Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF VEHICLE ACCIDENT ALERT USING VISIBLE LIGHT COMMUNICATION

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Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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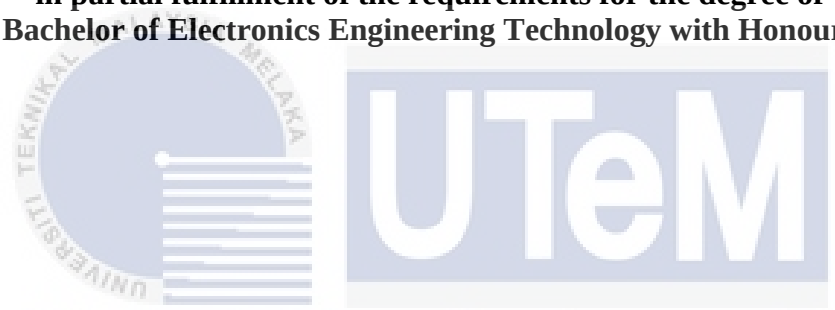
DEVELOPMENT OF VEHICLE ACCIDENT ALERT USING VISIBLE LIGHT COMMUNICATION

SITI NUR AFIQAH BINTI AHMAD RIZAL

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

DECLARATION

I declare that this project report entitled “Development Of Vehicle Accident Alert Using Visible Light Communication” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

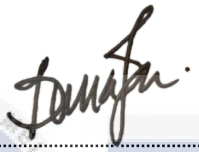
Signature : 

Student Name : SITI NUR AFIQAH BINTI AHMAD RIZAL

Date : 10 JANUARY 2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours.

Signature : 

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Date : 10 JANUARY 2022

DEDICATION

I am indebted to ALLAH SWT for his mercy. I am Siti Nur Afiqah Binti Ahmad Rizal student of UTeM Malacca successfully completed the final year project report. For my family especially my loving mother, Mrs. Suriana Binti Sulaiman. To my father, Ahmad Rizal Bin Abdul Rashid, and my dearest brother, Ahmad Muhaimin Bin Ahmad Rizal, who have all provided me with great support, encouragement, and counsel in order for me to complete this project. And don't forget about all of my dearest fellow buddies that cheer me up when I'm stuck on a project. Thank you a lot.

ABSTRACT

The ability to own a vehicle increases the rate of usage on the road. Many accidents occur especially on highways due to the distance of vehicles that are too close to each other. If the driver in front of the car slows down or applies the brakes, the following vehicle driver finds it difficult to manage his car, resulting in a collision. In order to reduce road accidents in Malaysia, a car accident alert system is vital as a warning to the driver before the crash. This system is also important to flatten the curve rate of fatalities on road accidents in Malaysia. This project aims to design vehicle accident alert by using Visible Light Communication (VLC). As Malaysia is geographically located on the equatorial line and is receiving plenty of sunshine over the years, the VLC Technology is suitable for this system. So, the proposed project is hoped to save the development cost. The project is divided into four main parts comprises input (distance), microcontroller (Arduino Uno), Li-Fi transmitter and Li-Fi receiver part and output. The microcontroller acts like a brain that reads the input or signal from the Ultrasonic sensor. Then, the Li-Fi transmitter and Li-Fi receiver will make a data transfer by using light. Lastly, the microcontroller will operate to activate the buzzer as an alarm alert in this project.

ABSTRAK

Kemampuan pemilikan kenderaan meningkatkan kadar penggunaan di jalan raya. Banyak kemalangan berlaku terutama di lebuh raya disebabkan penjarakan kenderaan yang terlalu rapat di antara satu lain. Apabila pemandu di hadapan memperlahankan kenderaan atau menekan brek, ini mengakibatkan pemandu kenderaan berikutnya sukar untuk mengawal keretanya, lalu mengakibatkan perlanggaran. Bagi mengurangkan kemalangan jalan raya di Malaysia, sistem amaran kemalangan kereta adalah penting sebagai amaran kepada pemandu sebelum kemalangan. Sistem ini juga penting untuk melengkung lekukan kadar kematian akibat kemalangan jalan raya di Malaysia. Projek ini bertujuan untuk merekabentuk amaran kemalangan kenderaan dengan menggunakan Komunikasi Cahaya Terlihat (VLC). Memandangkan Malaysia secara geografi terletak di garisan khatulistiwa dan menerima banyak cahaya matahari setiap tahun, Teknologi VLC sesuai untuk sistem ini. Maka, projek yang dicadangkan ini diharap dapat menjimatkan kos pembangunan. Projek ini dibahagikan kepada empat bahagian utama merangkumi input (jarak), mikropengawal (Arduino Uno), pemancar Li-Fi dan bahagian dan output penerima Li-Fi. Mikropengawal bertindak seperti otak yang membaca input atau isyarat daripada penderia Ultrasonik. Kemudian, pemancar Li-Fi dan penerima Li-Fi akan membuat pemindahan data dengan menggunakan cahaya. Akhir sekali, mikropengawal akan beroperasi untuk mengaktifkan penggera amaran dalam projek ini.

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ACKNOWLEDGEMENTS

I like to thanks my supervisor, Dr Suraya Binti Zainuddin, lecturer at the University of Technical Malaysia in Malacca's from the Electronic and Computer Engineering Technology Department, and my Co-Supervisor Ts Dr Zaiton Binti Abdul Mutalip from Electronic and Computer Engineering for their guidance and physical and mental support throughout my project work. During my Final Year Project, these two important people have been a source of motivation for me as long as my project has been in progress. They also prepared to give me some of their valuable time each week to check on my progress and offer advice when I'm stuck on how to finish the project. I am grateful and fortunate to have had the opportunity to work and learn under their direction and supervision for the project's duration.

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LIST OF ABBREVIATIONS

VLC	-	Visible Light Communication
AC	-	Alternating Current
DC	-	Direct Current
Li-Fi	-	Light Fidelity
LED	-	Light-Emitting Diode
LCD	-	Liquid Crystal Display
LDR	-	Light-Dependent Resistor
WHO	-	World Health Organization
Wi-Fi	-	Wireless Fidelity
WPT	-	Wireless Power Transfer
V2V	-	Vehicle to Vehicle
V	-	Voltage

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CHAPTER 1

INTRODUCTION

1.1 Background

During the past two decades, Malaysia has been one of the countries that extensively developed facilities and infrastructure, such as highway expansion, especially in the major metropolitan areas. However, the high traffic demand in certain areas resulted in an increased possibility cause of road accidents. From the road accident cases, people usually only know the cause and impact of an accident, without actually being aware of the main problem that brings to the road accident.

Based on Bloomberg (2017) reported that statistics from the World Health Organization (WHO) for 2013, Malaysia is among the emerging countries with the riskiest roads after Thailand and the Philippines. From the statistic, Malaysia registered 15 and 11 death rates, respectively. In addition, WHO's data released the average and estimated fatality in Malaysia, as illustrated in Figure 1.1 and Figure 1.2. The figure shows that Malaysia is one of the highest countries with a high fatality rate.

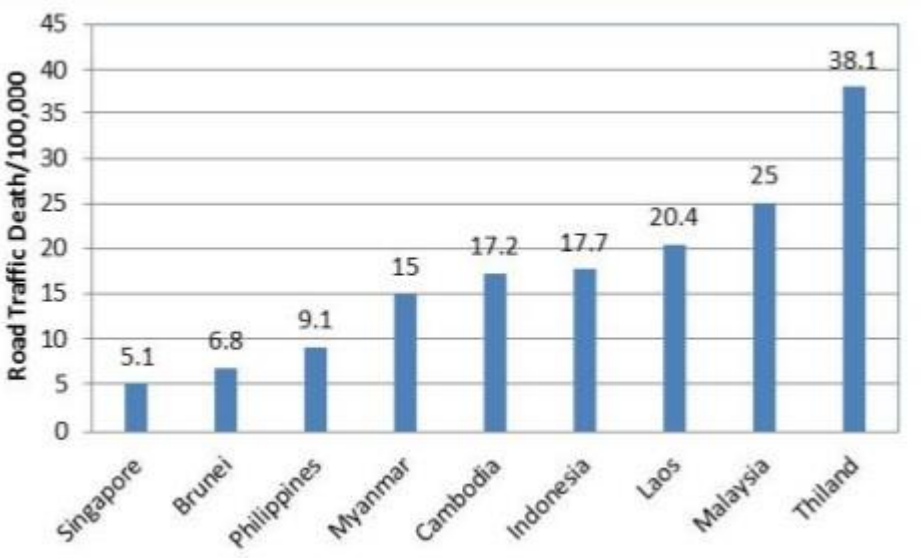

Figure 1. 1 Comparing the fatality rate in Malaysia with others Southeast Asia

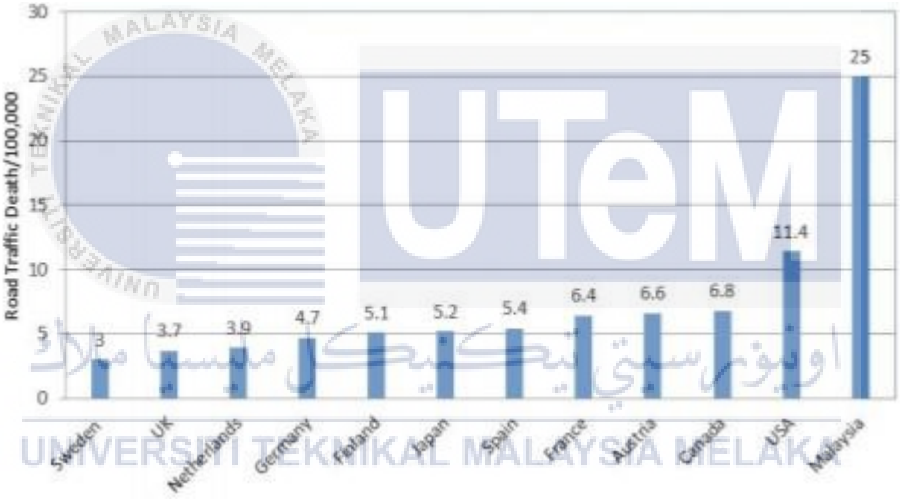

Figure 1. 2 Comparing the fatality in Malaysia to other developed countries

According to the Director General of Road Transport Department of Malaysia, 40% of road accidents in Malaysia are caused by following the front vehicles too closely. Sometimes, when the driver is not alert with the distance between vehicles are close, it can cause an accident. Ministry of Transport Malaysia also stated that the number of accidents in Malaysia has increased during the last ten years. Meanwhile, the number of fatalities has been reduced and achieved the lowest number of cases in 2019 with 6167 cases. Figure 1.3

shows the Malaysia road accident from 2010 to 2019, while Figure 1.4 shows the fatalities caused by road accidents in Malaysia from 2010 to 2019.

Figure 1. 3 Malaysia Road Accident from 2010 to 2019

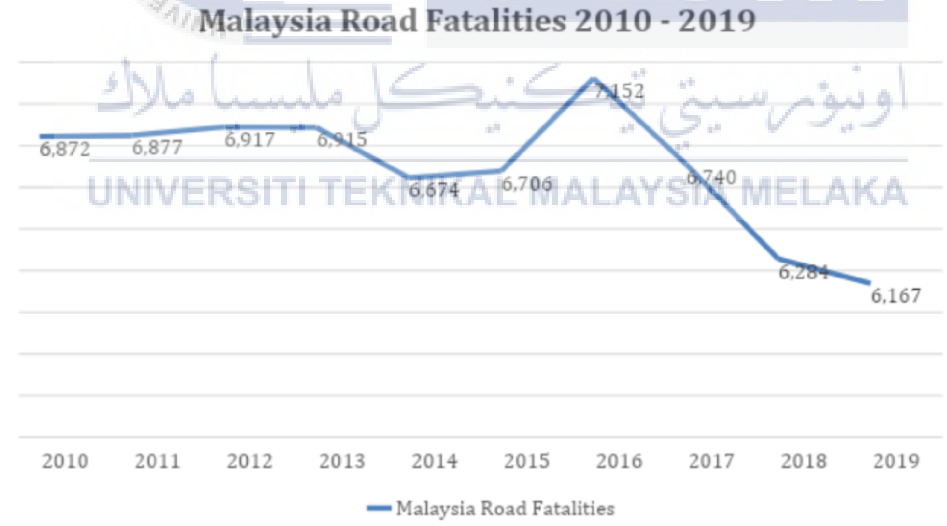

Figure 1. 4 Malaysia Road Fatalities from 2010 to 2019

Because of the cases of accident in Malaysia are increasing by the year, the Development of Vehicle Accident Alert using Visible Light Communication had been proposed to reduce the number of road accident in Malaysia. Visible Light Communication are choosen as a data transmission method for this project. The main parameters of this method is light as a data transmission. The light will used to transmit the data from one point to another point. To be clear, in this project basically light will transmit the data from the transmitter part to the receiver part. To proved that the data are successfully transmitted, the buzzer will produced a sound and the LCD Display is used to displayed the data successfully received as a notification.

1.2 Problem Statement

Most of these road incidents are now blamed on drivers over speeding and improper overtaking. Some locals living along the town and villages on the major highway have taken the law into their own hands to check some of these irritating drivers, due to their hazardous behavior on our roadways. Department of Road Transport established a goal of lowering fatalities by 30% by the end of the year. When comparing Malaysia's figures to those of several industrialized and developing countries, it appears that Malaysia falls somewhere in the middle of the two groups. However, Malaysia's accident mortality rate remains concerning, with a mortality rate per 10,000 vehicles far higher than the rest of the developed world.

Therefore, to reduce the cases of road accidents in Malaysia and the number of fatalities, an ideal car accident alert using Visible Light Communication has been proposed. It ensures a vehicle alert another vehicle before a collision happens. In line with the statistic by the Director General of Road Transport Department in Malaysia, 40% of road accidents

communication for data communication to minimise cost. In addition, visible light communication also doesn't have any radiation exposure, so that this technology is safe to be utilised.

1.3 Project Objective

Based on the problem statement discussed above, the objectives of this project are as follows:

a) To produce a concept design of Visible Light Communication technology for a vehicle accident alert system.
b) To develop the hardware of Visible Light Communication technology for a vehicle accident alert system utilizing a microcontroller.
c) To verify the capability of the developed hardware on sending and receiving data.

1.4 Scope of Project

The scope of this research is established based on the objectives mentioned above. Initially, a literature study was conducted to identify basic functional blocks for a vehicle accident alert system to produce the concept design. Then, upon finalizing the concept, a feasibility study on the hardware components was done.

The design circuit was simulated using Proteus 8 software before hardware development. The Arduino software was also utilised to develop programming code before it was flashed into the microcontroller.

Next, the hardware of a vehicle accident alert system applying the Visible Light Communication technology was built. Finally, the developed system was evaluated and verified on its transmitting and receiving capability.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will go over the literature review basics before delving into the construction of a vehicle accident alert system based on visible light communication. This section also includes the studied items and items important to the study. In order to build this project, it will be necessary to conduct some research linked to the project's proposed idea. The research will concentrate on the technology and software used to build this disaster alert. The mechanical portion that needs to be designed in a functional prototype is included in the hardware part.

2.2 Visible Light Communication

VLC is convinced as one of the important segments for academics and industry. This sector is more appropriate in having wireless communication techniques. A few types of wireless communication technologies have been proposed and also already look into for the ITS data exchange, for example, IEEE 802.11 or Wi-Fi, Bluetooth and also VLC. In terms of communication range, Radio Frequency is one of the most significant solutions for us to perform a Visible Light Communication system for high traffic to increase the number of users without any mutual interferences. Because of the rise of users, it will increase the latencies of the system. Due to this case, using visible light communication technology is an effective solution. This is because visible light communication mainly uses

a light-emitting diode (LED) as the connection to sending data and also can act as a wireless optical medium for the signal to transfer [1]

Other than that, from [2] Li-Fi, also known as Light Fidelity, is a new technology introduced, which refers to a Visible Light Communication (VLC) that uses light as a track to transfer data, especially at high speeds. Since this technology mainly uses light as the main parameter, it provides a wide range of frequencies and wavelengths. This paper also compares wireless communication technologies that have been used nowadays. The comparison is as in Table 2.1

Table 2. 1 Comparison of wireless communication technologies

Feature	**WiFi [5 – 8]**	**LiFi**	**Bluetooth [5]**	**ZigBee [5]**
Mode of Operation	Using radio waves	Using light waves	Using short wavelength UHF radio waves	Using radio waves
Coverage distance	32m	10m	10m, 100m, Based on classes	10 -100m
Frequency of operation	2.4GHz, 4.9GHz and 5GHz	10000 times radio waves	2.4 – 2.485 GHz	2.4GHz
Speed of transmission	150Mbps	1 Gbps	25Mbps	250 kbit/s

This paper also provides the physical layer of Li-Fi. The physical layer is responsible for taking over and handling the transmission part and data reception. There are three layers of the physical layer in the Li-Fi technology, as specified in Table 2.2

Table 2. 2 Physical Layer of Li-Fi

S.No.	Operating Mode	Application	Data rate
1	PHY I layer	Outdoor application	11.67 to 267.6 kbit/s
2	PHY II layer	Indoor application	1.25 to 96 Mbit/s
3	PHY III layer	Colour Shift Keying (CSK)	12 to 96 Mbit/s

The project by paper [3] focused on safety. The project is on the headlight. It consists of LEDs that act as transmitters and photo sensors as receivers. The head and tails light is more effective when using LEDs because it provides a short-range communication with the photodetectors. This application also comes with the least cost but yet is effective. LEDs are chips and have a simple design that can be proposed for a signal to generate and better transmission. Therefore, the simulation of transmitter and receiver by using Proteus 8 Professional is presented in this report. Figure 2.1 presents the transmitter circuit design in Proteus, and Figure 2.2 displays the transmitter output. Meanwhile, Figure 2.3 presents the receiver circuit design in Proteus and Figure 2.4 displays the receiver output.

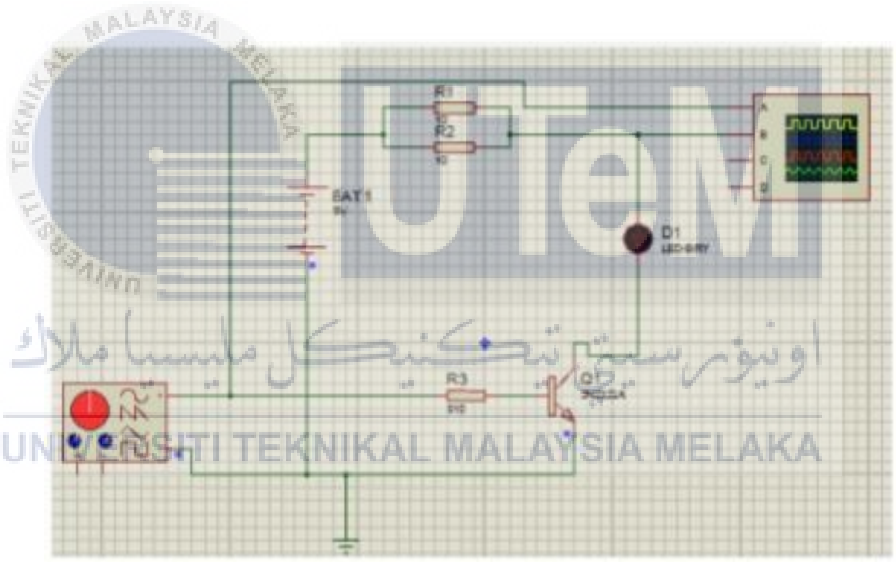

Figure 2. 1 Transmitter Circuit

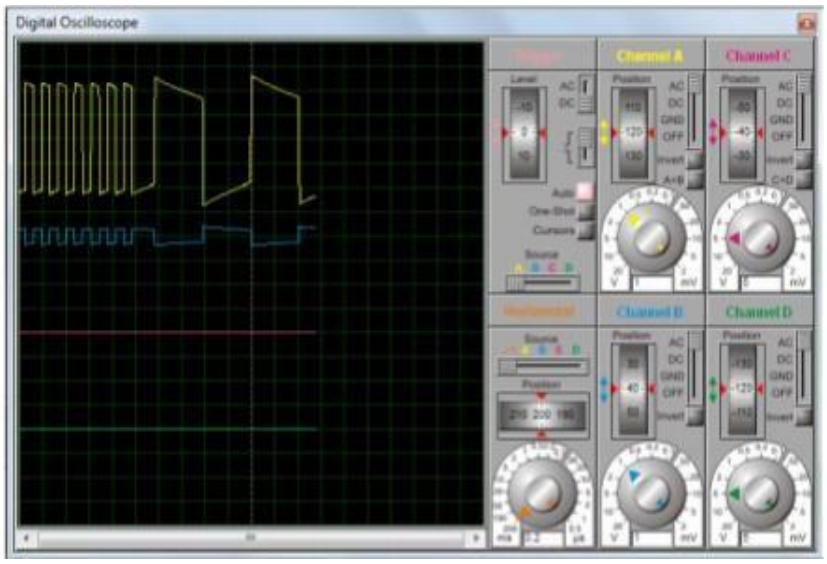

Figure 2. 2 Transmitter Output

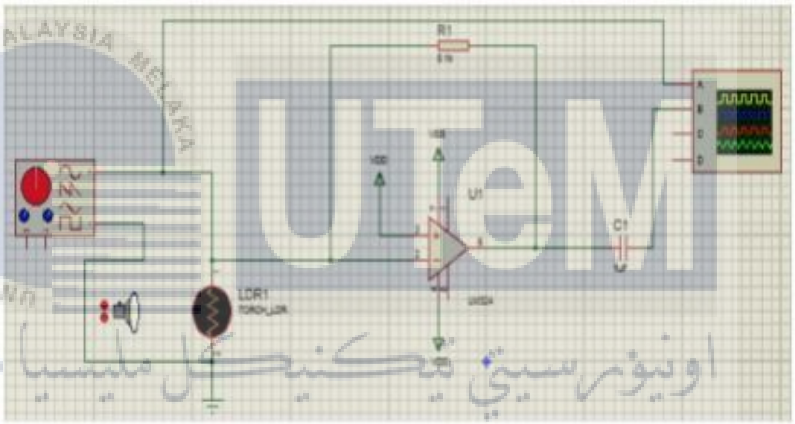

Figure 2. 3 Receiver Circuit

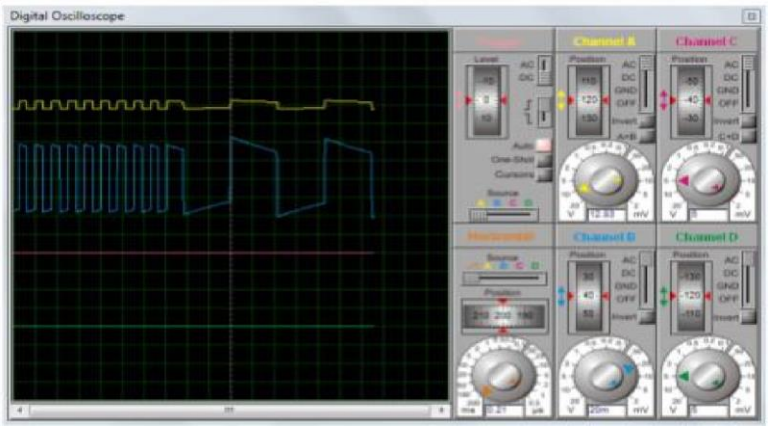

Figure 2. 4 Receiver Output

Wireless communication has become a useful technology in daily life. The basic use of wireless communication is the radio spectrum for data transfer. Nevertheless, everything has its advantages and disadvantages. Matters such as capacity, the efficiency of the radio spectrum itself, availability, and security has been focused on when utilising a radio spectrum. Thus, to overcome these matters, the concept of Li-Fi is delivered. Li-Fi is known as one of the VLC's applications, and this technology is advanced than others. A few surveys about this technology had been done, and the comparison has also been made [4]. Table 2.3 shows comparison on some recent works that utilised the VLC Technology.

Table 2. 3 Comparison between developed that use Visible Light Communication

S.NO	Paper	Technique	Result	Issues
1	Introduction to indoor networking concepts and challenges in LiFi	LiFi, function, mobility support, and multiple access capability	This paper has shown that it is possible to build future cellular systems based on free-spacelight communication.	Could not be used in larger organisations.
2	What Is Li-Fi?	Li-Fi, IOT	This Paper tells us how to setup an efficient Li-Fi communication.	Limited Range
3	A new approach to wireless data transmission using visible light	Light-Fidelity (Li-Fi), Internet of things, Computer-communication networks, Local Area Network (LAN)	This system has 2 versions, 1st version using only arduino and the 2nd version using python on pc interacting with arduino, 1st version is slower than the 2nd version and 1st version's range is smaller than 2nd version , so 2nd version is better than 1st version.	In both the versions the range is Limited so we cannot communicate with the vehicles which are in longer range.

Li-Fi is bidirectional and also has a high speed with the fully networked wireless communication technology similar to Wi-Fi. However, Li-Fi provides more transmission

of data through illumination. It works by sending data through the LEDs light that can differ in potency from human eyes. Light is used daily and has many supplies such as sun, LEDs, and pendaflour lamps. It's not also been used as a provider of light in daily life, but it also can be used for communication through illumination. Radio Frequency communication have to tolerate interference and high latency issues. Moreover, a Radio Frequency communication also needs a separate setup, especially for transmission and receiving the Radio Frequency signal itself. Because of the limitations, Visible Light Communication (VLC) has been an effective choice in the communication techniques benefiting from its high bandwidth and immunity to interference from electromagnetic sources. This paper also discusses the capability of Li-Fi to expedite the transmission of data, and it is more flexible than data transmitted by way of Wi-Fi. The application of a 5G Visible Light Communication system that uses LEDs as a medium is known to have high-speed communication while providing better performance in terms of capacity, efficiency, security and availability compare to Wi-Fi [5]. Table 2.4 tabulates the comaprison between previous rerearched and this project.

Table 2. 4 Comparison between previous researches and this project

Previous Research	**Similarities**	**Differences**
Vehicles to vehicle data transfer and communication using LI-FI Technology	Use Li-Fi transmitter and Li-Fi Receiver Use ultrasonic sensor	Previous project use Arduino MEGA while this project use Arduino UNO
Vehicle to Vehicle Communication using Light Fidelity	Use same parameter such as Ultrasonic sensor and same controller	Previous project use eye blink sensor to alert the driver while for this project, use speedometer to reduce speed of car
Li-Fi for Vehicle to Vehicle Communication	Use same method which is Arduino as a controller for receiver part and transmitter part	In previous project for Li-Fi transmitter and Li-Fi receiver use Li-Fi Transmitter and Li-Fi receiver module, but for this project it will be use coding into Arduino

2.3 Vehicle To Vehicle Communication System

Meanwhile, reference [6] provided the initial design and result of a small-scale prototype of a vehicle-to-vehicle communication system using Li-Fi (Light Fidelity) technology. This research work developed a new technology that needs further study on its sustainability for outdoor vehicular networks. It is realised that vehicle-to-vehicle communication system is the most effective way that can be used to solve accident cases. Consequently, reduce the number of accidents.

Paper [7] discusses a vehicle-to-vehicle communication using a wireless system to provide a warning in the first place before an accident happened. It was an attempt to reduce road accidents. Besides, this paper has proposed using Li-Fi Technology in vehicle-to - vehicle communication systems. The Light Emitting Diode (LED) bulbs can send data through the optical spectrum as a wireless optical medium. The article also have provided block diagram for vehicle-to-vehicle communication, as shown in Figure 2.5

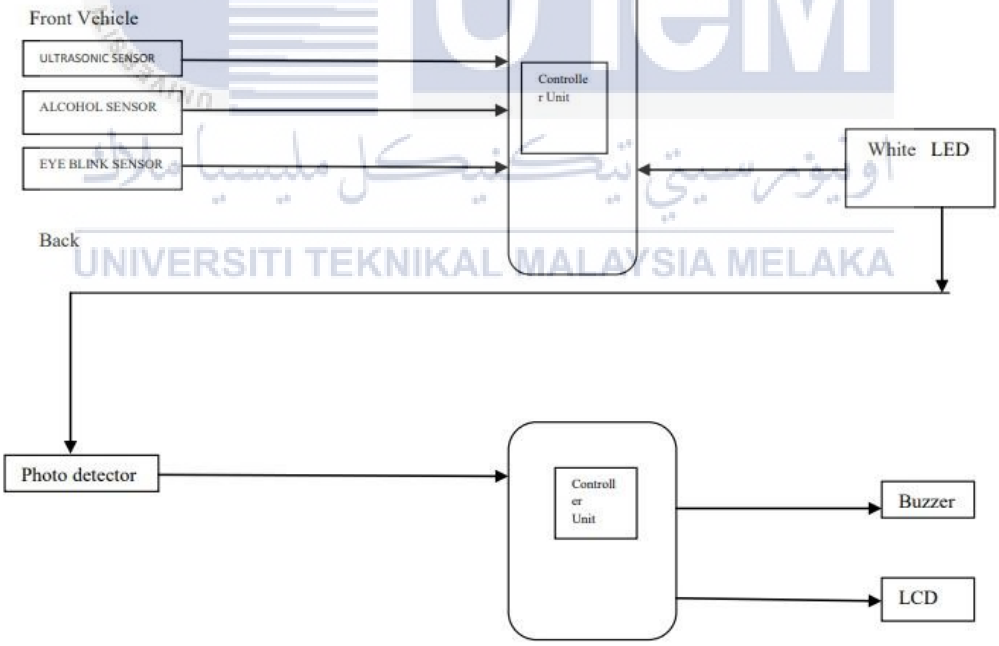

Figure 2. 5 Vehicle-to-Vehicle Block Diagram

The paper illustrates the scenario of vehicle-to-vehicle communication by using VLC technology as Figure 2.6

Figure 2. 6 Scenario of Vehicle to Vehicle Communication Using VLC

Reference [8] analysed optical wireless based on visible light communication applied in vehicle-to-vehicle communication. The LEDs was use as a main component for a full duplex communication. This full duplex communication consists of spatial diversity between head and tail lights. Figure 2.7 show that the diversity requirement in vehicle-to-vehicle communication applications.

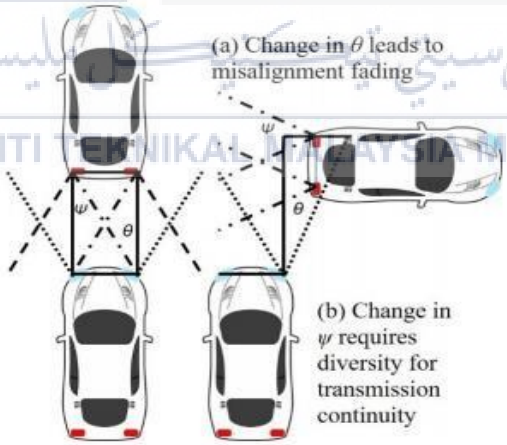

Figure 2. 7 Diversity requirement in V2V applications

2.4 Data Transmission

In paper [9], the author used Inductive Wireless Power Transfer (WPT) as data transmission to increase the application performance. The function is to utilize a charged electric vehicle. The author highlighted that this method consists of two main parts: the primary side and a secondary side. The primary side usually uses a DC-AC inverter to trigger a high-frequency of AC voltage to the transmitter coil. Meanwhile, the secondary part uses AC-DC rectifier as a function to receive power regulating to charge the vehicle battery. The data transmission from this method can be used for particular tasks such as load detection, battery status monitoring and others.

Next, the project from paper [10] is about developing Unmanned Underwater Vehicles (UVVs). However, this project was improvised and named Unmanned Surface Vehicles (USVs). This project is regarding the underwater vehicle that uses radio frequency as the data transmission with the frequency range from 915MHz-928MHz. USVs are vehicles suitable for use in water areas to do specific tasks like collecting hydrological information. Moreover, the vehicle characteristics enable it to reach certain water areas that mother ships cannot reach, such as harbour basins areas and coastal beaches. Figure 2.8 shows the structure block diagram of the wireless data transmission.

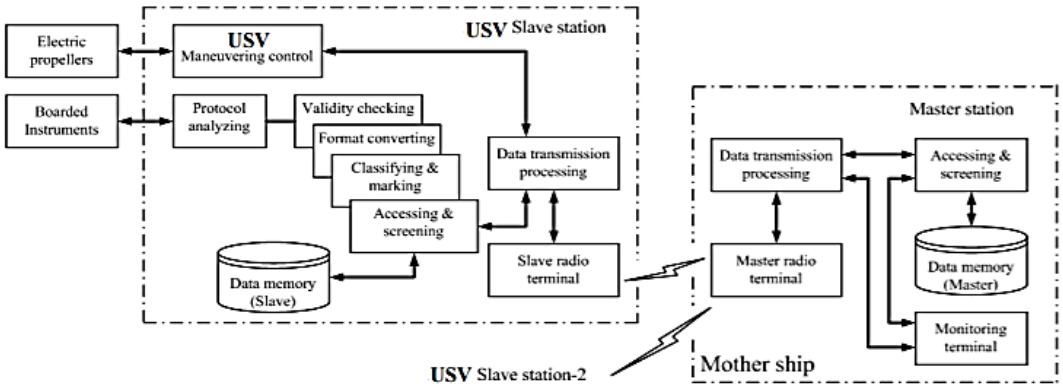

Figure 2. 8 Structure Block Diagram of the wireless data transmission

Lastly, for the project from the article [11] as the demand for autonomous technology, this paper aims to establish a link speed switching method by using auto-negotiation to fulfil the demand. This method can also prevent data loss when switching the link speed. Asymmetric data transfer is the method of data transmission used in switching link speed to examine the switching system. This data transmission method work depending on the speed of the switches. Figure 2.9 presents an example of asymmetric data transfer in In-Vehicle network.

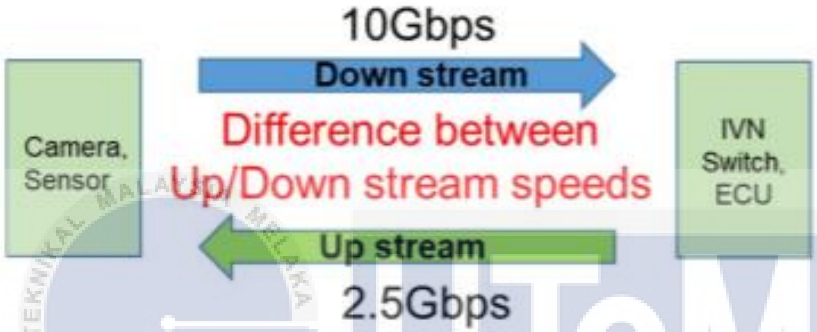

Figure 2. 9 Example of asymmetric data transfer in In-vehicle network

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses in detail the description and justification of the component employed, theoretical approaches to the project, project design, and method employed. As a result, the flowchart explaining the development drawn in order to provide a better and clearer explanation. The material used in the project and procedural information on how the circuit connection was made will be discussed.

3.2 Project Workflow

An operational workflow is needed to ensure that the project can be run smoothly without any issues and hiccups. As shown in the figure below, it started with good planning, followed by focused research on related topics. Many methods and resources have been studied to gain information for design reference and understand the project. Figure 3.1 decipts the overall project workflow.

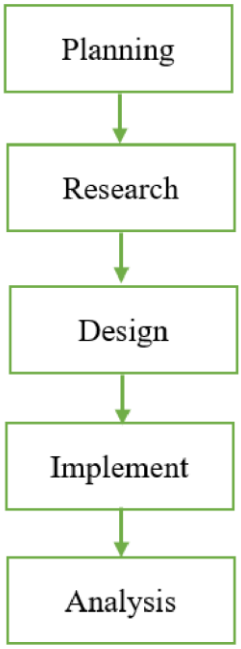

Figure 3. 1 Overall Project Flowchart

3.2.1 Planning

This project aims to design an Accident Car Alert using Visible Light Communication. A few tasks are developed along the road to fulfilling the goal. Gantt Charts was used to generate a timeline as a guideline for completing tasks according to the period given. And flowchart also importance as a guide for the project process. Figure 3.2 illustrates the project flowchart.

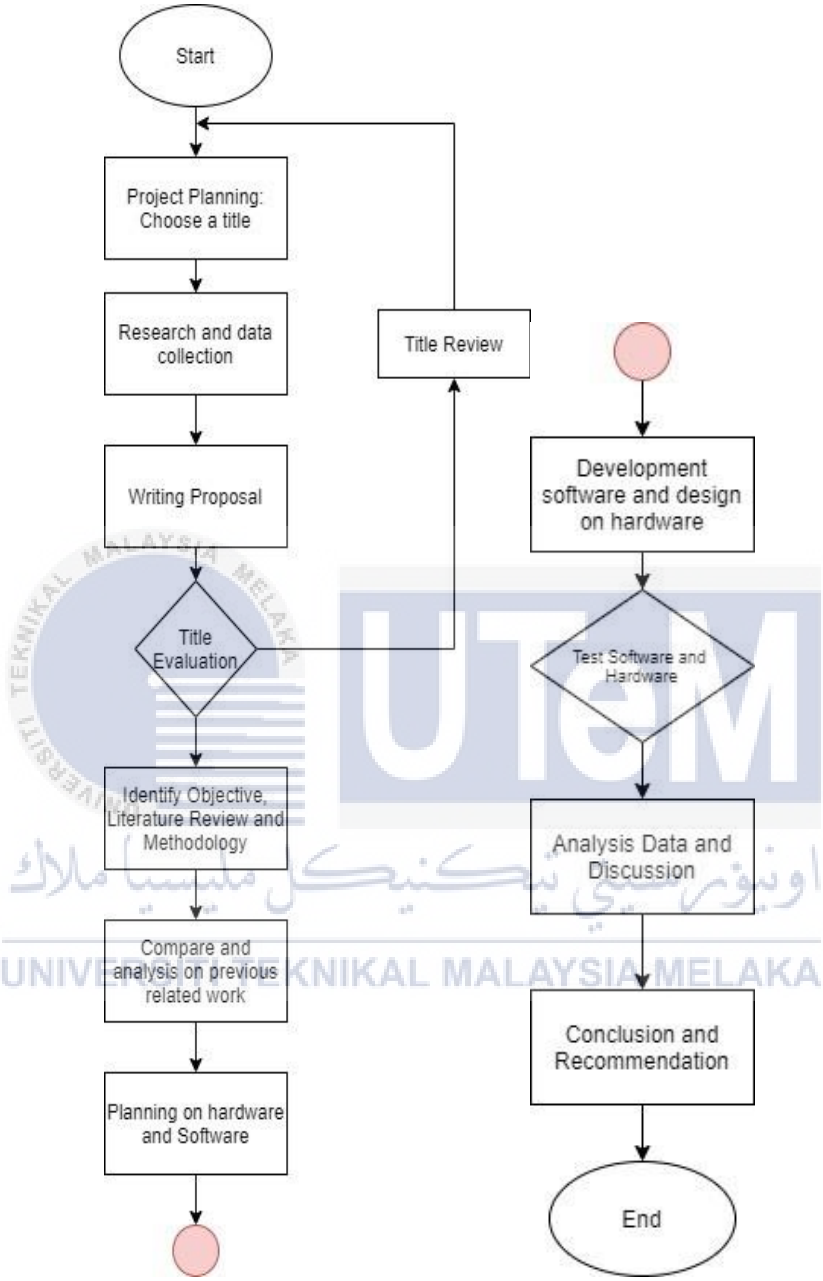

Figure 3. 2 The project flowchart

3.2.2 Research

The first stage of the study focused on identifying the external and internal factors contributing to the accident issues. From studies, it was observed that many factors contribute to a road accident. In addition, various car accident alert systems also have been used before. Previously developed systems and this proposed alert system using visible light communication were compared to find the most suitable solution for an operation. The primary technique for collecting data is to read through other research journals and engineering references books related to this project to retrieve useful information.

Furthermore, research via online sources through the website was conducted for more detail understanding about the concept and design of the car accident alert using visible light communication. The features of the Li-Fi transmitter, Li-Fi receiver and Arduino UNO are analyzed. In addition, the pros and cons of the microcontroller also been explored over Arduino Uno, Raspberry Pi and Arduino Nano. Finally, Arduino UNO was suggested as the most suitable microcontroller to be used in this project.

3.2.3 Designing

In this project, the Arduino UNO is selected for the controller in order to operate the Li-Fi transmitter and Li-Fi receiver to transmit and receive the data. Finally, the buzzer will produce an alarm to notify when the distance is very near and less than the allowable range. The distance that had been configured this project is 10 cm for the testing.

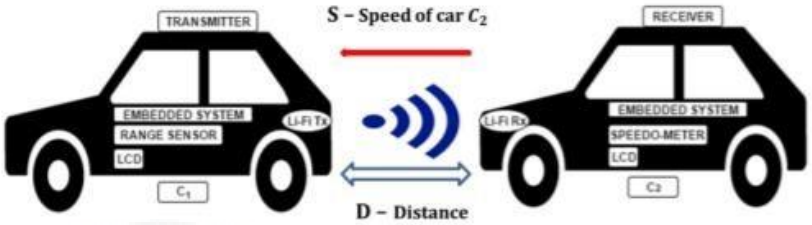

Figure 3. 3 Vehicle Accident Alert using Visible Light Communication Design

3.2.4 Implementation

The Arduino Uno board is utilized for computational and data processing purposes. The board collects real-time data from sensors and processes it in accordance with system requirements, serving as the proposed system's central processing unit or backbone. The proposed system is divided into two parts the which is transmitter and the receiver part. The former is concerned with electronics on the transmitter side, whereas the latter is concerned with circuitry on the reception side. Figure 3.4 presents the developed project system flow.

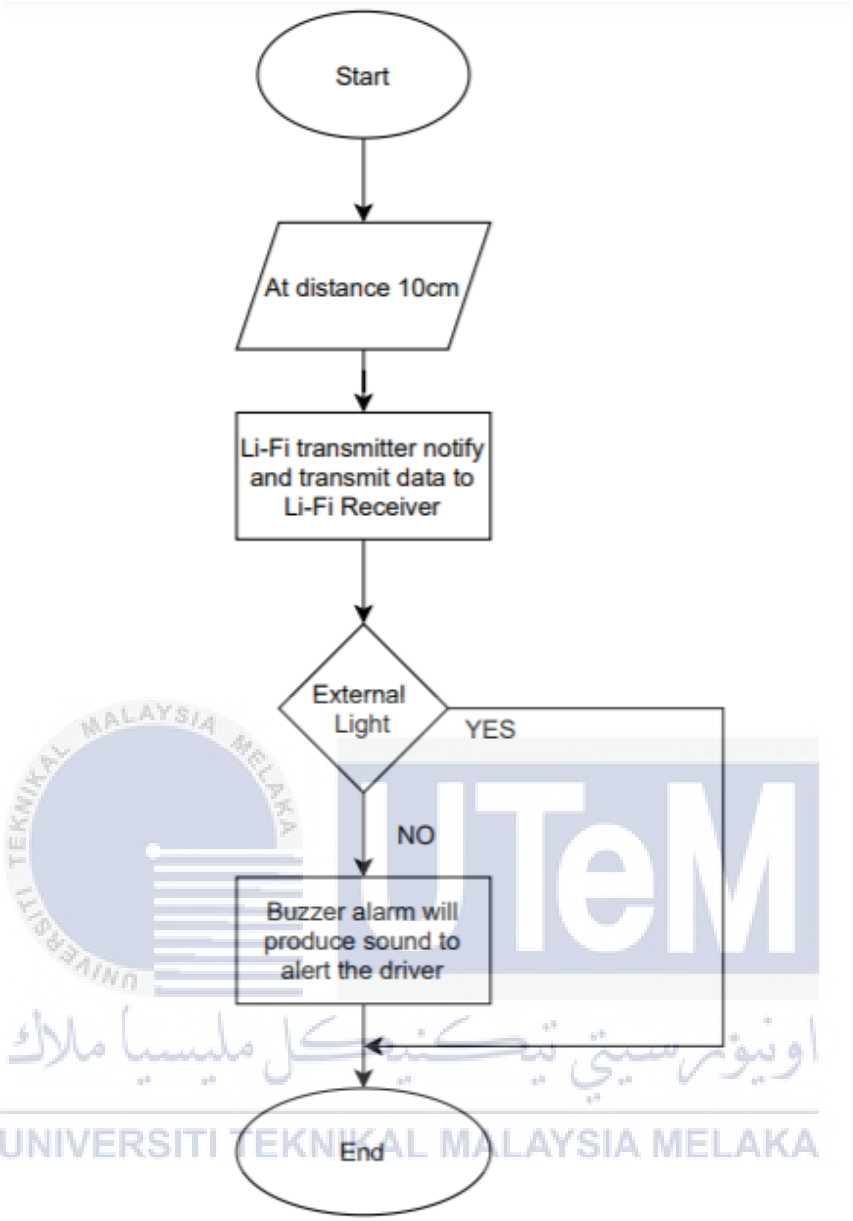

Figure 3. 4 The Developed Project System Flow

3.2.5 Analysis

Once the integration and programming completed, the hardware will be tested to ensure it is working and performance will be analyzed. At this level, fine tuning of the programming code is done to ensure the system works accordingly.

3.3 Equipment and Components

Equipment and components have been selected for development of the vehicle alert system. The following are the parts have been used.

Table 3. 1 Parts used in the development of the system.

NAME OF COMPONENT	PART NUMBER	QUANTITY
White LED 	SLX-LX5093 UWC/C	3
Arduino Uno 	A000066	2
Buzzer 	AI-1440-TWT-12V-R	1
LDR Sensor 	N5AC501085	1

LCD Display 	DFR0063	1
Membrane 1x4 Keypad 	AF1332	1

3.4 Design Block Diagram

The project comprised two parts which were transmitter and receiver. Figure 3.9 presents the block diagram of the transmitter, while Figure 3.10 presents the block diagram of the receiver.

The transmitter part was developed using Arduino Uno, Li-Fi transmitter in the coding that uploaded into the Arduino for the LED part. The button is use in this project is to start the LED to give a signal to the receiver part.

The receiver part consists of Arduino Uno, Li-Fi receiver, LDR sensor, Buzzer and LCD Display. In this part, Li-Fi receiver also been used in the coding and uploaded to the microcontroller, Arduino Uno. When the LDR sensor detect the light from the LED at the transmitter part, the Li-Fi Receiver will trigger the alarm alert which is Buzzer and the

buzzer will produce a sound to alert the driver. While, LCD Display will display “Data Received” if the signal is received.

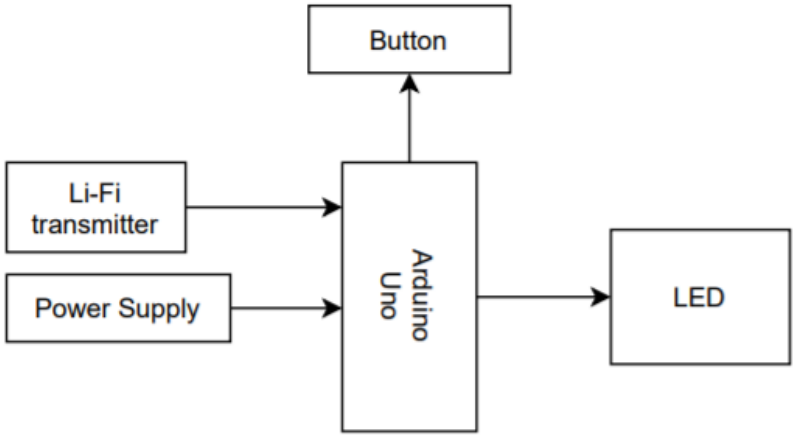

Figure 3. 5 Block diagram of the transmitter

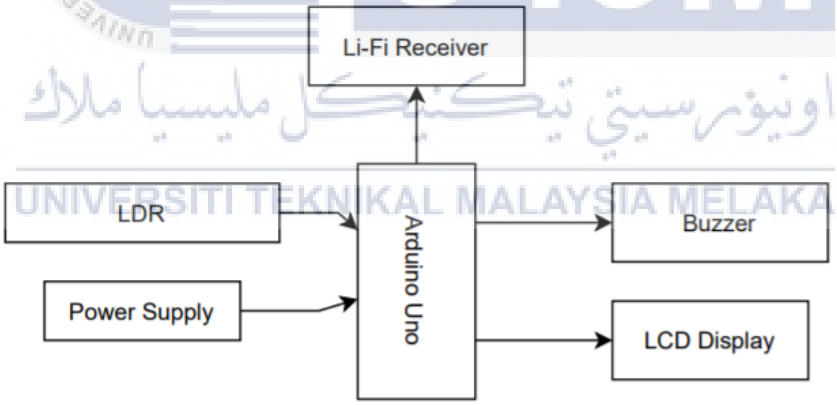

Figure 3. 6 Block diagram of the receiver

3.5 Circuit Design using Proteus

In this project, Arduino Uno was used as a microcontroller. The coding uploaded in the microcontroller consists of a declaration of the Li-Fi parameters to utilise Visible Light Communication technology as data transmission. LED was used to supply the signal from the transmitter to the receiver part. The button's function is to start the LED to transmit the signal to the receiver part. Figure 3.7 shows the schematic diagram of the transmitter part for this project.

The LDR sensor is one of the known infrared sensors used to detect light. As this project used light as data transmission, the transmitter and receiver parts have to use light as the main parameter.

The crucial part of this project is to make sure that there is a response between transmitter and receiver parts. Similar to the transmitter part, the receiver also uses the Li-Fi receiver declared in the coding into the microcontroller. When the Li-Fi receiver receives the LDR sensor signal, there will be light detected. The Li-Fi receiver will configure and trigger the buzzer to alert the driver. Figure 3.8 is a receiver schematic diagram of this project.

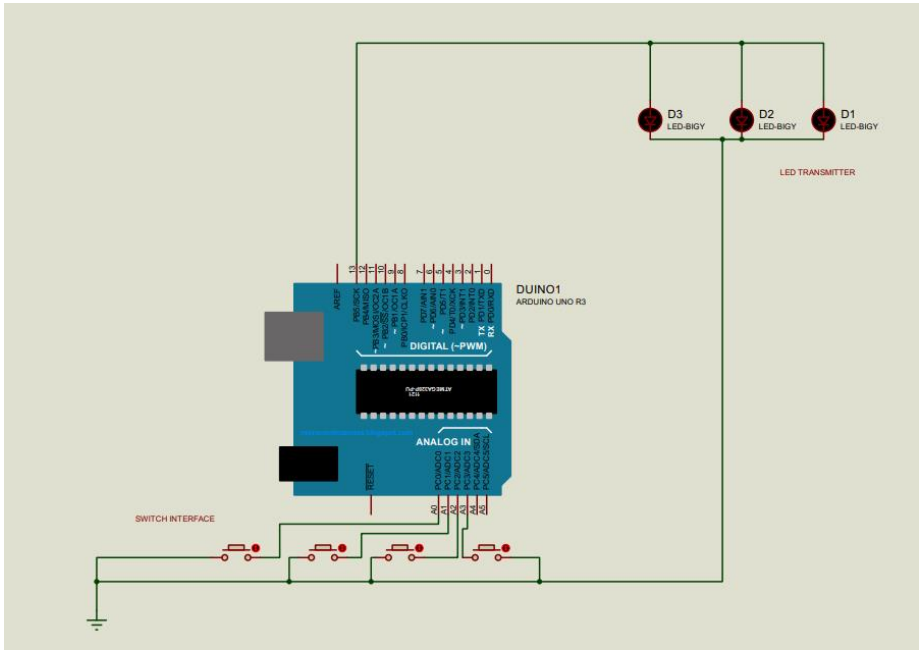

Figure 3. 7 Transmitter schematic diagram

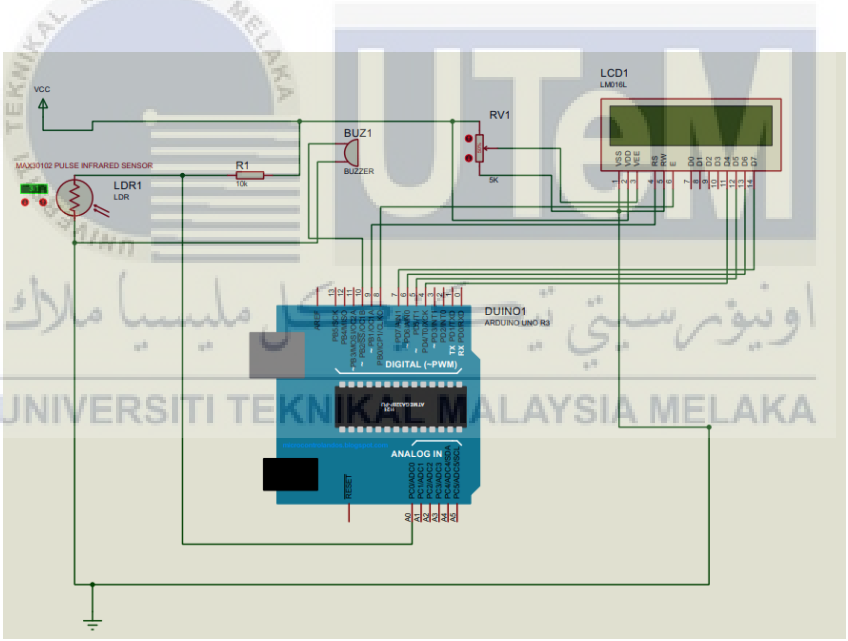

Figure 3. 8 Receiver schematic diagram

3.6 Microcontroller Workflow

3.6.1 Transmitter Part

For the transmitter, the flowchart is as Figure 3.9. The code process is started with the switch. When the switch is at button 3, which is to start the LED and the Li-Fi concept will be automatically used. The light is used as a medium as a data transmission before being transmitted to the receiver part. When the switch is at button 2, it is used to stop the sound of the buzzer when the signal is successfully transmitted. The example of the code for the transmitter part is attached in the Appendix A.

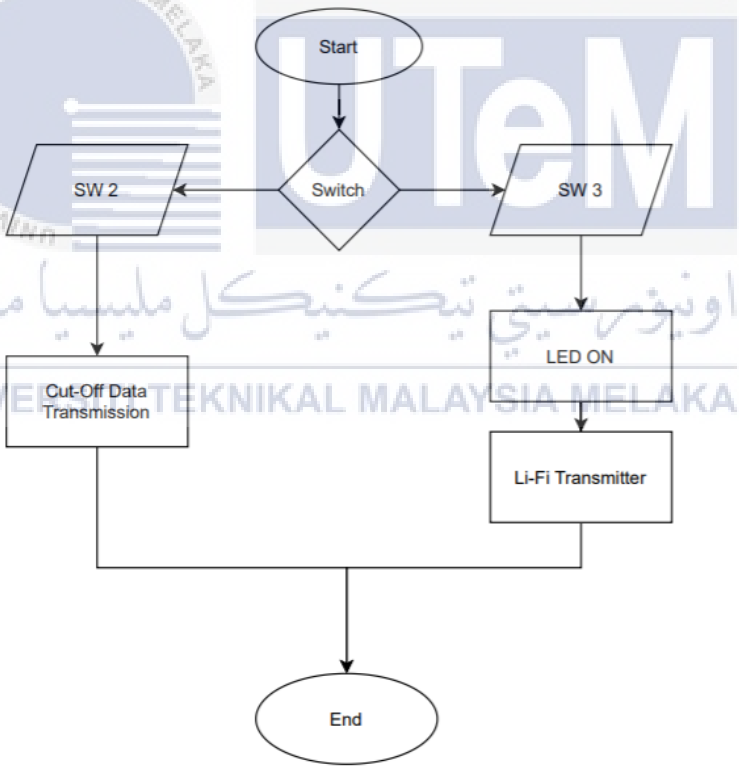

Figure 3. 9 Arduino Uno Transmitter Flowchart

3.6.2 Receiver Part

While, for the receiver's code process flow, as shown in Figure 3.10. The LDR Sensor will receive the signal from the LED from the transmitter. When the LDR Sensor receives the light, the code written will trigger the buzzer to produce a sound. At the same time, the LCD is used to display data to prove that the signal is received. If the LDR Sensor does not receive the light, the Li-Fi Receiver can't read the signal, the buzzer will not turn on, and the alarm alert system will not be triggered. The example of the Li-Fi code for the receiver part can be referred to in Appendix B.

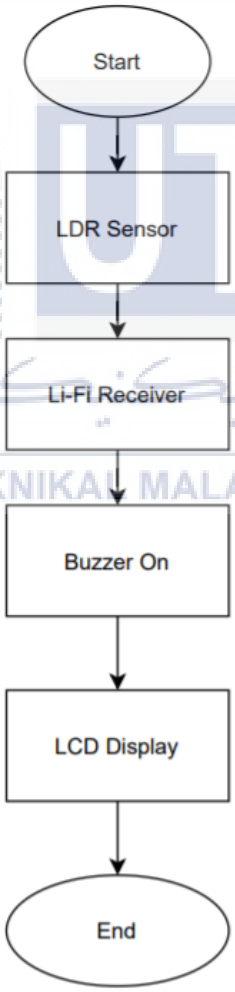

Figure 3. 10 Arduino Receiver Flowchart

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter is to discuss on the result and analysis data collected when run the software and hardware simulation. The part of simulation and hardware are being observed and analyse in this chapter.

4.2 Result and Analysis

Development of the hardware began with circuit design using Proteus. Next the operational flow of the alert system was developed using Arduino software and loaded into the microcontroller. Finally, the hardware was built using the components determined earlier. Upon completion of hardware development, the functionality of the system was verified.

4.2.1 Hardware Development for Development of Accident Car Alert using Visible Light Communication

This project was divided into two parts which were transmitter and receiver parts. For the transmitter part, this hardware consists of LEDs that have been put in the PVC pipes. It has a button to stop the buzzer when the signal has been received. Meanwhile, the receiver part consists of an LDR sensor that will receive the LED's signal. The LDR sensor also been put in the PVC pips to reduced the external light. But the pros when the sensor

been placed in the PVC pipes is the angle of the hardware are limited. Besides, the receiver also has an LCD to display the data received.

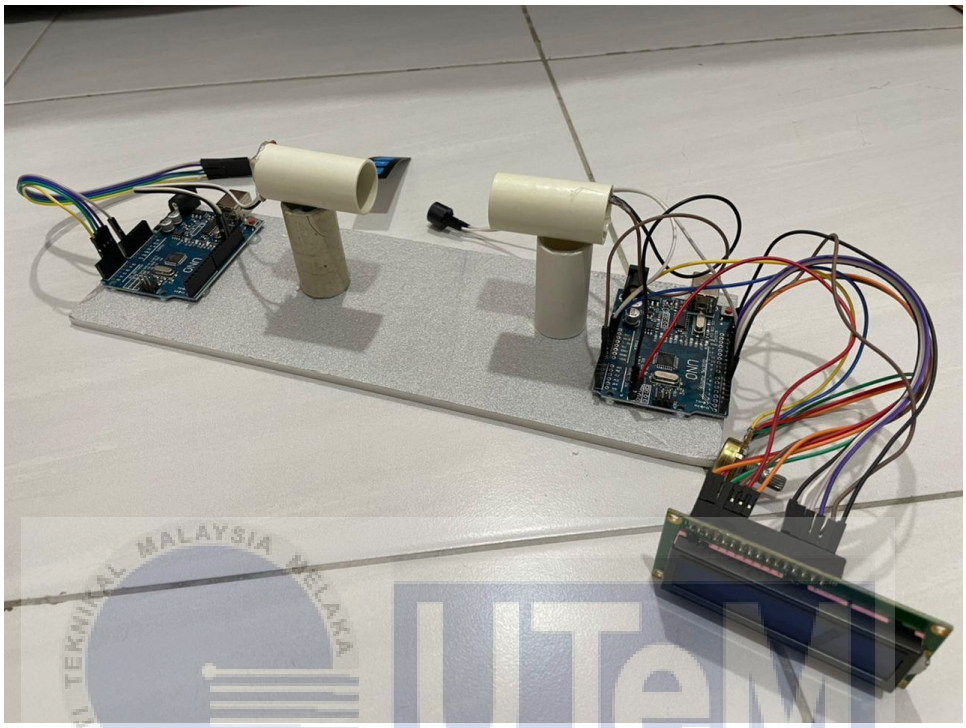

Figure 4. 1 Hardware Development

4.2.2 Verification of Hardware Functionality

4.2.2.1 Scenario 1: Vehicle Distance is out of the Allowable Range and Near to Other Vehicle.

Figure 4.2 is the LCD that displayed the "Data Received" when the receiver part is received the light signal from the transmitter part. The distance configured for hardware testing was at 10 cm distance. The signal from the transmitter will be transmitted to the receiver part, and the buzzer will produce a sound when the distance still is not allowable, which is 10 cm or less.

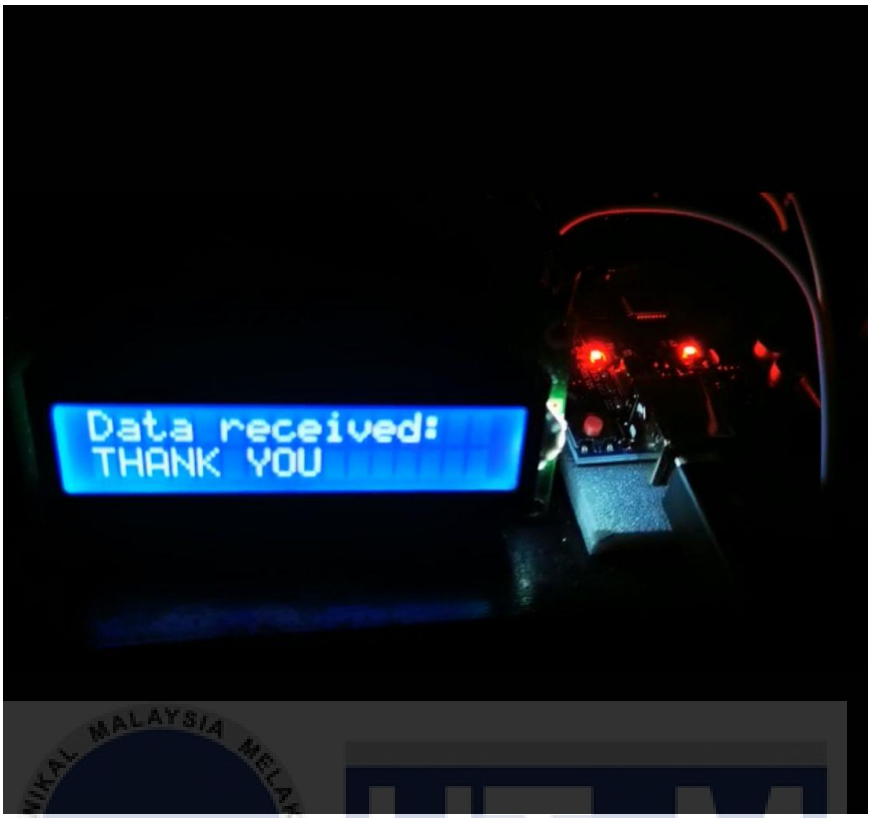

Figure 4. 2 Data Received

4.2.2.2 Scenario 2: Vehicles Distance is Allowable and Distance is Safe Between Vehicles

Figure 4.3 is an example of the LCD Display when the data that transmit from the transmitter is not received to the receiver part. It indicates that the distance between vehicles is far and safe. Hence, the buzzer will not produce a sound.

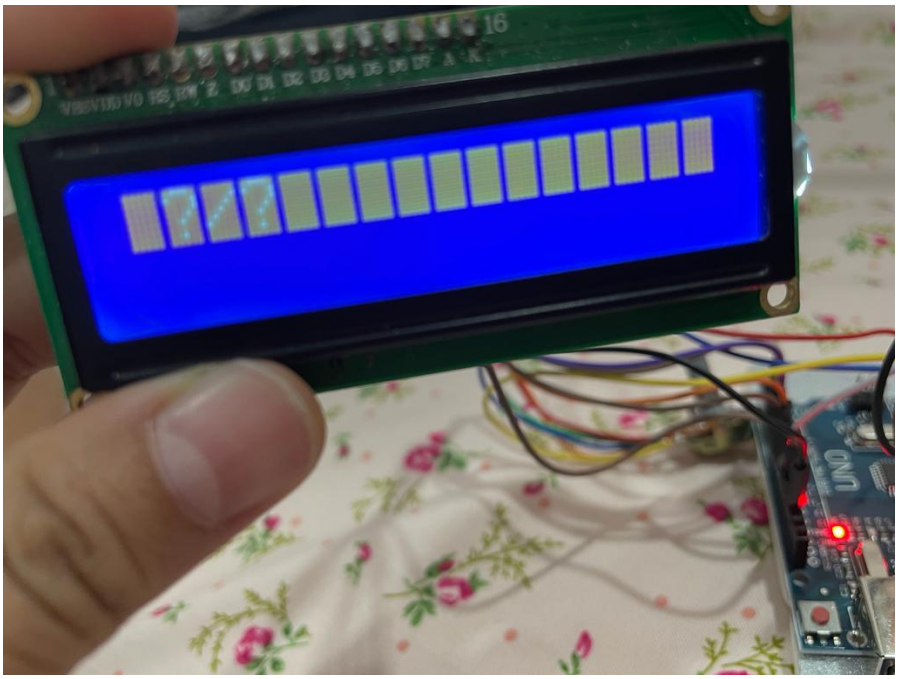

Figure 4. 3 Data not sucessfully received

4.3 Analysis of Parameters Changing

4.3.1 Angle Changed

Table 4. 1 Angle Changed

Angle (°)	Voltage (V)
0	0
45	0.023
65	0.037
90	0.058
135	0.034
180	0

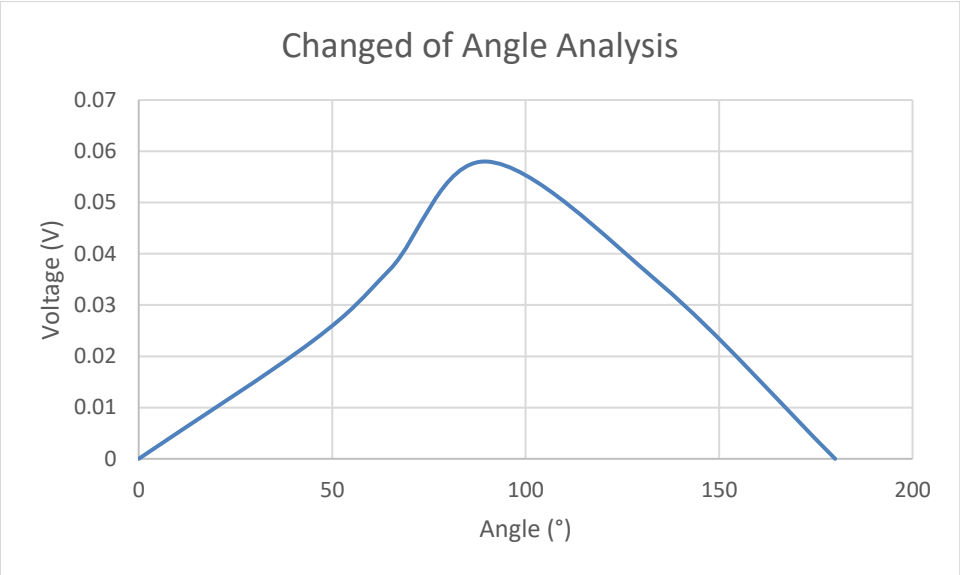

Figure 4. 4 Changed of Angle Analysis

Figure 4.4 is the analysis between angle of the LDR sensor and the voltage received between transmitter and receiver. For this angle analysis, the distance between transmitter and receiver was fixed at 10 cm, the further distance can be measured using the developed hardware. This analysis observed that at an angle of 90°, the voltage received is the highest as the transmitted signal was directly received by LDR. On the other hand, at 0° and 180°, LDR was not receiving any voltage; thus, the voltage drop is at the highest. Meanwhile, slightly lower volatge reading at 45°. This indicates that the receiver need to be provisioned accordingly to received a higher signal for better detection performance.

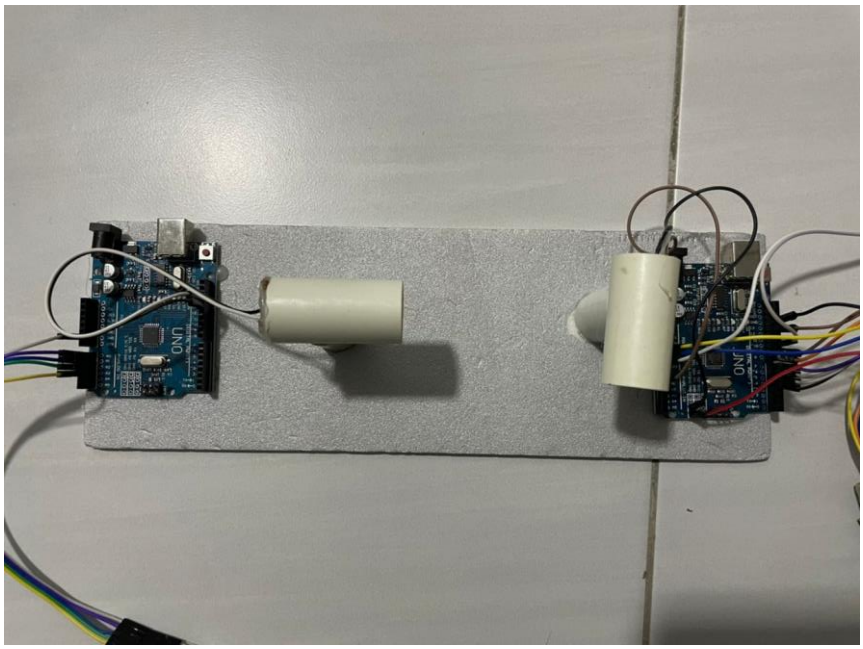

Figure 4. 5 Receiver at 0°

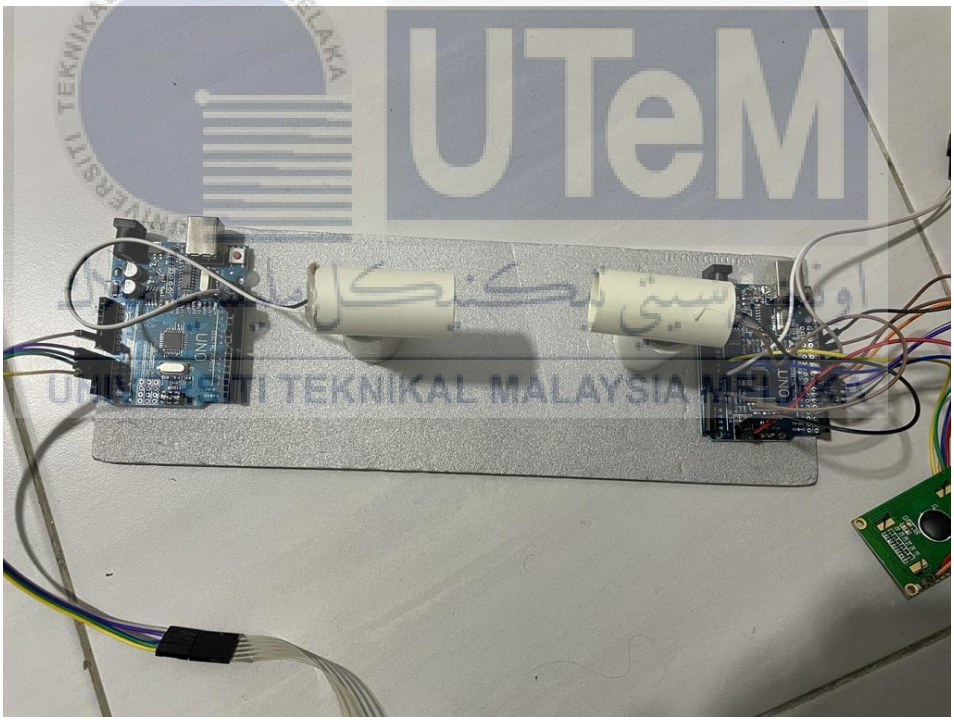

Figure 4. 6 Receiver at 90°

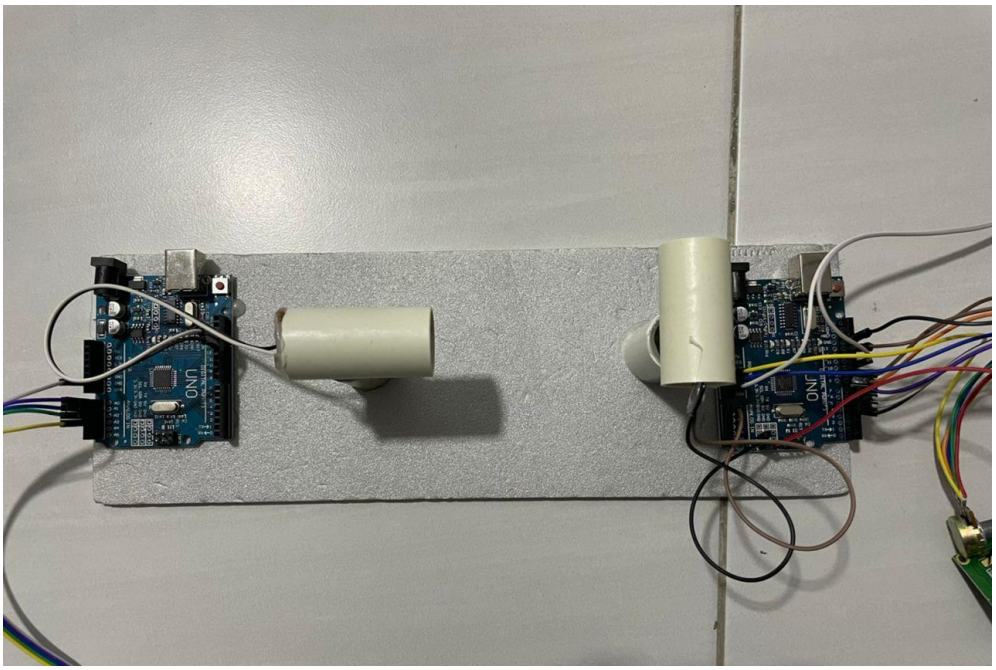

Figure 4. 7 Receiver at 180°

4.4 Summary

This project mainly is to alert the driver when the car is about to hit another car. Therefore, it is an alternative approach to reduce the rate of accidents. This project was proven successful and functioning by using Visible Light Communication as data transmission. The LCD at the receiver part displayed the "signal received" when the distance is very near between vehicles. Also, the buzzer from the receiver part will produce a sound to trigger the driver.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This project is necessitated an extensive investigation into the theory and algorithm of the project. Prior to that, studies on several Visible Light Communication (VLC) methods were conducted to determine the optimum approach and hardware for this project that can be used in this project. In order to make sure that the objectives is achieved, the data transmission needs to use light as the main medium with the integration to other components and controller. Apart from this, Li-Fi transmitter and Li-Fi receiver that use light as a medium to transmit and receive, is one of the selection criteria for the project.

The understanding fundamentals of Visible Light Communication is critical before it can be applied to car accident alert system. Besides, two other difficult parts were the development of transmitter and receiver; to ensure that the data transmission is successful using light. Moreover, an external light must be considered because it might affect data transmission from the transmitter to the receiver. By doing some prior research, all the proposed methods can be applied, and problems were able to be resolved.

At the end of the research, the vehicle accident alert using Visible Light Communication (VLC) was successfully designed and developed. It involved the utilisation of Proteus for circuit simulation and Arduino software for microcontroller's code programming. The hardware of the system was developed and finally tested workable. It was hoped that this project may benefit by adapting to the real environment and reducing the accident rate in Malaysia.

5.2 Future Works

This Development of Vehicle Accident Alert project using Visible Light Communication can be improved by doing additional testing on the hardware for other scenarios with external light. It is to understand the project's sensitivity to other external light, and how the light is affecting the outcome of this project. If the hardware fails to transfer the data, an external source of light needs to be considered. An LED filter that have daylight filter may be required to reduce ean ambient light noise.

Next, is to develop a proper prototype for vehicles for better performance and better data transmission results. Speed of car also can be tested using this prototype. This may include a study of the data transmission with speed to apply this Visible Light Communication System better, to make sure this project is successful.

Other than that, the distance between the transmitter and receiver to transmit the data also can be improved with a larger the distance using a different hardware, to mimic the actual collission scenario. This project hardware test on a distance of 10 cm, with range limitation.

Lastly, this project will be more interesting to be adapted into the automotive field by having a modulation technique to strengthen it. One of the modulation technique that is attractive to be explored is Color Shift Keying (CSK). With the modulation technique, another exploration can be made on collision detection.

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APPENDICES

Appendix A: Example of Code for Transmitter Part

Appendix B: Example of Code for Receiver Part

```
#define Buzz 10
#define LEDX 13
int LIFI=0;
int COUNTER=0;
int MODE=0;
//--------------------------------EEPROM VR-------------------------
float Sens1;


void setup(void)
{
  pinMode(Buzz,OUTPUT);
pinMode(LEDX,OUTPUT);
digitalWrite(LEDX,HIGH);

  lcd.begin(16, 2);
  lcd.clear();
```

```
  if (COUNTER>=100){
    lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Data received:");
    lcd.setCursor(0,1);
  lcd.print(LIFI);
  //delay(1000);
   if (LIFI==16 || LIFI==19){
      lcd.setCursor(0,1);
  lcd.print("HELLO..");
  }
  if (LIFI==30 || LIFI==29){
      lcd.setCursor(0,1);
  lcd.print("ALARM ON..");
  digitalWrite(Buzz,HIGH);
  }
   if (LIFI==31 || LIFI==32){
      lcd.setCursor(0,1);
  lcd.print("ALARM OFF..");
  digitalWrite(Buzz,LOW);
```