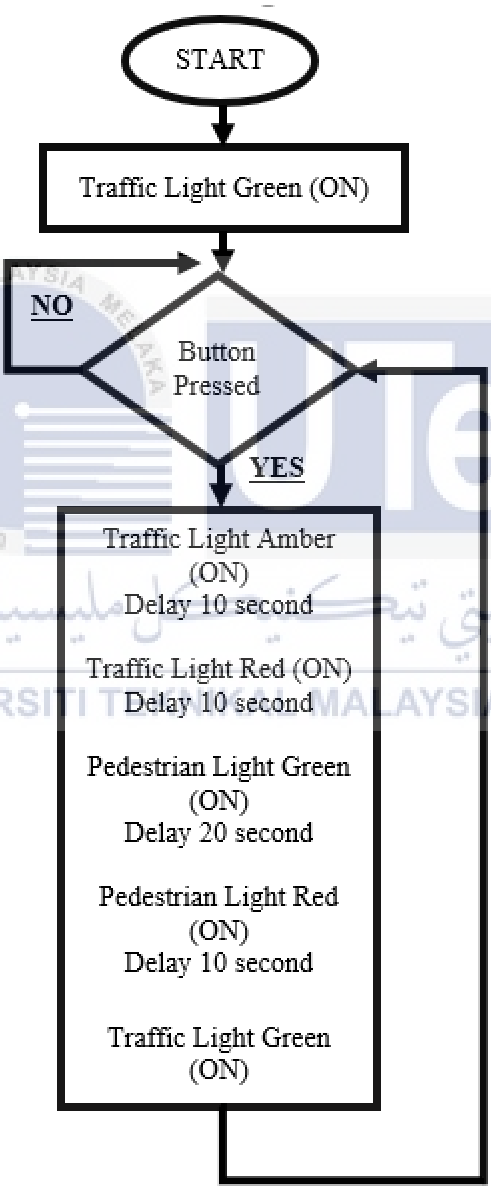


Figure 3.21: Project Flowchart

3.4.2 Project Coding

In order connect both receiver part and transmitter part to operate, it is very important to have program code to give instruction that need to be run. The software used for program development is Arduino IDE 1.8.7. The coding Arduino is called as a sketch and it is uploaded to the Arduino UNO R3 and LoRa Shield.

Transmitter Program on Push Button to run Traffic Light. The setup programs that must be written when creating a program for LoRa communication as shown in Figure 3.22 this setup program must be written to the program to receive or to transmit data.

```
#include <SPI.h>
#include <LoRa.h>

int PushButton = A0;
int PushButton_pressed;

void setup() {

  pinMode (PushButton,INPUT);
  Serial.begin(9600);
  while (!Serial);

  Serial.println(" LoRa Sender");

  if (!LoRa.begin(915600000)) {
    Serial.println("Starting LoRa failed!");
    while (1);
```


Figure 3.22: Setup Program for LoRa Communication

Figure 3.23 is the button program that is sent to run the traffic light. The sending data or packet begins with *"if (PushButton_pressed==LOW)"* which means when the button is pressed the program reads that the button is in a state "LOW " or " 0 " so that the value 0 is what LoRa sends to run the Traffic Light.

```
void loop() {

  int PushButton_pressed = digitalRead(PushButton);

  if (PushButton_pressed==LOW){
    LoRa.beginPacket();
    LoRa.print(PushButton_pressed);
    Serial.print("Data Send ");
    Serial.println(PushButton_pressed);
    LoRa.endPacket();
    while (digitalRead(PushButton)== LOW);
```

Figure 3.23: Transmit data Program on Push Button

Figure 3.24 is a program for receiving data sent by LoRa. The setup programs that must be written when creating a program for LoRa communication. This setup program must be written to the program to receive or to transmit data.

```
#include <SPI.h>
#include <LoRa.h>
```

```
int LEDTL_R = A1;
int LEDTL_Y = A2;
int LEDTL_G = A3;
int LEDPED_R = A4;
int LEDPED_G = A5;
```

Light Pin Setup


```
void setup() {

  pinMode ( LEDTL_R, OUTPUT );
  pinMode ( LEDTL_Y, OUTPUT );
  pinMode ( LEDTL_G, OUTPUT );
  pinMode ( LEDPED_R, OUTPUT );
  pinMode ( LEDPED_G, OUTPUT );
```

Pin Mode Output

```
 Serial.begin(9600);
 while (!Serial);
 Serial.println("LoRa Sender");

 digitalWrite ( LEDTL_G,1 );
 digitalWrite ( LEDTL_R,0 );
 digitalWrite ( LEDTL_Y,0 );
 digitalWrite ( LEDPED_R,0 );
 digitalWrite ( LEDPED_G,0 );
```

Initial Condition

Figure 3.24: Receiving Setup Program

Figure 3.25 is a LoRa program that receives transmitted data. This program is a program to receive data value 0 which is sent by the button from the transmitter. The data is received by LoRa and then processed by Arduino and reads the data to run the lights.

```
void loop() {
  // try to parse packet
  int packetSize = LoRa.parsePacket();
  if (packetSize) {
    // received a packet
    Serial.print("Received packet ");

    // read packet
    while (LoRa.available()) {
    Serial.print((char)LoRa.read());

      digitalWrite( LEDTL_G,1 );
      digitalWrite ( LEDTL_R,0 );
      digitalWrite ( LEDTL_Y,0 );
      digitalWrite ( LEDPED_R,0 );
      digitalWrite ( LEDPED_G,0 );
      delay (5000);

      digitalWrite ( LEDTL_Y,1 );
      digitalWrite( LEDTL_G,0 );
      digitalWrite ( LEDTL_R,0 );
      digitalWrite ( LEDPED_R,0 );
      digitalWrite ( LEDPED_G,0 );
      delay (2000);
```


Figure 3.25: Receiving Data Program

Function on *"LoRa.packetRssi"* program is to find out the signal strength as shown in Figure 3.26. The signal strength that can be received by the receiver and this RSSI (Receiver Signal Strength Indicator) is always there in wireless technology to measure the signal strength of the wireless device.

```
//print RSSI of packet
Serial.print(" with RSSI:");
Serial.println(LoRa.packetRssi());
```

Figure 3.26: RSSI program

3.4.3 Access and Configuration for Dragino Gateway LG01-P

Take the LG01-P gateway and connect it to electricity using the adapter that came with it. It is necessary to connect the adapter to the 12V-1A port. Then, as shown in Figure 3.27, connect the LAN cable to the LAN port on the LoRa Gateway and the other end of the LAN cable to the laptop.

Figure 3.27: The Connection between Dragino Gateway to Laptop

The laptop's IP address would be 10.130.1.xxx, but the LG01's default IP address is 10.130.1.1. Enter 10.130.1.1 into the browser on your laptop. The user will see the LG01 login interface. The Web Login Account's username and password are: The user name is root. The password is Dragino, as seen in Figure 3.28.

Figure 3.29: The account for Web Login

Then, connect the gateway to the internet using WiFi. Select the Network section, clicked at Internet Access and the WiFi name filled in Service Set Identifier (SSID) and the password of the SSID entered shown in Figure 3.29.

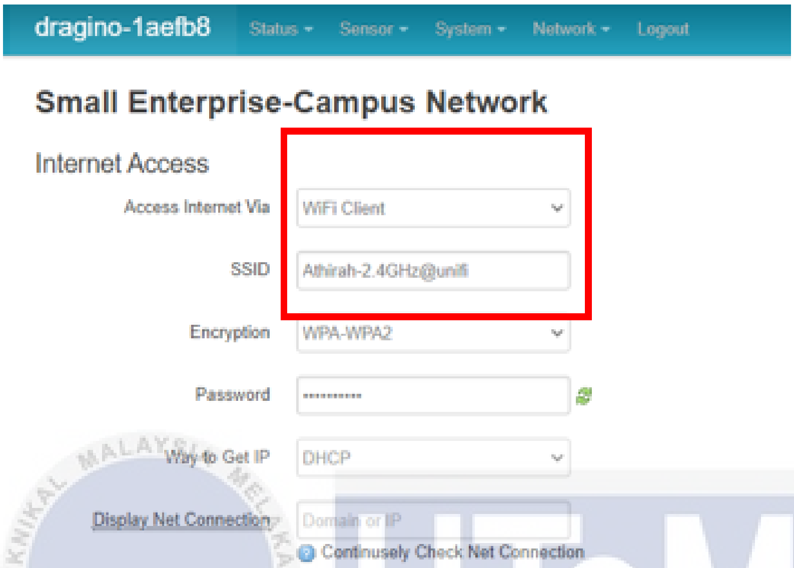


Figure 3.29: Internet Access Configuration

Continued scroll to the USB Modem Setting set default. Clicked save and apply to end this section shown in Figure 3.30.

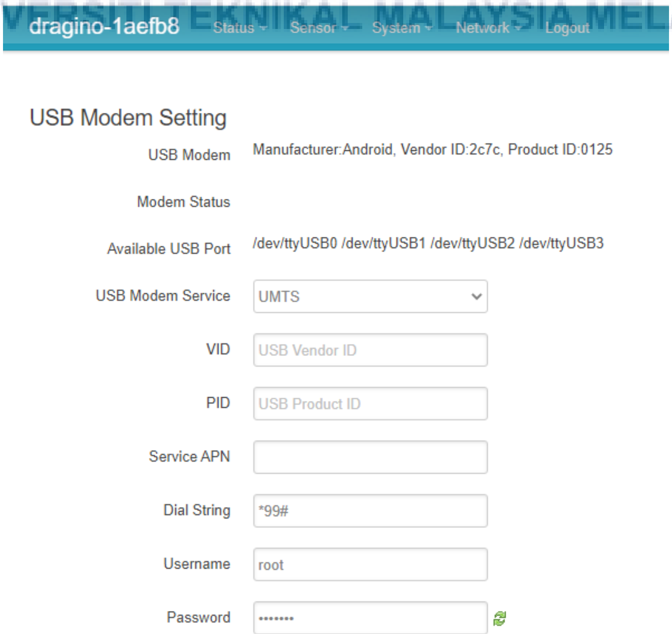


Figure 3.30: USB Modem Setting

After save and apply the Internet Access section. Continued the setting for LAN and DHCP section. In this section, the DHCP Server ticked to enabled it as shown in Figure 3.31. Clicked save and apply to end this section.

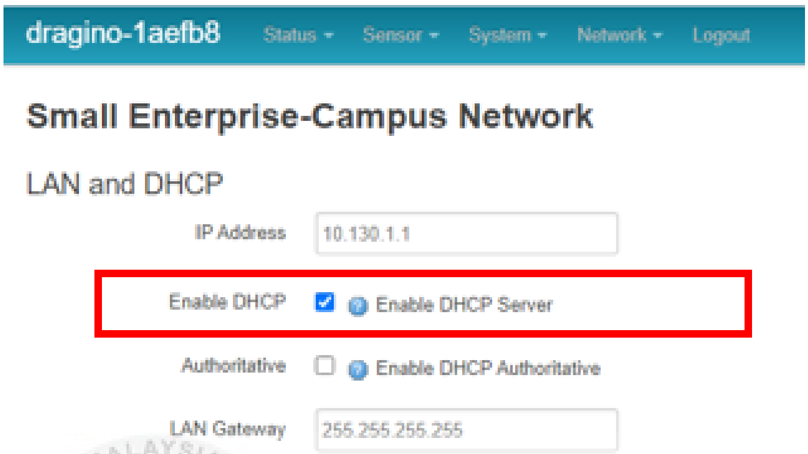


Figure 3.31: LAN and DHCP

Then, move to access point in network part. Unticked the WiFi AP as shown in Figure 3.32 to block the WiFi AP for access point. Clicked save and apply to end this section.

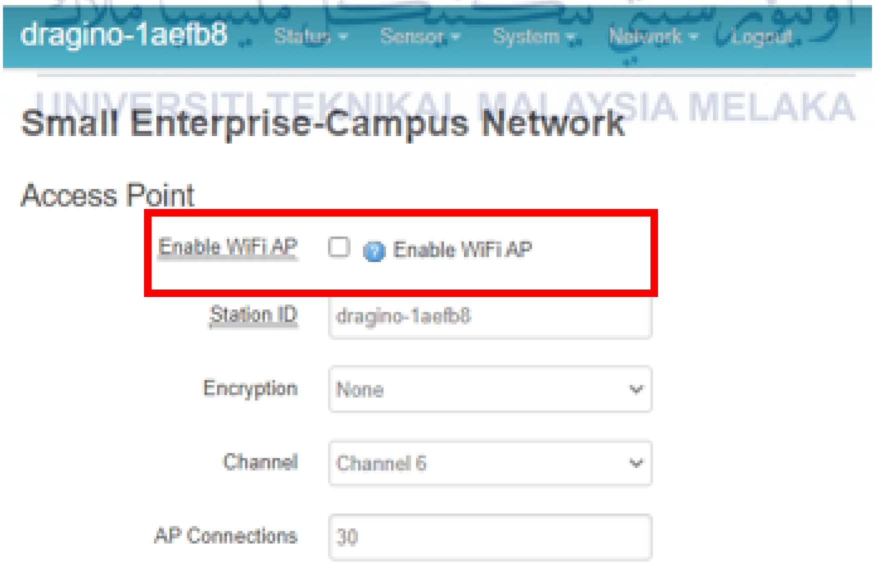


Figure 3.32: Access Point

Next step is move to the Mesh Network section, unticked the Enable Mesh Network box as shown in Figure 3.33. Click save and apply.

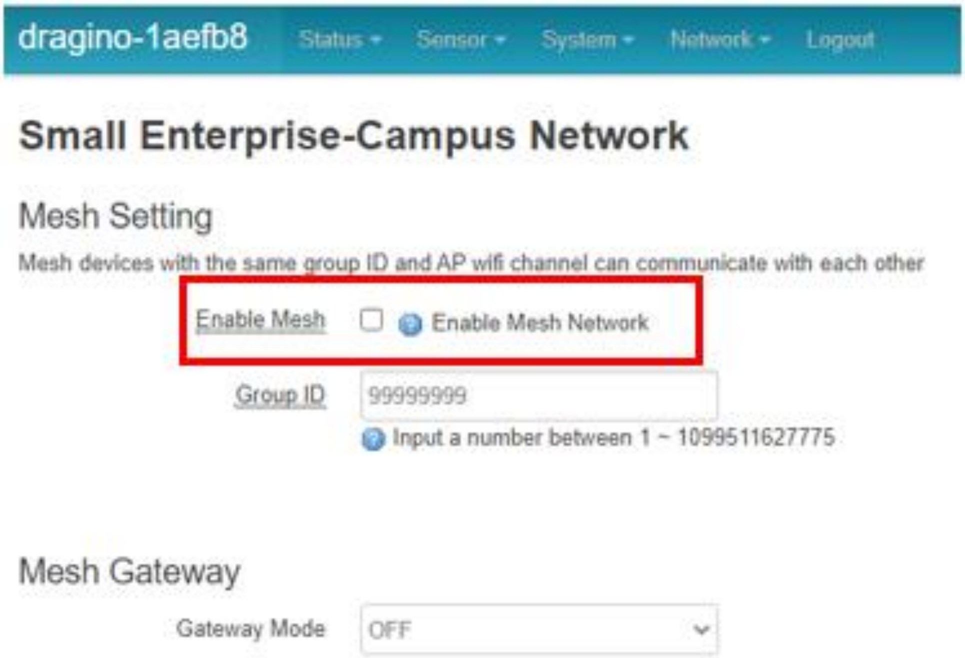


Figure 3.33: Mesh Setting

To make sure that the gateway is connected to the router, the connection status (IPv4WAN Status) will be appeared in the Status section as shown in Figure 3.34.

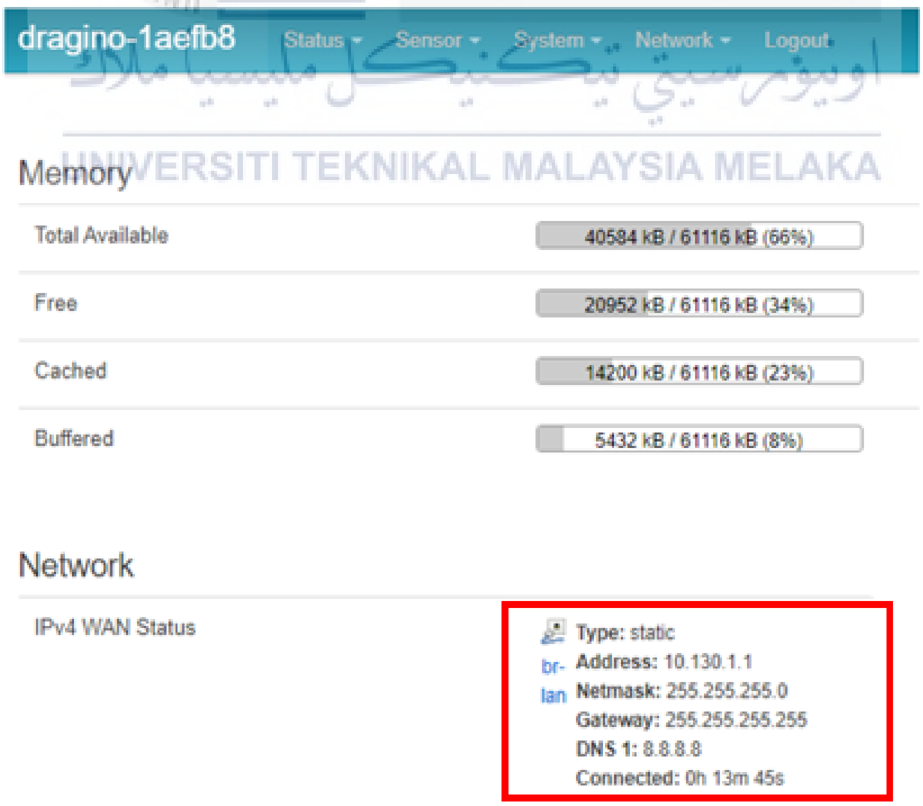


Figure 3.34: IPv4WAN Status

After successful associate, the gateway is currently connected to the AP. In order, to make sure the PC and LG01-N is in the same network, Secure Shell (SSH) as shown in Figure 3.35 from PUTTY Software used in this part to check the internet has access or not.

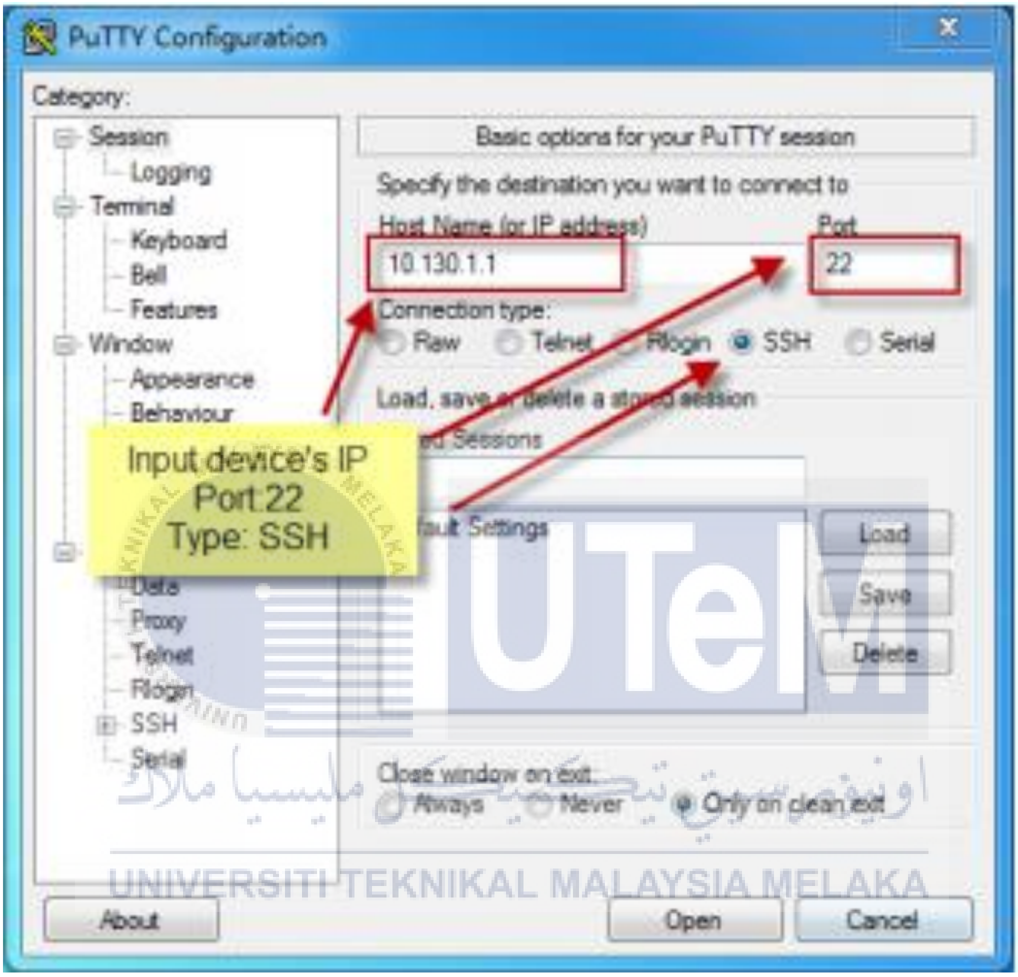


Figure 3.35: PuTTY Configuration

For the Host Name for IP Address use 10.130.1.1 since IP Address of LG01-N. Login root as user name and dragino in password session. Then, the Linux console and input commands will be appeared as shown in Figure 3.36.

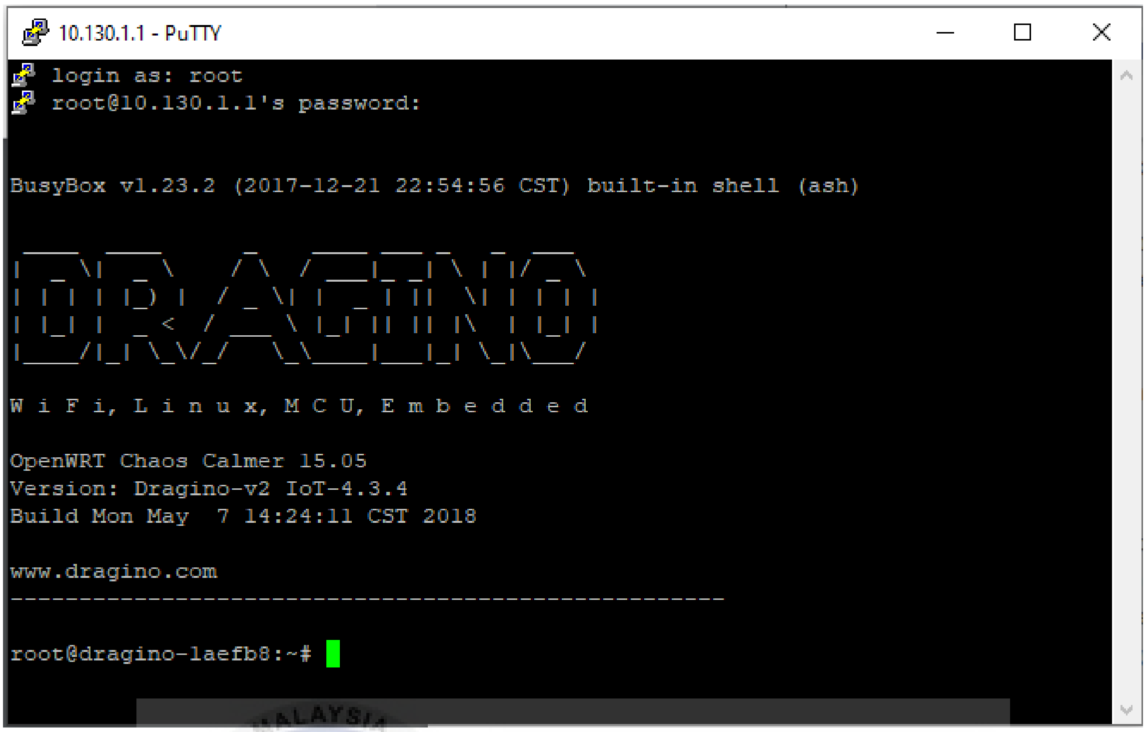


Figure 3.37: Linux Console and Input Commands

CHAPTER 4

RESULT AND DISCUSSION

This chapter will discuss the results obtained from the analysis, past studied and any related sources. This chapter consist of analysis, output data and specification of this project. The result is important to show the functionality of wireless traffic light for pedestrian crossing system featuring with LoRa technology.

4.1 Transmitting Packet by Using LoRa Technology with Aligned Antenna Testing.

This test aims to ensure that communication between the transmitter and receiver can run well so that data transmissions can be received by the LoRa node. The first test in LoRa communication was carried out between the Sekolah Menengah Kebangsaan Ayer Keroh Melaka Jalan Tasik Utama 10 and the intersection of Jalan Tasik Utama 21, which is 325 meters distance as shown in Figure 4.1.

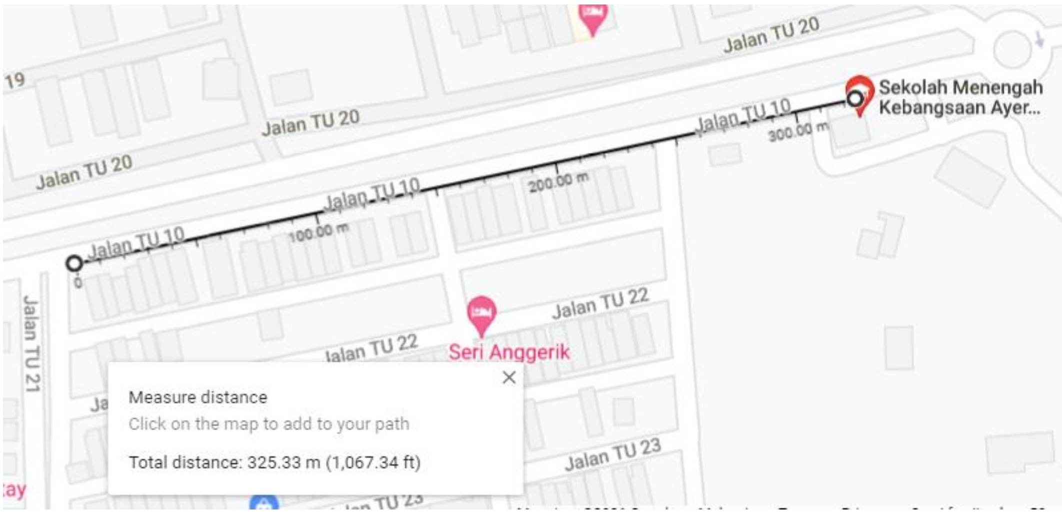


Figure 4.1: LoRa testing at the Sekolah Menengah Kebangsaan Ayer Keroh and the intersection of Jalan Tasik Utama 10

The results of distance over Received Signal Strength Indicator (RSSI) and SNR testing as shown in Table 4.1 carried out as far as 300 meters. The value in Table 4.1 is the test result with the conditions around the tool in the form of a roadside with quiet conditions with only trees and a few passing vehicles.

Table 4.1: Result Distance over RSSI and SNR Aligned Antenna

Distance (m)	RSSI					SNR					Signal Quality
	1	2	3	4	5	1	2	3	4	5	
100	-100	-100	-102	-102	-102	11	11	11	11	10	VERY STABLE
200	-118	-123	-120	-120	-123	8	6	6	6	6	VERY STABLE
300	-130	-125	-130	-130	-130	9	8	8	9	9	VERY STABLE

The results obtained by the RSSI value and SNR value in Table 4.1 are analyse in graphical. Figure 4.2 shows the Graphic Changes of Distance over RSSI and SNR.

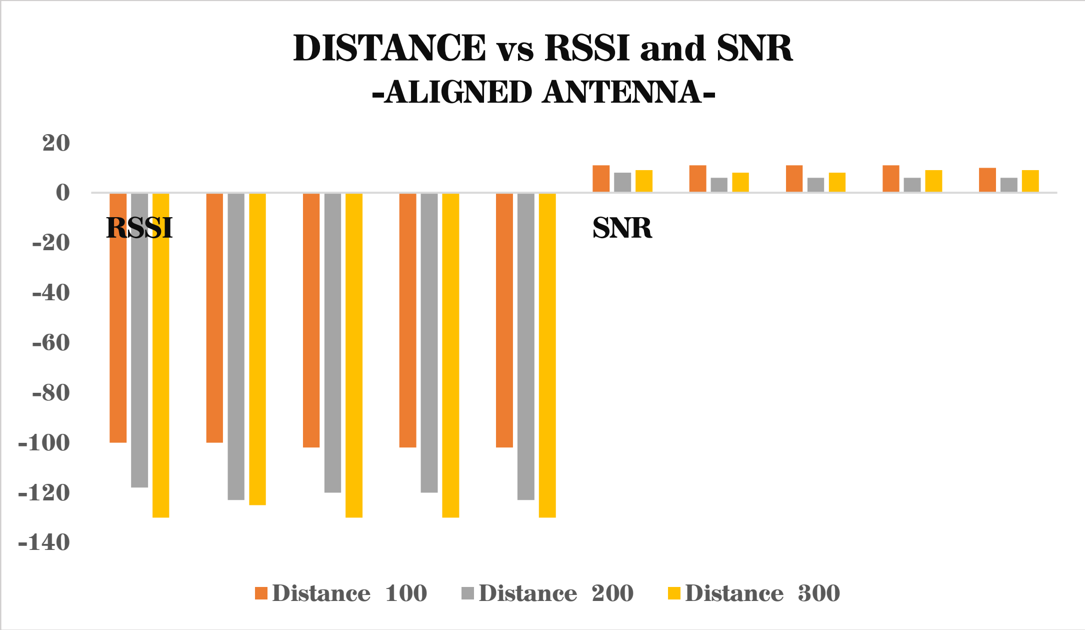


Figure 4.2: Graphic Distance over RSSI and SNR with Aligned Antenna

The results obtained by the RSSI value and SNR value in Table 4.1 are also analyse in ThingSpeak server graphical for 300 meter aligned antenna. Figure 4.3 shows the Graphic Changes of Distance over RSSI and SNR.

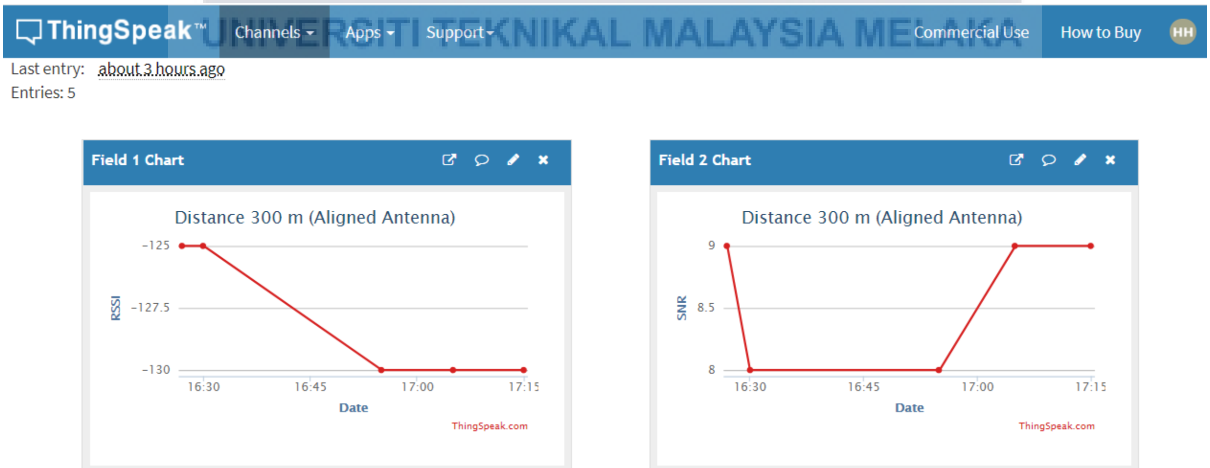


Figure 4.3: ThingSpeak Graphic Result Distance over RSSI and SNR with Aligned Antenna

4.2 Transmitting Packet by Using LoRa Technology with Misaligned Antenna Testing

The second test in LoRa communication was carried out in an open area with many vehicles passing, people around the test equipment, trees, and buildings. Start with Apartment Bukit Beruang Permai to Restoran Asri Rosmerah, which is 120 meters distance as shown in Figure 4.4.

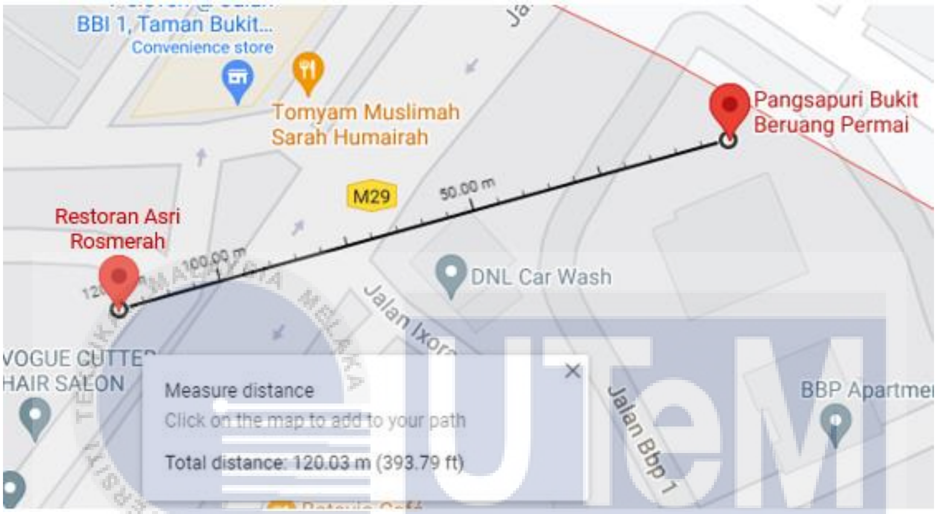


Figure 4.4: LoRa testing at Apartment Bukit Beruang Permai to Restoran Asri Rosmerah

The results of distance over RSSI and SNR testing as shown in Table 4.2 carried out as far as 100 meters. The value in Table 4.2 is the test result with the conditions around the tool in the form of a roadside with busy conditions.

Table 4.2: Result Distance over RSSI and SNR Misaligned Antenna

Distance (m)	RSSI					SNR					Signal Quality
	1	2	3	4	5	1	2	3	4	5	
100	-115	-115	-105	-110	-115	8	8.5	9	9	8.5	STABLE

The results obtained by the RSSI value and SNR value in Table 4.2 are analyse in graphical. Figure 4.5 shows the Graphic Changes of Distance over RSSI and SNR.

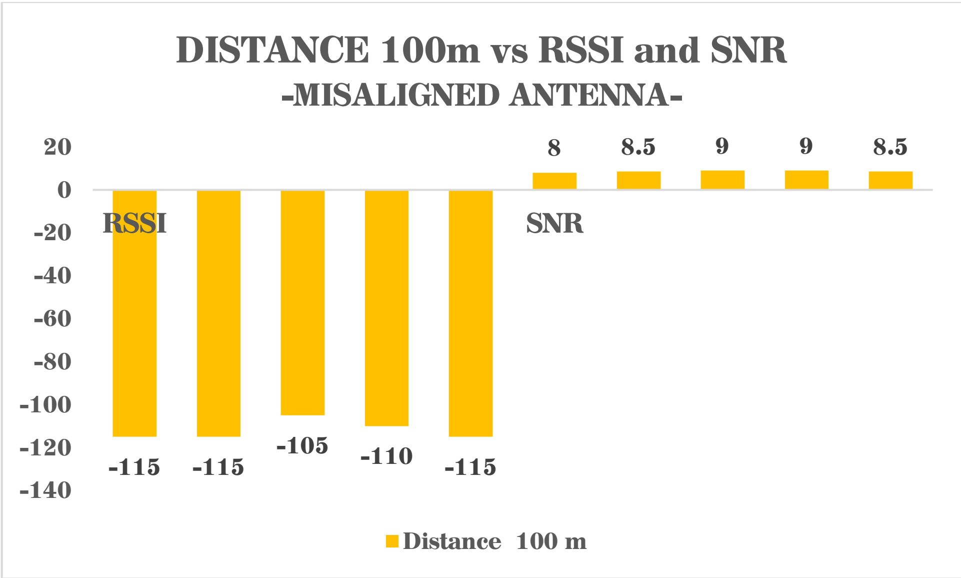


Figure 4.5: Graphic Distance 100m over RSSI and SNR with Misaligned Antenna.

The results obtained by the RSSI value and SNR value in Table 4.2 are also analyse in ThingSpeak server graphical for 100 meter misaligned antenna. Figure 4.6 shows the Graphic Changes of Distance over RSSI and SNR.

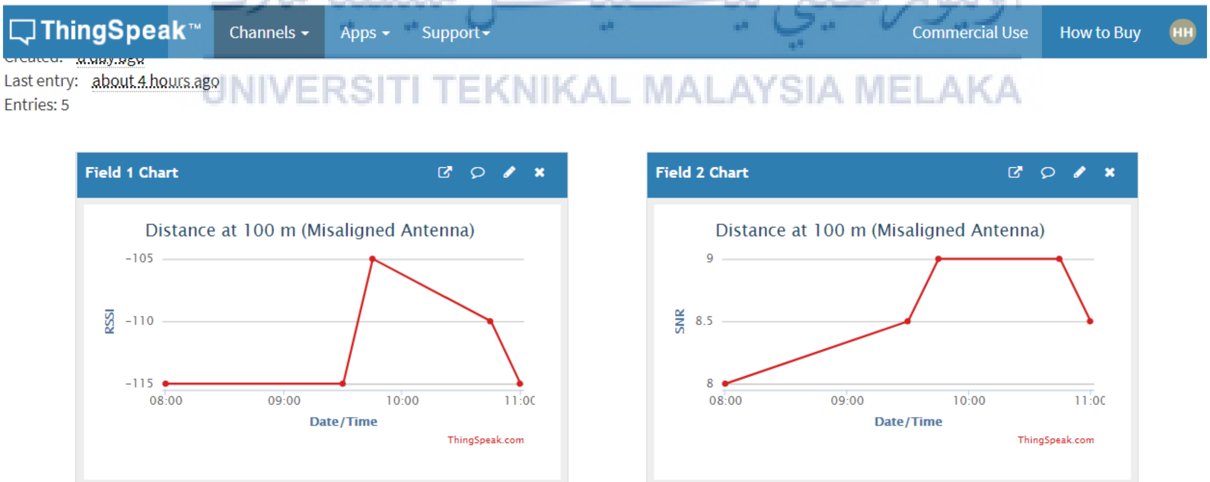


Figure 4.6: ThingSpeak Graphic Result Distance over RSSI and SNR with Misaligned Antenna

The third test in LoRa communication was carried out between Apartment Bukit Beruang Permai to 99 Speedmart Bukit Beruang, which is 225meters distance as shown in Figure 4.7.

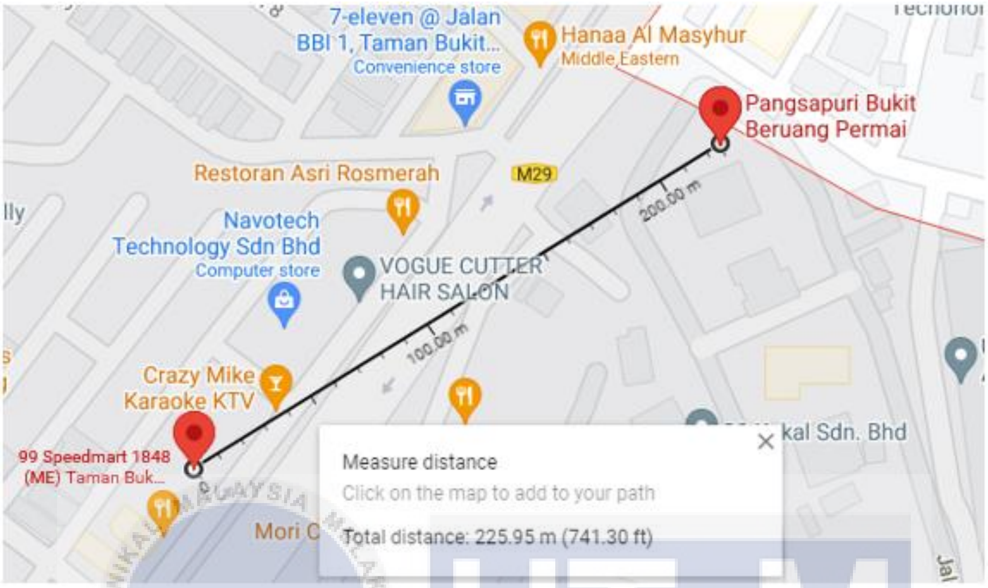


Figure 4.7: LoRa testing at Apartment Bukit Beruang Permai to 99 Speedmart Bukit Beruang

The results of distance over RSSI and SNR testing as shown in Table 4.3 carried out as far as 200 meters. The value in Table 4.3 is the test result with the conditions around the tool in the form of a roadside with busy conditions.

Table 4.3: Result Distance over RSSI and SNR Misaligned Antenna

Distance (m)	RSSI					SNR					Signal Quality
	1	2	3	4	5	1	2	3	4	5	
200	-120	-122	-128	-125	-118	8	8	8	7.5	8	STABLE

The results obtained by the RSSI value and SNR value in Table 4.3 are analyse in graphical. Figure 4.8 shows the Graphic Changes of Distance over RSSI and SNR.

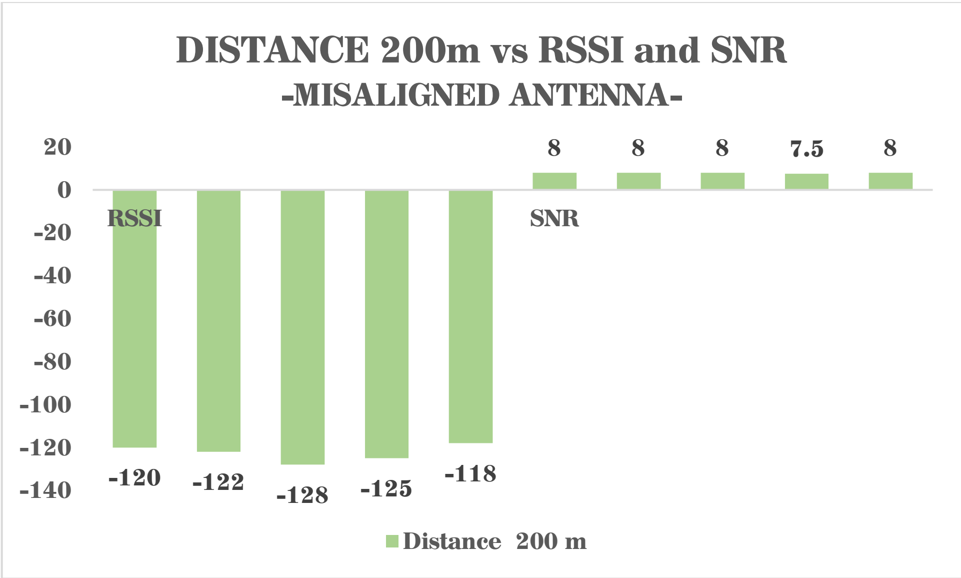


Figure 4.8: Graphic Distance 200m over RSSI and SNR with Misaligned Antenna.

The results obtained by the RSSI value and SNR value in Table 4.3 are also analyse in ThingSpeak server graphical for 200 meter misaligned antenna. Figure 4.9 shows the Graphic Changes of Distance over RSSI and SNR.

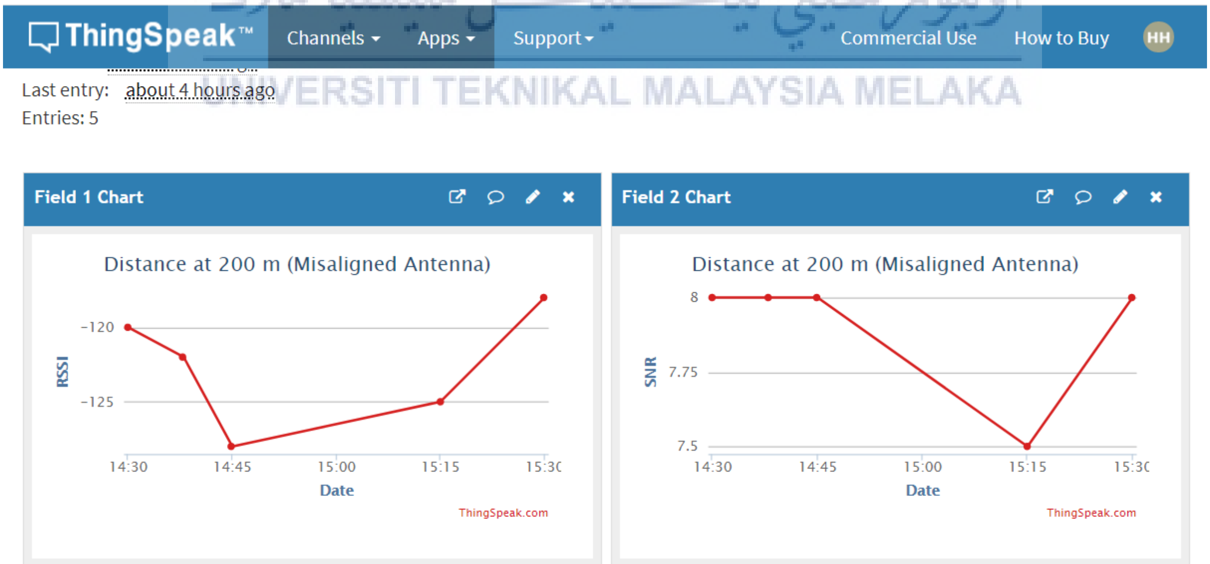


Figure 4.9: ThingSpeak Graphic Result Distance over RSSI and SNR with Misaligned Antenna

The last test in LoRa communication was carried out between Apartment Bukit Beruang Permai to Restoran 7 Terbalik, which is 313 meters distance as shown in Figure 4.10.

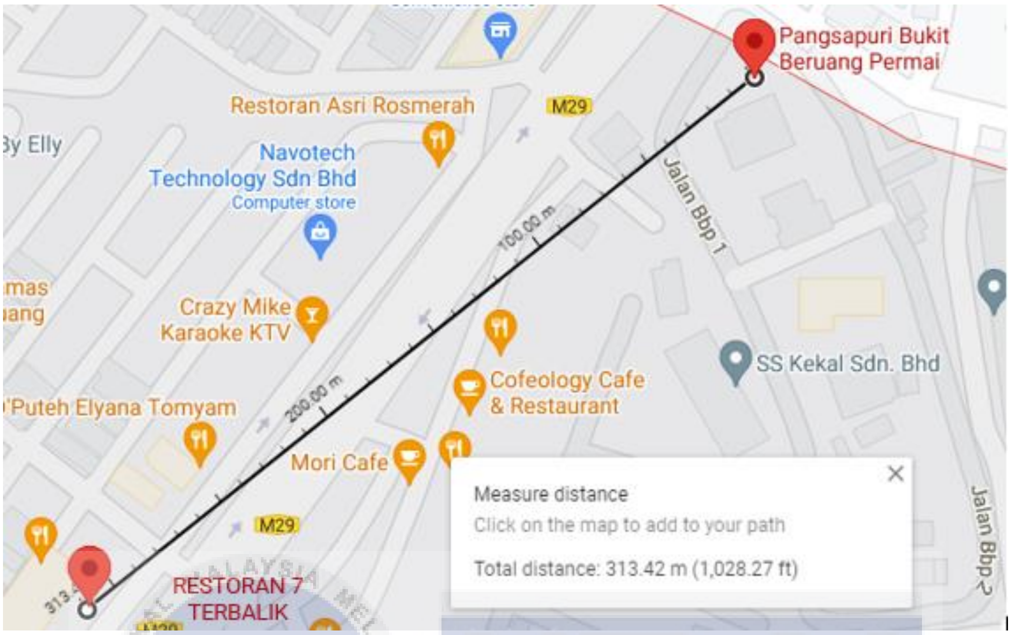


Figure 4.10: LoRa testing at Apartment Bukit Beruang Permai to Restoran 7 Terbalik

The results of distance over RSSI and SNR testing as shown in Table 4.4 carried out as far as 300 meters. The value in Table 4.4 is the test result with the conditions around the tool in the form of a roadside with busy conditions.

Table 4.4: Result Distance over RSSI and SNR Misaligned Antenna

Distance (m)	RSSI					SNR					Signal Quality
	1	2	3	4	5	1	2	3	4	5	
300	-130	-125	-125	-125	-130	8	8	8	7	7	STABLE

The results obtained by the RSSI value and SNR value in Table 4.4 are analyse in graphical. Figure 4.11 shows the Graphic Changes of Distance over RSSI and SNR.

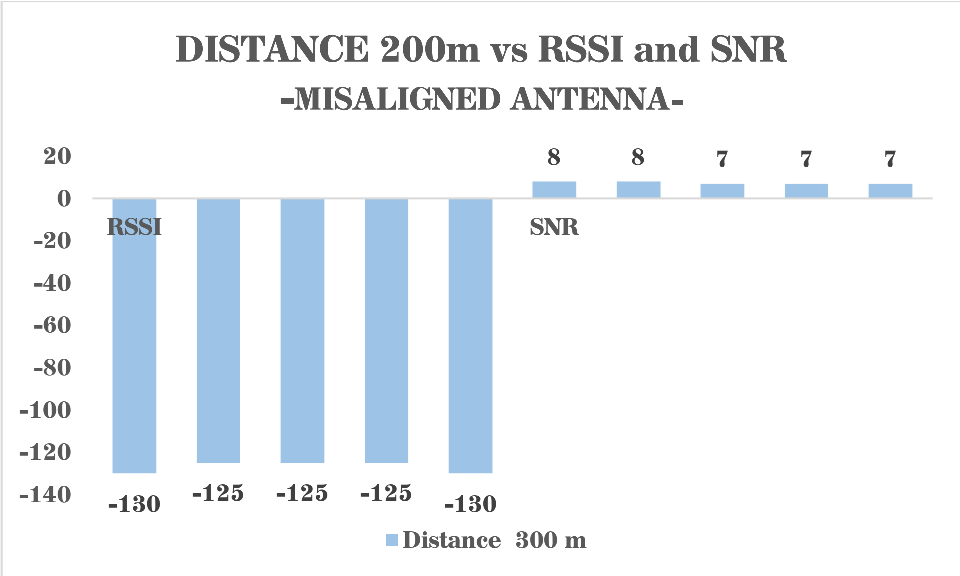


Figure 4.11: Graphic Distance 300m over RSSI and SNR with Misaligned Antenna.

The results obtained by the RSSI value and SNR value in Table 4.4 are also analyse in ThingSpeak server graphical for 300 meter misaligned antenna. Figure 4.12 shows the Graphic Changes of Distance over RSSI and SNR.

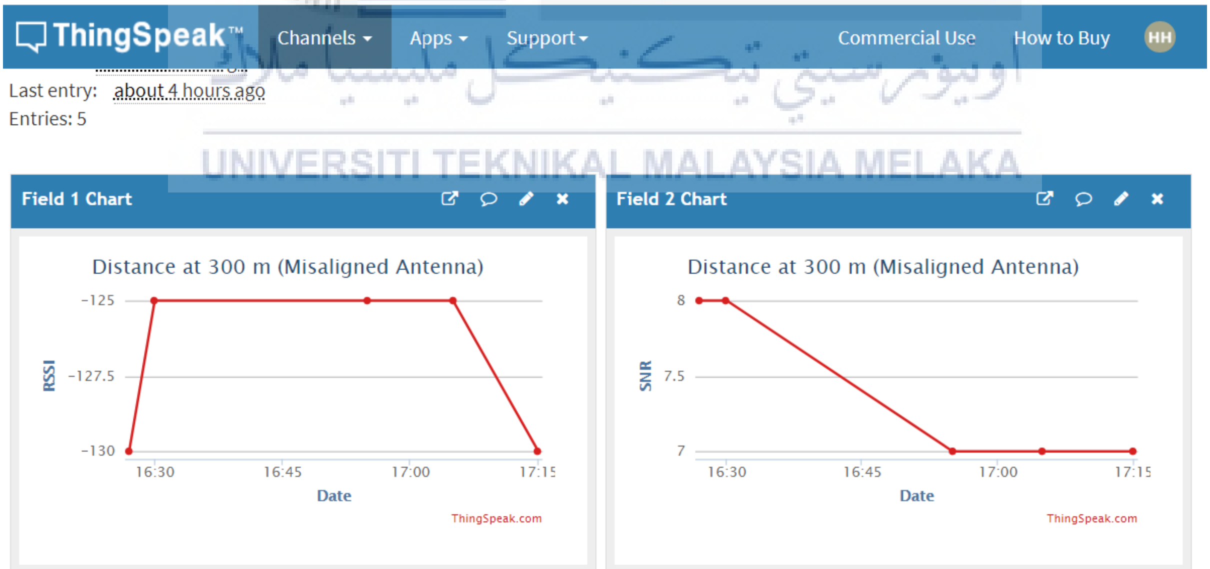


Figure 4.12: ThingSpeak Graphic Result Distance over RSSI and SNR with Misaligned Antenna

4.3 Analysis Discussion

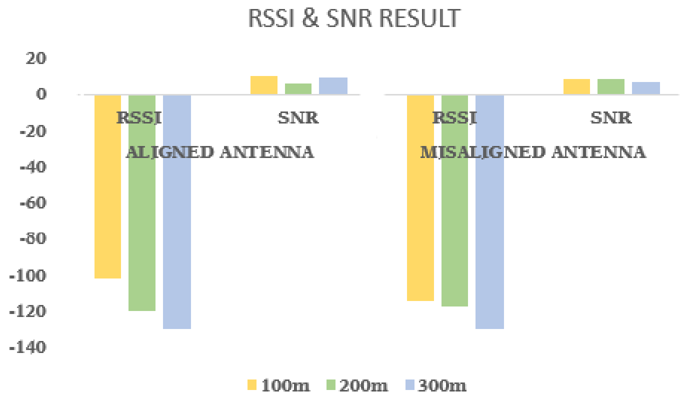


Figure 4.13: Aligned Antenna and Misaligned Antenna Result

Figure 4.13 shows the results obtained by the RSSI value and SNR value in aligned antenna is better than result obtained by misaligned antenna which has more barriers to communication. In aligned antenna testing which test in free space and no obstruction of signal, the results shown that the value of RSSI and SNR is decrease when the distance is increase. This means that the more far the distance between transmitter node and the receiver node, the less the signal strength to communicate between transmitter node and receiver node. However, this LoRa Technology still can communicate even the distance between transmitter and receiver node is more than 2000 meter. This phenomenon is also observable in article [39] where they show that with a clear view and a gateway located 24m above the sea level it was possible to reach distances of about 30km while maintaining a PRR of approximately 67%.

The misaligned antenna testing was conducted in UTeM area which more building and vehicle environment. The results shown that the pattern value of RSSI and SNR is quite similar with aligned antenna will decrease when the distance is increase, but the value of misaligned antenna is more a bit than the value of aligned antenna. This means that in a busy environment there is a heavy dependency on the placement of both transmitter node and receiver node. Even though there is a heavy dependency on the placement, LoRa Technology still can communicate in busy environment in good result with lowest percentage loss packet.

CHAPTER 5

CONCLUSION AND FUTURE WORK

This chapter concludes all the findings that successfully or unsuccessfully achieved throughout this Final Year Project with the justification of the objectives and finding. This chapter also discusses the suggestion for future work.

5.1 Conclusion

As a conclusion, the objective of this project is to design and develop a Wireless Traffic Light for Pedestrian Crossing to establish communication between sensor nodes and gateways that can transmit data over a WiFi network. For the first objective, this project achieved by Transmitting Packet by Using LoRa Technology with Aligned Antenna Testing and Transmitting Packet by Using LoRa Technology with Misaligned Antenna Testing. This testing shows the good result for LoRa Technology in Wireless Traffic Light for Pedestrian Crossing. The communication between sensor node (transmitter) and gateway (receiver) is doing well in project testing. The second objective is to determine how performance of a LoRa network (range, signal quality and packet loss) is affected by placement in Wireless Traffic Light for Pedestrian Crossing. For this objective Wireless Traffic Light for Pedestrian Crossing achieved by observed the result obtained from the aligned antenna testing and misaligned antenna testing.

By doing this project, I can apply the knowledge that I get from the University of Technical Malaysia Melaka (UTeM) in a good manner. The project was successful because I carried out all the tests when finishing the project. Some more I have followed all the procedures given correctly. I hope that this project will give many advantages to the government and underground mining works. The objectives are achieved.

5.2 Recommendation of Future Work

Wireless Traffic Light for Pedestrian Crossing can be improved in the future for a better outcome. Considering the current situation of Malaysia that is being hit by the COVID-19 Outbreak, I suggest adding more sensor to reduce touch and human interference. Ultrasonic sensor can be added to detect people over a wide range of distances with a high read rate and excellent reading to reading stability. So that all pedestrian no need to press the button to cross the road. Besides, artificial intelligence (AI) technology can be used to track the Pedestrian Traffic Light. This can help to identify the Traffic Light problem in the road. As the engineer can track the problem (damage or accident hit by vehicle) faster and efficiently. A notification alarm to the company server system is another suggestion to improve this project. The notification alarm via mobile phone or computer will help the company who responsible for the traffic light to get know about any accidents and problem immediately. This also can avoid any unnoticed incidents.

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