DESIGN AND DEVELOPMENT OF WIRELESS BRAKING SYSTEM FOR MOTORCYCLE HELMET.

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A report submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering (Automotive)

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I declare that this project report entitled “Design and Development of Wireless Braking System for Motorcycle Helmet.” is the result of my own work excepts as cited in the references.

Signature : ……

Name : IHSAN BIN ISMAIL

Date : ……

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Automotive).

Signature : .....

Supervisor's Name : MOHD ZAKARIA B. MOHAMMAD NASIR

Date : .....

DEDICATION

To my beloved mother and father

ABSTRACT

Road accident is one major factor death causes in Malaysia. There are many factors that cause the accident such as driver attitude, weather, and road condition. One of the most victims in the fatal accident happen mostly involves the motorcyclist. Critical situation accident could happen at night or dark condition due to low sight, where the motorcyclists are difficult to see their absent on the road. These situations are very dangerous to the road user especially to the motorcycle and bicycle at night condition. In this project, adding the LED light blinking system to the helmet to make sure motorcyclist will easy to spot by another road consumer. This system used the Arduino microcontroller to used wireless connection and control the LED blinking. The LED light will be located on the back of the helmet that is parallel to the sighting of the driver eyes from behind. Based on analysis, this Smart Safety Helmet can improve the visibility of the other vehicle to rider when using this helmet when low light and bad weather conditions. Construction prototype of the Smart Security Helmets and wireless systems functioning and tested.

ABSTRAK

Kemalangan jalan raya adalah salah satu punca utama penyumbang kadar kematian di Malaysia. Terdapat banyak factor yang menyebabkan kemalangan seperti sikap pemamdu, cuaca and keadaan jalan raya. Jumlah mangsa yang maut apabila berlakunya kemalangan kebiasaannya melibatkan penunggang motosikal. Tambahan lagi, faktor waktu kemalangan biasanya berlaku pada waktu malam atau keadaan gelap apabila jarak penglihatan menjadi rendah menyebabkan motosikal sukar untuk dilihat di jalan raya. Situasi ini amat bahaya kepada pengguna jalan raya terutama sekali kepada motor dan basikal. Dalam projek ini, menambah sistem lampu brek berkelip LED pada helmet adalah untuk memastikan penunggang motosikal akan lebih senang untuk diperhatikan oleh pengguna jalan raya yang lain. Sistem yang menggunakan pengawal mikro Arduino adalah untuk menghubungkan brek menggunakan hubungan tanpa wayar dan mengawal kelipan LED. Lampu LED akan dipasang pada belakang topi keledar yang kedudukannya adalah sejajar dengan mata pemandu daripada belakang. Berdasarkan analisis, Topi Keledar Keselamatan Bijak ini boleh mempertingkatkan kepekaan pemandu lain terhadap motorsikal apabila waktu gelap dan cuaca yang buruk. Pembinaan prototype Topi Keledar Keselamatan Bijak dan sistem tanpa wayar yang berfungsi dan diuji.

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TABLE OF CONTENT

CHAPTER	CONTENT		PAGE
	DECLARATION		**i**
	DEDICATION		**iii**
	ABSRACT		**iv**
	ABSTRAK		**v**
	ACKNOWLEDGEMENTS		**vi**
	TABLE OF CONTENTS		**vii**
	LIST OF TABLES		**x**
	LIST OF FIGURES		**xi**
	LIST OF APPENDICES		**xiv**
	LIST OF ABBREVIATIONS		**xv**
	LIST OF SYMBOLS		**xvii**
CHAPTER 1	**INTRODUCTION**		**1**
	1.1	Background	1
	1.2	Problem Statement	5
	1.3	Objective	6
	1.4	Scope of Project	6
CHAPTER 2	**LITERATURE REVIEW**		**7**
	2.1	Overview	7
	2.2	Introduction of Safety Helmet	7
		2.2.1 Helmet History	8
		2.2.2 Helmet Type	10
	2.3	Basic Electrical Principle	11
		2.3.1 Electric Components	12
		2.3.2 Integrated Circuit	18
	2.4	Light Emitting Diode	19
	2.5	Electric Connector	20
		2.5.1 Circuit Wiring	20

	2.6	Switch	21
	2.7	MOSFET	22
		2.7.1 Voltage Divider and Voltage Controller	23
	2.8	Wireless system Protocols	25
	2.9	Electronic Device and System	28
CHAPTER 3	**METHODOLOGY**		**30**
	3.1	Overview	30
	3.2	General Methodology	30
	3.3	LED Blinking System	33
	3.4	Wireless Connection	35
	3.5	Schematic diagram of the system	36
		3.5.1 Transmitter	36
		3.5.2 Receiver	38
	3.6	Fabrication Process	39
		3.6.1 Transmitter	41
		3.6.2 Receiver	42
CHAPTER 4	**DATA AND DISCUSSION**		**42**
	4.1	Understand wireless system	42
	4.2	Wireless NRF24L01	45
	4.3	Coding and Program of Arduino (Uno and Nano)	45
	4.4	Prototype Smart Safety Helmet	50
	4.5	Test the System	53
	4.6	Graph of Visibility	56
	4.7	Discussion and Analysis	59
CHAPTER 5	**CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH**		**62**
	5.1	Conclusion	62
	5.2	Recommendation	63

REFERENCES **64**

APPENDIXES **67**

LIST OF TABLES

TABLE	TITLE	PAGE
1.1	Death road user in various region in 2012	3
2.1	symbols and component used in electrical circuit	12
2.2	Comparison on the wireless protocols	27
2.3	Comparison on the wireless protocols	28

LIST OF FIGURE

FIGURE	TITLE	PAGE
1.1	Statistic road traffic death by MIROS.	2
1.2	World Health Organisation (WHO) report on Road safety 2015	2
1.3	Total death and Road Safety Index in Malaysia	5
2.1	Global Report on Road Safety 2015 by WHO	8
2.2	First helmet made from leather and Pudding Bowl helmet	8
2.3	First full face helmet (BELL STAR)	10
2.4	Types of helmet	10
2.5	Direction of electron and conventional current	12
2.6	Resistor	13
2.7	Resistor Colour Code	14
2.8	Capacitor	15
2.9	Common Capacitor type and specification	16
2.10	Transistor	16
2.11	Diodes	17
2.12	Integrated Circuits	18
2.13	LED operating mechanism	19
2.14	Copper with PVC insulator cable	21
2.15	Roller Lever Limit Switch	21
2.16	Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET)	22
2.17	N-channel type MOSFET symbol	22
2.18	Voltage divider circuit schematic diagram	23

2.19	current flow in voltage divider	24
2.20	Ultra-Wide Band transmitter or receiver	25
3.1	flowchart of the project	32
3.2	Basic blinking system using Arduino Software	34
3.3	Schematic diagram for basic blinking system using Arduino	34
3.4	Coding declaration library for wireless system (transmitter)	36
3.5	Schematic diagram for transmitter circuit system	37
3.6	NRF24L01 Arduino transceiver module	37
3.7	Schematic diagram for receiver circuit system	38
3.8	Male to male jumper wire	40
3.9	Testing for blinking system	40
3.10	flow chart transmitter fabrication	41
3.11	flow chart receiver fabrication	42
4.1	Illustrated wireless system	43
4.2	The “No radio available” massage show receiver not get signal	44
4.3	Massage “111” show the signal reach the receiver	45
4.4	Coding for blinking system	45
4.5	NRF24L01 radio transceiver and NRF24L01 connect to Arduino	46
4.6	Arduino Software interface	47
4.7	Writing radio library and coding for sending signal	47
4.8	Coding to receive command from switch	48
4.9	Writing radio library use and initialize the output pin	48
4.10	Declaration output pin and looping method	49
4.11	Performing the output signal and massage	50
4.12	Final Product of the smart safety helmet model system	51
4.13	Isometric view design of the bracket Smart Safety Helmet	52
4.14	Side view design of the bracket Smart Safety Helmet	52

4.15	Back view design of the bracket Smart Safety Helmet	53
4.16	ordinary tail light back view	54
4.17	Ordinary tail light with smart safety helmet when brake	54
4.18	Testing visibility at distance 70m	55
4.19	Testing visibility at afternoon condition (1.30 p.m)	55
4.20	Graph distance vs visibility fine condition at afternoon.	56
4.21	Graph distance vs visibility fine condition at evening.	57
4.22	Graph distance vs visibility fine condition night with road lamp.	57
4.23	Graph distance vs visibility fine condition at night without road lamp.	58
4.24	Graph distance vs visibility rainy condition at night.	58
4.25	Graph Distance Vs Visibility for overall conditions.	59

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Data for Visibility Experiment	67
B	Codding of Arduino (microcontroller) for transmitter	72
C	Codding of Arduino (microcontroller) for receiver	75
D	Gantt Chart PSM I	79
E	Gantt Chart PSM II	80

LIST OF ABBREVATIONS

WHO	World Health Organisation
PDRM	Polis DiRaja Malaysia
IC	Integrated Circuit
USB	Universal Serial Bus
LED	Light Emitting Diode
Wi-Fi	Wireless Fidelity
RFID	Radio Frequency Identification
PNP	Positive-Negative-Positive
NPN	Negative-Positive-Negative
PVC	Poly Vinyl Chloride
MOSFET	Metal-Oxide-Semiconductor Field-Effect Transistor
WPAN	Wireless Personal Area Network
UWB	Ultra-Wide Band
FFD	Full Function Device
POS	Personal Operating Space
RFD	Reduce Function Device
AP	Access Point
DC	Direct Current
AC	Alternating Current
VCC	Verified Concurrent
MOSI	Master Output Slave Input

MISO	Master Input Slave Output
GND	Ground

LIST OF SYMBOLS

V	=	Voltage
I	=	Current
R	=	Resistance
P	=	Power
Ω	=	Ohm
F	=	Farad
m	=	metre
A	=	Amplitude
C	=	Capacitance
d	=	Distance
l	=	Length
W	=	Watt
Hz	=	Hertz
V_{in}	=	Input Voltage
V_{out}	=	Output Voltage

CHAPTER 1

INTRODUCTION

1.1 Background

Accidents in Malaysia are the one of main cause of death among the road user. According from the statistic shown in Table 1.1, Malaysia is top five very popular in the ASEAN countries that had the higher motorcycle fatalities. Motorcyclists are the most of the victim of the death and serious injury accident that had always happen nowadays. There are many factors that cause the accident such as driver attitude, weather, and road condition. Based on the statistical from the PDRM, the major death accident happens at night and also when heavy raining condition. Road condition as know are the main factor can cause accident to all user of the road. Road that has hole, unfinished road and, bad condition can cause fatal accident to user. Besides that, road without importance facilities such as separated line, signboard, road reflector and road lamp also can increase the factor of accident (Erhardt, Rice, Troszak, & Zhu, 2016).

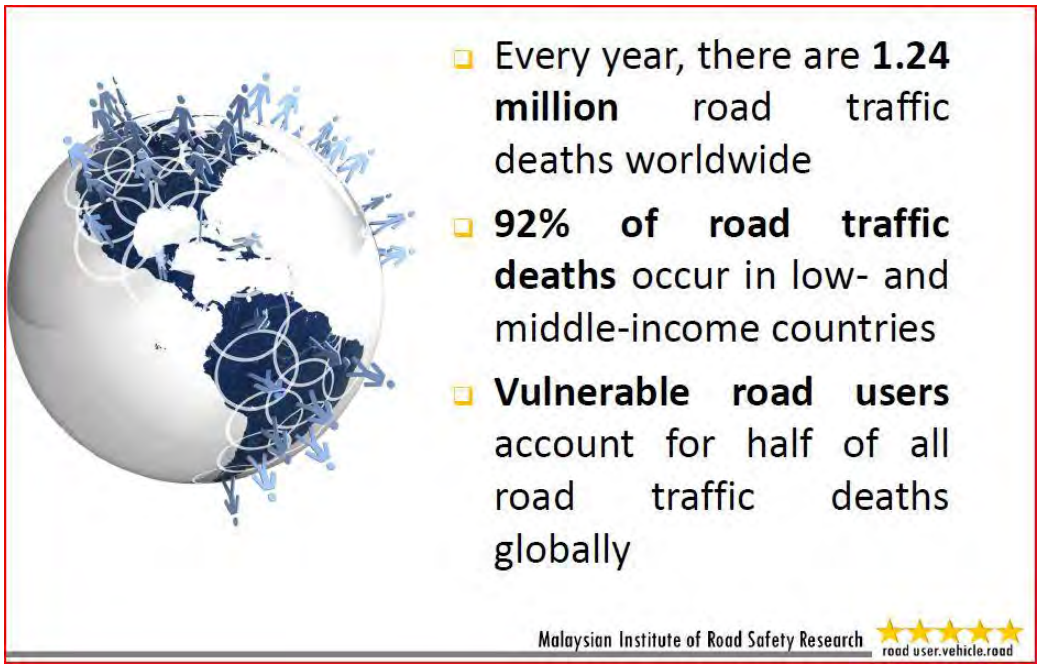


Figure 1.1: statistic road traffic death by MIROS.

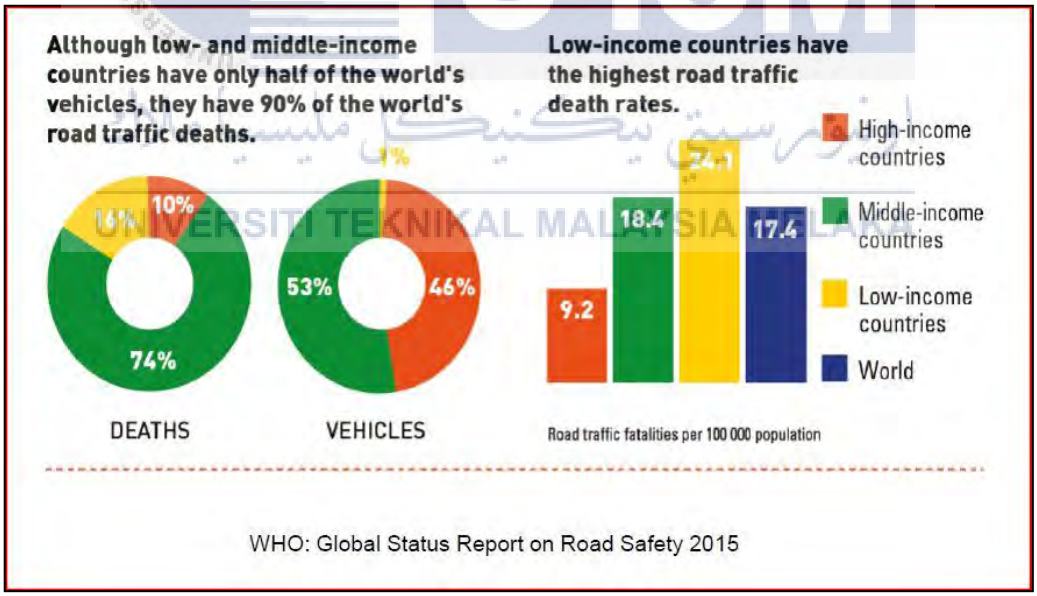


Figure 1.2: World Health Organisation (WHO) report on Road safety 2015.

Table 1.1: Death road user in various region in 2012 (Polis DiRaja Malaysia)

No.	ASEAN country	population	Registered motorcycle (2012)		Report fatalities (2012)		Road fatalities per 100000 populations	Motorcycle fatalities per 10000 registered motorcycle
			Total (million)	(%)	Total	%		
1.	Brunei	390056	0.01	4	54	11	13.8	4.9
2.	Singapore	4436281	0.14	17	214	48	4.8	7.1
3.	Lao P.D.R.	5859393	0.51	79	608	80	10.4	9.6
4.	Cambodia	14443670	0.13	84	1545	63	10.7	75.1
5.	Malaysia	26571879	7.91	47	6282	58	23.6	4.6
6.	Myanmar	48798212	0.68	65	1638	10	3.4	2.4
7.	Thailand	63883662	16.14	63	12493	70	19.6	5.4
8.	Vietnam	87375196	21.78	95	12800	80	14.6	4.7
9.	Philippines	87375196	2.65	48	1185	37	1.3	1.7
10.	Indonesia	231626978	46.22	73	16548	61	7.1	2.2
Total		571345453	96.17	58	53366	52	-	-

In Malaysia, the death of the road user always increasing and growing by years. Although, the Road Safety Index in Malaysia based on the Figure 1.3, the road value decreasing and lower per 10000 vehicles. From the data shows that the accident happens become lower over years because of the improving the safety equipment and developing new system by the vehicle and motorist company. Based on the scientific study by MIROS, road fatality in Malaysia is projected to reach 10,716 in 2020. The fatalities will cause minimum loss to Malaysia that estimate at RM 20.6 Billion in 2020.

Other than that, motorcycle at night are very hard to see from far away distance because the tail light is too dim and not give attraction to the other vehicle from back. From that, the main factor to focus are sighting of the other vehicle when the motorcyclist used the road at low light condition. One of the alternative to reduce the factor of the accident is motorcycle's user can wear the safety reflector vest or at least wearing bright and attracted colour to make sure the other user can spot motorcyclist in low light. Attitude of the motorcyclist in Malaysia are bad because they are always overlook about their own safety while using carriageway. Uncomfortable, unattractive, and difficult to use are some reason that make mostly motorcyclists are not using safety vest. Existing safety vests are not interesting and looking like contractor worker are main reason claim by the user especially by youth and middle age.

Based on government and safety law, all motorcyclist or cyclist must wear helmet (Buckley, 2016). From that, redesign and make improvement to existing product by adding some LED light at the back of the helmet can improve the safety to the motorcyclist. Other than that, adding some blinking light when crash to make sure the other vehicle from back slow down. The accident occurs when the other vehicle could not the motorcycle crash or stop at the middle ways (Buckley, 2016).

Year	Total death for Road User in Malaysia	Road Safety Index in Malaysia		
		Per 10,000 vehicles	Per 100,000 population	Per Billion VKT (Vehicle Kilometre Travelled)
1999	5794	5.83	25.5	26.79
2000	6035	5.69	26.0	26.25
2001	5849	5.17	25.1	23.93
2002	5891	4.90	25.3	22.71
2003	6286	4.90	25.1	22.77
2004	6228	4.52	24.3	21.10
2005	6200	4.18	23.7	19.58
2006	6287	3.98	23.6	18.69
2007	6282	3.74	23.1	17.60
2008	6527	3.63	23.5	17.65
2009	6745	3.55	23.8	17.27
2010	6872	3.40	23.8	16.21
2011	6877	3.21	23.71	14.68
2012	6917	3.04	23.61	13.35
2013	6915	2.90	23.1	12.19
2014	6674	2.66	22.0	10.64
2015	6706	2.55	21.5	9.6

10 Malaysian Institute of Road Safety Research road user.vehicle.road

Figure 1.3: Total death and Road Safety Index in Malaysia.

1.2 Problem statement

Motorcycle accident could lead to serious injuries and death. Severe situation of accident mostly happens at night and at heavy raining condition when the sight of the driver decreased and the motorcycles are hard to spot just by tail light from more than sighting distance. Sighting distance in normal are 10-20m, rainy condition less than 10m, heavy rain and storm less than 3m. The most dangerous when motorcycle had a crash on the federal highways, the motorcyclist on the road can crash by following vehicle if they cannot notice the injured men on the road.

The present helmet on today market that only used to protect head and face from injuries are not enough function. Reflected helmet or helmet with bright colour are not interested by young that always want to used simple and dark colour helmet especially black colour. Wearing black and dark colour of the helmet are not recommended because the motorcyclist can be hard to vehicle's driver to spot the rider at night or low light condition. Other than that, the accident that happen after first accident always happen. As known, the following accident can be preventing from happen if the other driver from behind are can see the signal from the accident area to decelerate the vehicles.

1.3 Objective

The objectives of this project are:

1) Design of brake light circuit system for motorcycle helmet.
2) Prototype development of safety helmet with wireless LED brake light.

1.4 Scope of the project

Scopes of this project are as the following:

1. Literature study of the helmet, wireless technology, radio frequency identification (RFID) system, Bluetooth, Wi-Fi, electrical system and microcontroller.
2. Design the bracket used safety feature for braking and signal LED light attached on current helmet.
3. Design and analysis on electrical system for blinking.
4. Fabricate the model and prototype.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

In this chapter the research from the journal, internet, books and other source had been made to gather information and fact about this research project.

2.2 Introduction to Smart Safety Helmet

Road accident is the one of the major causes of death in the world. Every year, about 1.25 million death caused by accident and the most victims among age 15-21 years old (World Health Organisation, WHO, 2015). Motorcycle accident is the most popular accident that always happen especially at night and rainy condition (Buckley, 2016). Tail light or brake light are not bright as the front light, so the other alternative to make sure the other vehicle driver can easily spot the motorcycle in rains and night is wearing bright colour shirt or reflector vest. At normal practices, safety vest is complicated to wear, bad look and take some times when used it.

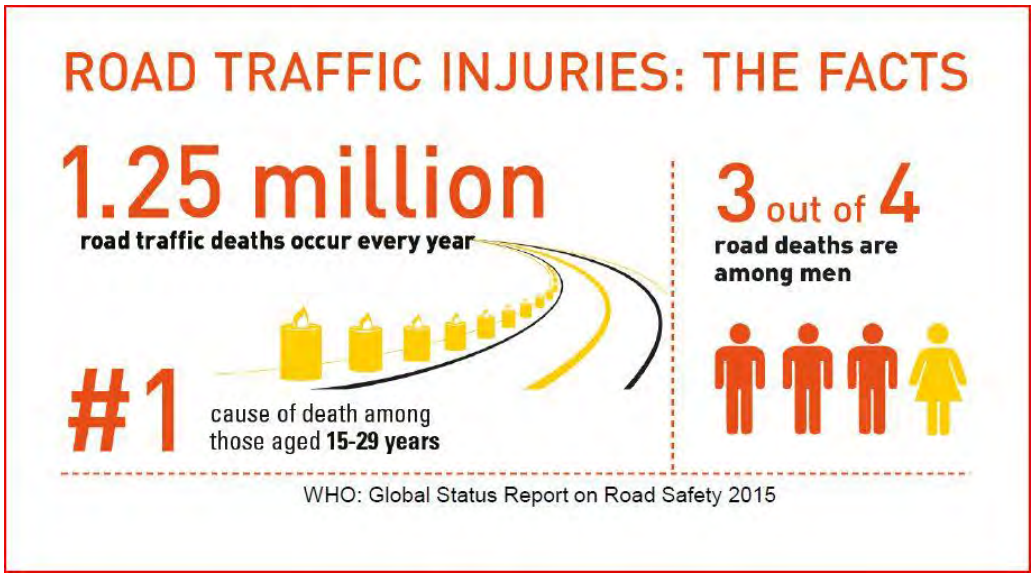


Figure 2.1: Global Report on Road Safety 2015 by WHO

2.2.1 Helmet History

Figure 2.2: First helmet made from leather (left) and Pudding Bowl helmet (right).

Helmets are used to protect head from the injuries when crash happened. Helmets are used in many activities include construction and transportation. First motor helmets were using leather as the protective the head as shown in Figure 2.2. In May 1935, death of war heroes T.E Lawrence by sustain massive head injuries caused the British Army have made wearing a helmet a mandatory practice for their dispatcher. The new and upgrade model of helmet was created using hard composite compare to the first model. Next, new helmet and the most popular now known as Pudding Bowl Helmet show in Figure 2.2 was using among the motorcycle rider around 1950's until 1960's. This new design helmets have no eye protection but was improved by adding cross webbing that used for added ventilation, stabilities and comfort.

At 1960's there were many major helmet industries including the famous branded helmet, Bell. Bell has design improved and new type of helmet. In 1967, Bell was keeping ahead when it comes to stunt riding and racing. Bell created first full-face helmet know as Bell Star. At 1980's the helmets design was changing rapidly by adding some new modern and trendy design. Today, many type of helmets in marketplace. Technologies bring the new function and safety of the helmet is taken seriously by the developer such as Shoei, Arai, and other.

Figure 2.3: First full face helmet (BELL STAR).

2.2.2 Helmet Type

Figure 2.4: Types of helmet.

Due to time constant, all motorcycles rider are required to wear helmet when bike motorcycle (Buckley, 2016). There are many types of helmets nowadays that have their own function and safety factor. The most popular and basic helmet used by mostly rider

are open face helmet with the visor as face shield. In the market, there also have the half face, full face, modular and motocross helmet. Type of the helmet is usually depending on the type of motorcycle used and also type of road.

Almost all the riders are not like to give the attraction by using some strike colour on their helmet. Helmet used by riders usually dark colour and hard to spot in the low light situation by another vehicle. To reduce the possibility accident from occur, by adding some extra light on the helmet to improve the visibility are the good idea to make the other user more alert while driving. Yellow strike or reflector strike on the helmet is not much function to increase the visibility during heavy rains. Using some blinking light is the best way to attract more attention from the other vehicle that approaching from behind the motorcycle (Liu et al., 2008). Using LED as the light source are the choice because the LED light are sharp light, bright, low power consume and long lasting.

2.3 Basic electrical principle

The flow of the electron from one atom to another produce the electric current(Components, n.d.). The flow of the electric current is from the repellent electron at negative terminal and attraction at positive terminal. An electron flow is termed an electric current. The flow of the electron is from negative terminal to positive terminal, is opposite direction flow of the conventional current that flow from positive terminal to negative terminal as shown in Figure 2 .5 below.

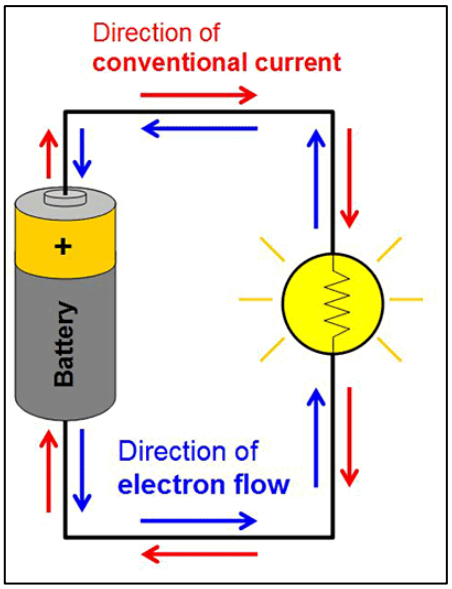
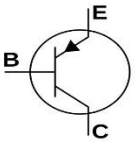
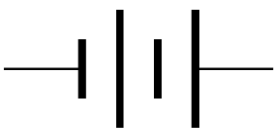
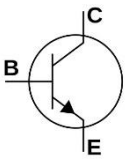


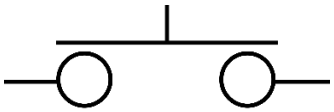
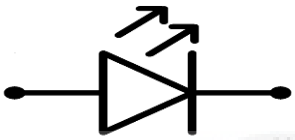
Figure 2.5: Direction of electron and conventional current

2.3.1 Electric component

The components that are always used in the simple circuit are show in the Table below that show symbol and component widely used.

Table 2.1: symbols and component used in electrical circuit(top)

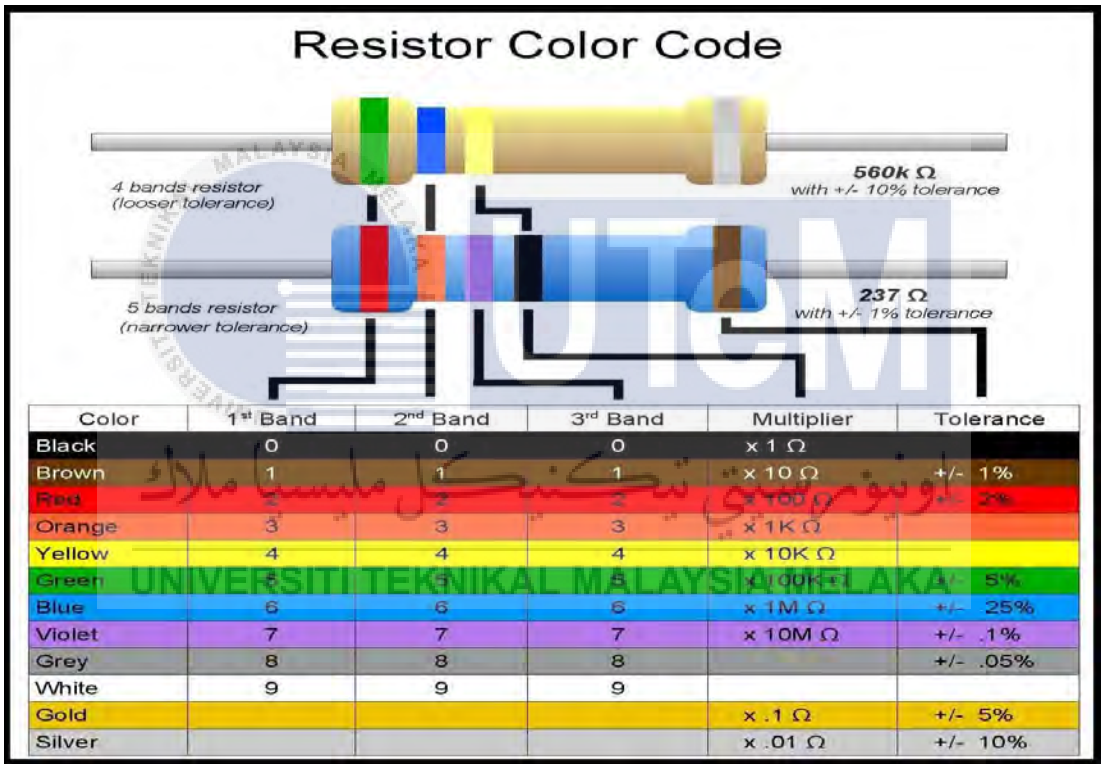
Symbols	Component name	Symbols	Component name
	Bulb		p-n-p transistor
	Battery		n-p-n transistor

	Capacitor		Variable capacitor
	Resistor		Variable resistor
	Switch		Push switch
	LED (Light Emitting Diode)		Ground connection

Resistors are the most used component to complete the electronic circuit. There are two factor must consider when selected the most suitable resistor that are ohms' value and power rating. Commonly resistor used in electronic circuit are made from carbon rod and the resistance value depend on the size of the rod. Resistor are used to limit current flow and provide fixed voltage drop (Denton, 2004).

Figure 2.6: Resistor.

Resistor value measure in unit Ohm (Ω) using ammeter or calculate the value of resistor using colours stripe code on the resistor itself. The colour code band depend on type of resistor, there two type that commonly used are 4 band and 5 band colour stripe. 1st and 2nd band shows the value and 3rd or 4th band show the multiplier value. The other colour, gold, silver and white are used as the tolerance value of the resistor. The table show colour code of the resistor value.



Color	1st Band	2nd Band	3rd Band	Multiplier	Tolerance
Black	0	0	0	x 1 Ω	
Brown	1	1	1	x 10 Ω	+/- 1%
Red	2	2	2	x 100 Ω	+/- 2%
Orange	3	3	3	x 1K Ω	
Yellow	4	4	4	x 10K Ω	
Green	5	5	5	x 100K Ω	+/- 5%
Blue	6	6	6	x 1M Ω	+/- 25%
Violet	7	7	7	x 10M Ω	+/- .1%
Grey	8	8	8		+/- .05%
White	9	9	9		
Gold				x .1 Ω	+/- 5%
Silver				x .01 Ω	+/- 10%

Figure 2.7: resistor colour code.

A capacitor is a device that have the ability for storing an electric charge that are consist of two plates separated by an insulating material. Capacitors are described as two plates separated by a dielectric. Metal foil sheets are rolled up together inside tin can insulated by the type of paper are often used to construct capacitors. Reduce the distance

between the plates to achieve higher value of capacitance. To determine the value of capacitance can be calculated by area of the plates A, the distance between them d, and permittivity,ε, by the equation:

$$C = \varepsilon A / d \tag{2.1}$$

The unit of capacitance is Farad(F). Capacitor have many type with different value of capacitance and specification as show in Figure 2.9.

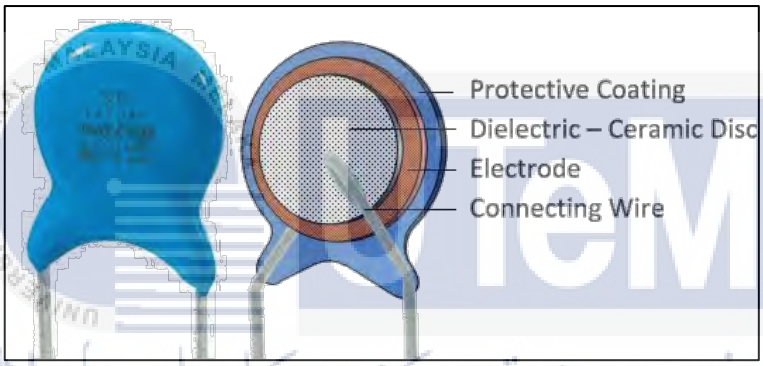


Figure 2.8: capacitor.

Type ⊕ = polarized	Pic	Cap Range	ESR	Leakage	Voltage Rating	Temp Range	Gen Notes
Ceramic		pF - µF	low	med	high	-55° to +125°C	Multipurpose Cheap
Mica (silver mica)		pF - nF	low 0.01-0.1Ω	low	high	-55° to +125°C	For RF filters Expensive Very stable
Plastic Film (polyethylene polystyrene)		few µFs	med	med	high	varies	For low freq Cheap
Tantalum ⊕		µFs	high 0.5-5.0Ω	low	lowest	-55° to +125°C	Expensive Nonlinear (bad for audio)
OSCON ⊕		µFs	low 0.01-0.5Ω	low	low	-55° to +105°C	Best quality Highest price
Aluminum Electrolytic ⊕		high µFs	high 0.05-2.0Ω	med	low	-40° to +85°C	For low-med frequencies Cheap Hold charge for long time – not for production test

Figure 2.9: Common Capacitor type and specification.

Transistor is a semiconductor device used to amplified or switch for electrical and electronic device that have allowed the development of small and complex electronic system (Denton, 2004).

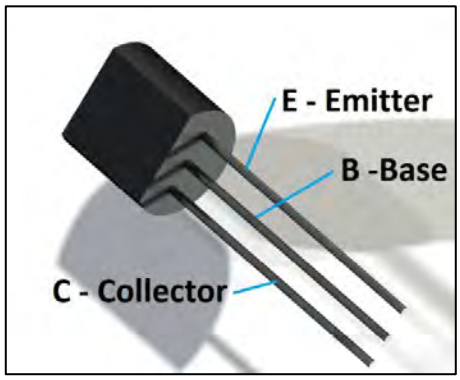


Figure 2.10: transistor.

Transistors have three terminals known as base, collector and emitter. The transistors are constructed from semiconductor materials and there can be either made in NPN or PNP format (Denton, 2004).

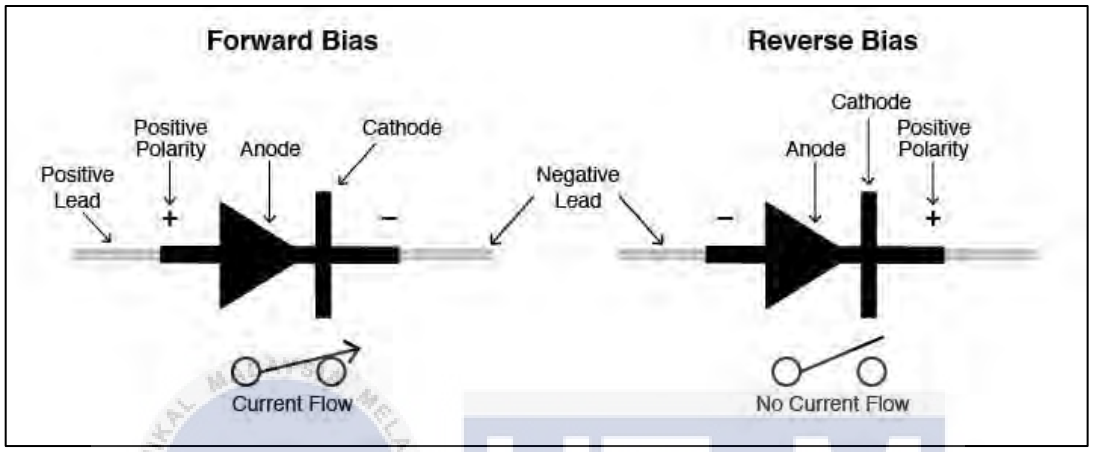


Figure 2.11: Diodes

Diodes are describing as one-way valves for the most application that have Positive and Negative (PN) junction. The materials usually constructed from doped silicon. Diodes are not perfect devices and required 0.6 V voltage to switch on forward biased direction. Zener diodes are very similar in operation, with the exception that they are design to breakdown and conduct in the reverse direction at a pre-determined voltage. The diodes can function similar to pressure relief valve (Denton, 2004).

2.3.2 Integrated circuit

Integrated circuit (ICs) known as a substrate are constructed on a single slice silicon that are combination of the previous components to carry out various task such as logic function, switching, and amplifying. Using this integrated circuit give the great advantages because of the size of ICs smaller and the most importance are the speed at which they can be made to work due to short distances between components. Construction of an ICs take four main stages. Firstly, oxidization process by exposing the silicon slice to an oxygen stream at high-temperature to form oxide that act as an excellent insulator. Second stage is photo-etching to remove the oxide part and after that it possible to imprinted the oxidized silicon slice. The slice now can be washed in acid to etch back to the silicon. Next stage is diffusion where the slice is heated in atmosphere. Final stage is epitaxy, which the new layers of silicon can be growth and doped to become n or p type. Nowadays, there are many type and range of integrated circuits that a chip is available for almost any application (Denton, 2004).

Figure 2.12: Integrated Circuits.

Amplifiers are the simplest combination of only one transistor and one resistor. A small charge of current on the input terminal will cause a similar change of current through the transistor and an amplified signal will be the output terminal (Denton, 2004).

2.4 Light Emitting Diode (LED)

Light Emitting Diode (LED) are simply p-n junction devices constructed in direct-bandgap semiconductor and convert the electrical power to visible optical power that is light. Light produce through the spontaneous emission of radiation which wavelength determine by the bandgap of the semiconductors. LED used to replace the indicator lamp because LED highly energy efficiency of the light source. Furthermore, device packaging also had to adopt strategies not only to remove the heat generated by the process but also to deal with the thermal misplace between the chip and the heat sink owing to the Joule heating effect (Morkoç, 2009)

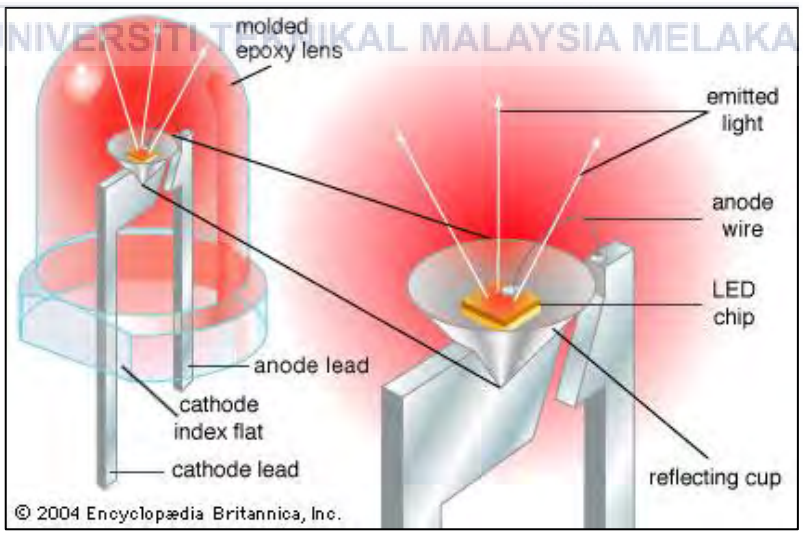


Figure 2.13: LED operating mechanism.

LEDs are produce many colour of light such as red, yellow, green and others based on the wavelength produced as shown in Figure 2.13. Each of the colour had their own voltage to make it complete the circuit (Royal, Academy, & Sciences, 2014). Furthermore, LED also had many type and version. The most commonly used in the industries such as traffic light signal are dome lens that produce the bright and sharp light. The other type of LEDs is stripe, single flat and other shape according to the its function and usage (Algainn, Leds, Properties, Devices, & Efficiencies, n.d.)

2.5 Electrical Connector

2.5.1 Circuit Wiring

The most importance thing to make the electrical circuit complete are connectors. The connectors are consisting of the wire, break board or circuit board. Circuit boards used to make electrical circuit more short in distance and simples without any complex wire connection that can prevent the short circuit from the leaking of the wire. The cable or wire also used to make the circuit complete and to connect the system used. Cable used for motor vehicle application are always copper strands insulated with PVC. Copper are widely used in the cable because of its give low resistivity about $1.7 \times 10^{-8} \Omega$m. PVC are the most suitable choice as the electrical conductor because PVC properties very high resistance to electrical and also to water, oil and other contaminants. (Denton, 2004)

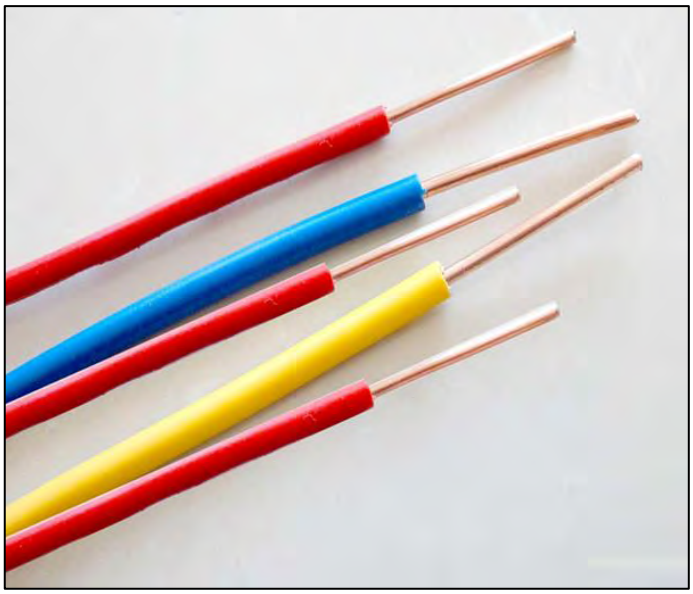


Figure 2.14: Copper with PVC insulator cable.

2.6 Switch

Selection for switch are based on the usage of the project. There are many types of switch used in electrical circuit such as, push button switch, toggle, tacks and slide switch. Difference switch had differences application and usage in circuit. For this project, the most suitable switch to connect to the brake system is using roller lever limit type actuator switch as shown in Figure 2.15.

Figure 2.15: Roller Lever Limit Switch.

2.7 MOSFET

Metal-oxide-semiconductor field-effect transistor (MOS FET) is based on the original field-effect transistor. MOSFET have the highest reverse base drive currents that can obtain fast turn-off. Figure 2.16 show that MOSFET have three channel same as the transistor. Three channel consist of Gate (G-channel), Drain (D-channel) and Source (S-channel) and each channel have their own function. Gate and Source channel have the voltage difference. The input Gate had very high resistance that can handle current until obtain the current handling required. High resistance of the Gate and Source can be used as open switch. For N-channel MOSFET the source is connected to the ground and to let the current flow at Source, applied the voltage on the gate allow current to flow.

Figure 2.16: Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET IRFZ44n)

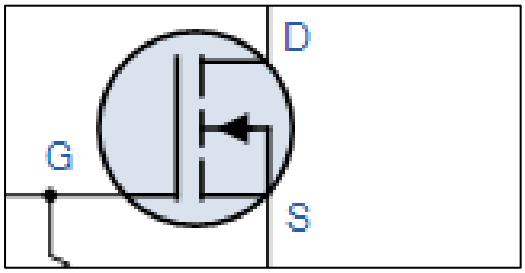


Figure 2.17: N-channel type MOSFET symbol.

2.7.1 Voltage divider and voltage controller

Figure 2.18 shows a voltage divider consists of two resistors in series(Chen, 2011). Input voltage is applied across R1 and R2. Output voltage V_{out} , is the voltage drop across R2. V_{out} is less than V_{in} because the total voltage across R1 and R2 must add up to V_{in}.

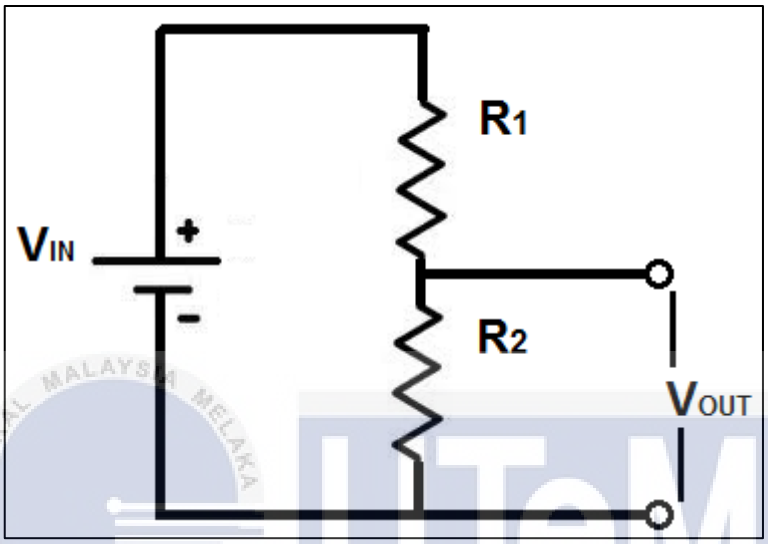


Figure 2.18: Voltage divider circuit schematic diagram.

If the load resistance is infinite, I_{load} will be zero. Figure 2.19 the current flow in a voltage divider with an infinite load resistance. If it assumes that load current is negligible, then equation (1) shows that $I_1 = I_2$. When $I_{load} = 0$ all the current supplied by the voltage source flows to ground through the series combination of R1 and R2(Recktenwald, 2012).

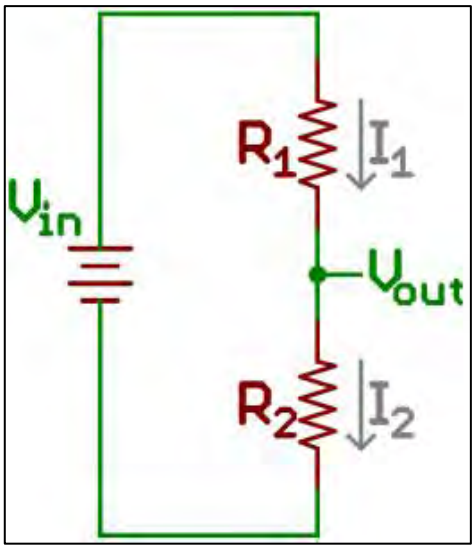


Figure 2.19: current flow in voltage divider.

Apply Kirchhoff's current law to the node between the two resistors in the voltage divider depicted in Figure 2.19.

$$I_1 = I_{load} + I_2 \tag{2.2}$$

Apply Ohm's law to the series combination of R1 and R2 with the common current I.

$$V_{in} = IR_{eff} \tag{2.3}$$

$$V_{in} = I(R1 + R2) \tag{2.4}$$

2.8 Wireless System Protocols

There are many type of connection option can be used to complete the circuit such as direct wiring from motorcycle brake wiring to the helmet or using wireless system. For the direct wiring system are not suitable to use because the helmet and motorcycle are separate part. Using direct wiring system will make the rider uncomfortable and will lead to factor of the accident. For the system selection, the most suitable for the Smart Safety Helmet are using wireless system. Using wireless system can make the system more complex but will give the ergonomic value to the consumer.

Wireless system is a system for connecting two components that do not use wire as communication components instead of using cable. In this chapter, it will present the comparison between three main short range wireless network (Hiscocks, 2011).

Bluetooth is a one type of wireless system that design for short range connection and cheap devices. There are two connectivity in Bluetooth are piconet and scatternet. Wireless Personal Area Network (WPAN) is application range used in Bluetooth (Statham, n.d.). A piconet is a WPAN formed by a Bluetooth devices serving as master. Each piconet defines address of the master based on frequency hopping channel. A Bluetooth device ca participate in several piconet at the same time, and information could be flow beyond the coverage area of the single piconet (Lee, Su, & Shen, 2007).

Figure 2.20: Ultra-Wide Band transmitter or receiver

Ultra-Wide Band (UWB) are the high speed and wireless communication that have the bandwidth over 110 Mbps up until 480 Mbps. UWB can replace the high speed serial bus (USB) because it can satisfy multimedia application such as audio and video (Lee et al., 2007).

ZigBee is low-rate WPAN (RT-WPAN) used for support simple devices that used minimum power compare to the other wireless protocols. It operates in the personal operating space (POS) range up to 10m. The full-function device (FFD) can operate in three modes, and it can talk to reduce-function device (RFD) or other FFD. RFD is intending for applications that used simple application such as light-switch or passive infrared sensor. RFD can be implement using minimal resource and memory capacity (Lee et al., 2007).

Third connection protocol is most known and popular nowadays as Wi-Fi or Wireless fidelity. Wi-Fi use wireless local area network (WLAN) that allows the user surf the internet or connection when connect to access point (AP) (Lee et al., 2007).

Radio Frequency Identification (RFID) have lower position accuracy than Wi-Fi and UWB technology. RIFD have the advantages of the lower cost, technical matter, simple, affordable and compatible (Sattlegger & Denk, 2014). The disadvantages of this communication are short range communication and low in positioning accuracy (Tsirmpas, Rompas, Fokou, & Koutsouris, 2014).

Comparison of the all connections are shown in the Table 2.2 and Table 2.3 below:

Table 2.2: Comparison on the wireless protocols.

Standard	**Bluetooth**	**Ultra-wide band (UWB)**	**ZigBee**
Frequency band	2.4GHz	3.1-10.6GHz	2.4GHz
Max signal rate	1Mbps	110Mbps	250Kbps
Range	10 m	10 m	10 m–100 m
Advantage	Simple Compatible	High positioning accuracy	Low cost
Disadvantage	Not affordable High cost Lower in positioning accuracy	Antenna misplace	Lower in positioning accuracy

Table 2.3: Comparison on the wireless protocols.

Standard	**Wi-Fi**	**RFID**
Frequency band	2.4GHz/5GHz	300MHz-3GHz
Max signal rate	54Mbps	13Mbps
Range	100 m	1m-15m
Advantage	High positioning accuracy	Simple Compatible Lower cost
Disadvantage	More expensive	Lower in positioning accuracy

2.9 Electronic devices and systems

Electronic system is the complex and physical interconnection of the electric and electronic components. The electronic can gathers various amount of information together more fast. Its consist of the input and output action to control the process. The input devices example that used is sensors, switch, and command. Electronic signal is representing either by voltage or current. Direct current (DC), sinusoidal or known as Alternating Current (AC), pulse modulated signal and square wave are the time dependent characteristic voltage (Hongshen ma,2005).

Sinusoidal signal is specified by its amplitude (A), angular frequency (ω), and phase ($\emptyset$) as,

$$V(t) = A\ \sin(\omega t + \emptyset) \tag{2.4}$$

When working with sinusoidal signals, the mathematical manipulations often involves computing the effects of the circuit on the amplitude and phase of the signal, which can involve cumbersome trigonometric identities. Operations involving sinusoidal functions can be greatly simplified using the mathematical construct of the complex domain.

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter explain about the methodology of the whole process and system that will be use in the development of the safety helmet.

3.2 General methodology

The step must be carried out to achieve the objective of this project are listed as bellow:

1) Literature review

   Journal, article, helmet history and technology, wireless, communication technology Radio Frequency Identification (RFID), safety and other related information.

2) Design the product

   Design for the brake light as well as the wireless system function

3) Fabricate

   Fabricate the circuit system.

4) System function

   Focuses on design and development circuit for system functioning follow with fabricate the product.

5) Test and Analysis

   Test the visibility of the motorcycle using extra brake light and FEA for bracket to hold the LED attached on helmet.

6) Result

   Collect the result and analysed.

7) Final report

   Write the final report.

Flowchart of General Methodology.

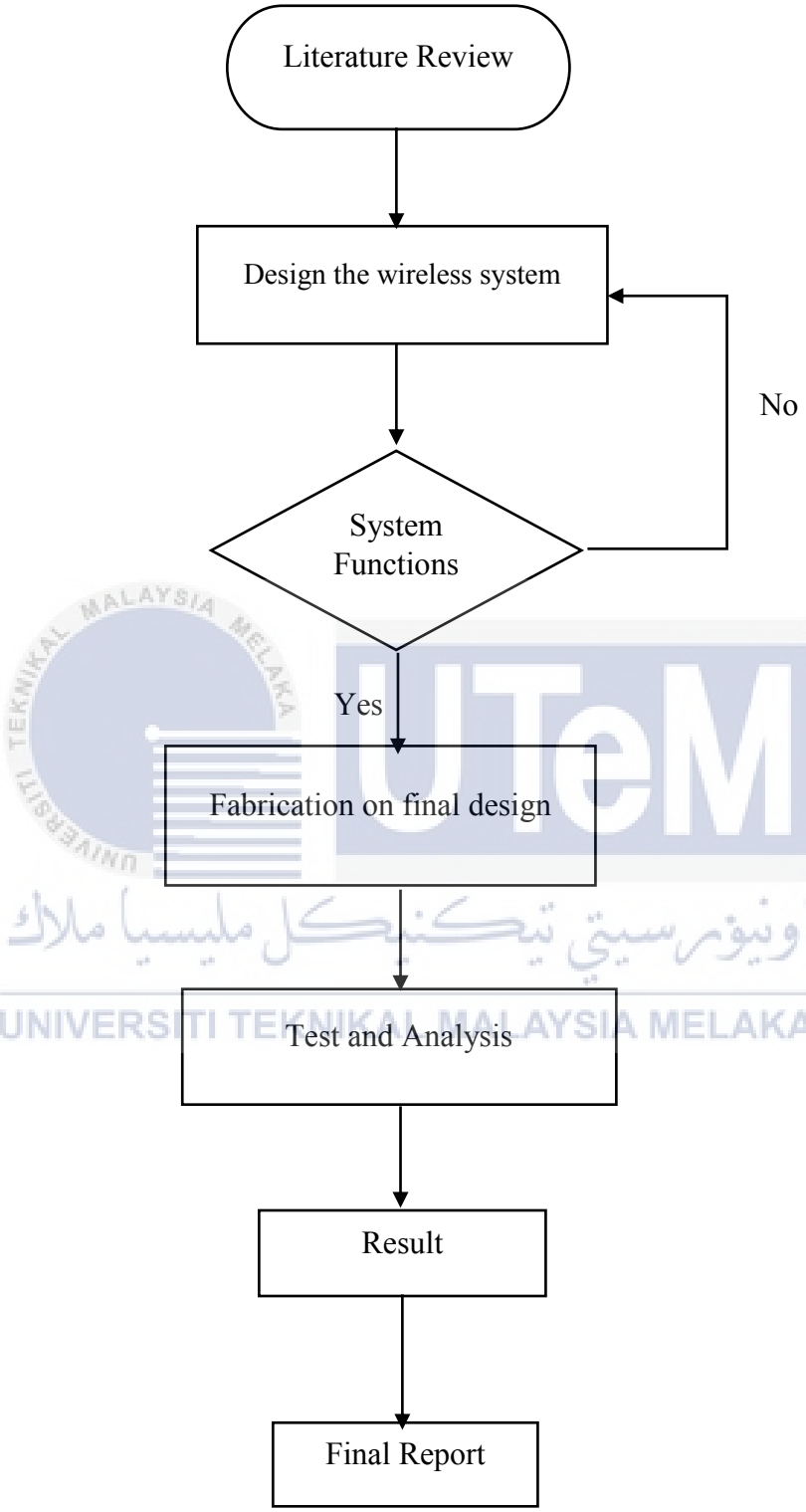


Figure 3.1: flowchart of the project.

3.3 LED Blinking System.

LED blinking system using LED as the source of light that will emit light. To make the LED flashing and blinking, the electronic system had been used consist of the power source, resistor, capacitor and integrated circuit to complete the system. The blinking rates can be adjusted by adding the resistor and capacitor. In this project, integrated circuit (chip) type NE 555 had been used. This NE 555 or timer integrated circuit is used to provide time delays, as an oscillator and as flip flop element. The supply voltage use in this system is around 4.5v – 12v.

The system starts by use the simulation electric circuit using Proteus 8 Professional simulation software to design and testing the suitable circuit for this project design. Sketch the circuit and check the error in the Proteus software to make sure all the components are suitable and accomplish the design function to blinking.

Upgrade the system by using electronic device that can control all the activities of the circuit. Arduino software that use coding to give the input and instruction to run the circuit. Advantage using Arduino are, easies and simple coding to make the circuit smaller and compact. Figure 3.2 show the code and Figure 3.3 show the diagram for simple LED blinking system using Arduino Uno software.

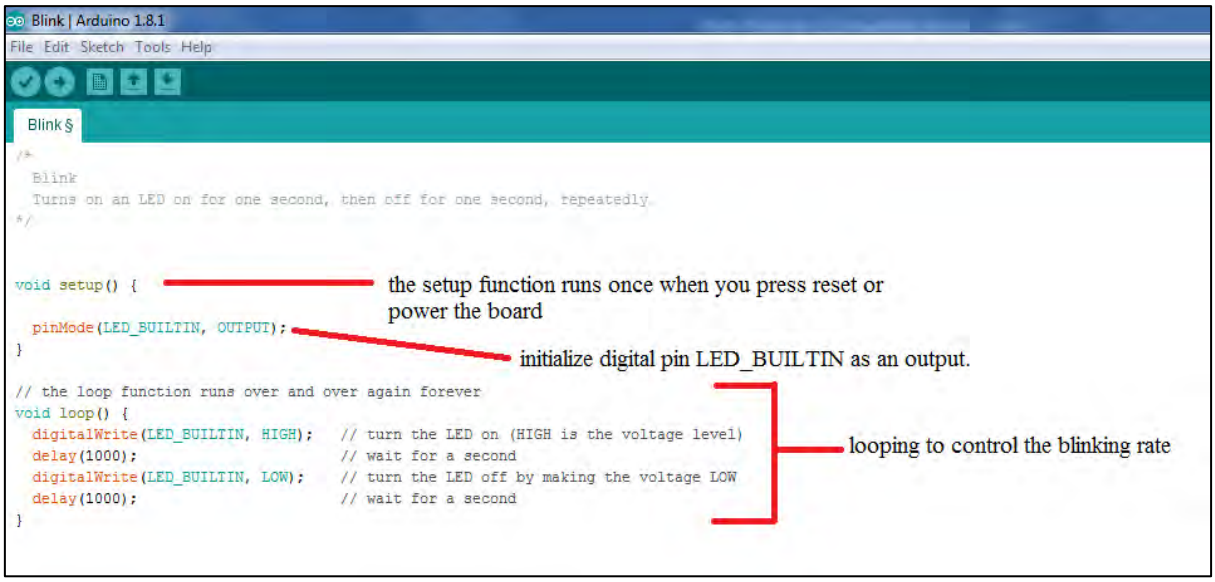


Figure 3.2: Basic blinking system using Arduino Software.

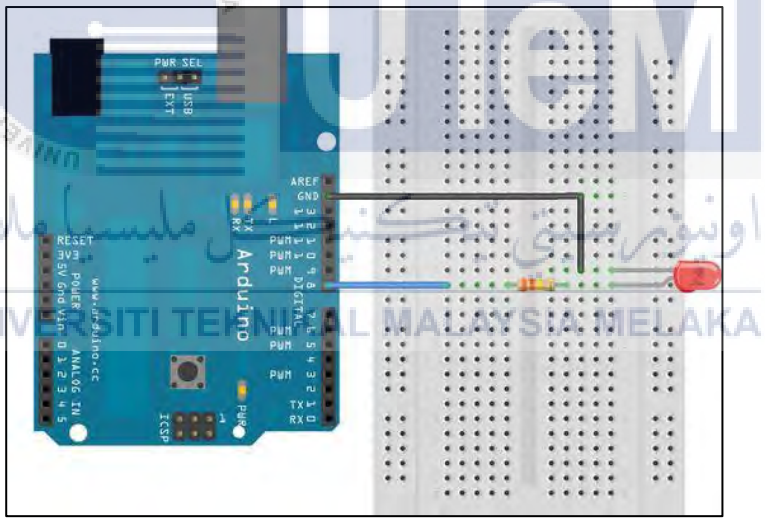


Figure 3.3: Schematic diagram for basic blinking system using Arduino.

3.4 Wireless Connection

From the research in literature review, the most suitable wireless protocol to use in this system is Radio Frequency Identification (RFID) that most commonly used in remote control (RC) cars toy and other. RFID was selected because the system simpler, compatible and low cost compare to the other four. RFID signal range about 1m to 15m only and suitable for smart helmet system that only required 2m to 3m range only. The RFID frequency used usually between 27MHz – 49MHz for the connection radio transmitter.

After some research and survey, the most suitable based on the market availability and low cost NRF 24L01 transceiver Arduino radio wave connection had been chosen. The radio wave connection using Arduino are needed to install the wireless library system into the Arduino software to make the wireless system can run. Installing the library that had been download from the internet. Coding the program using suitable coding and make sure the system working properly. Figure 3.4 shows the coding using Arduino software for the transmitter system. Looping method use to make sure signal sent continuously and will perform instruction inside looping system.

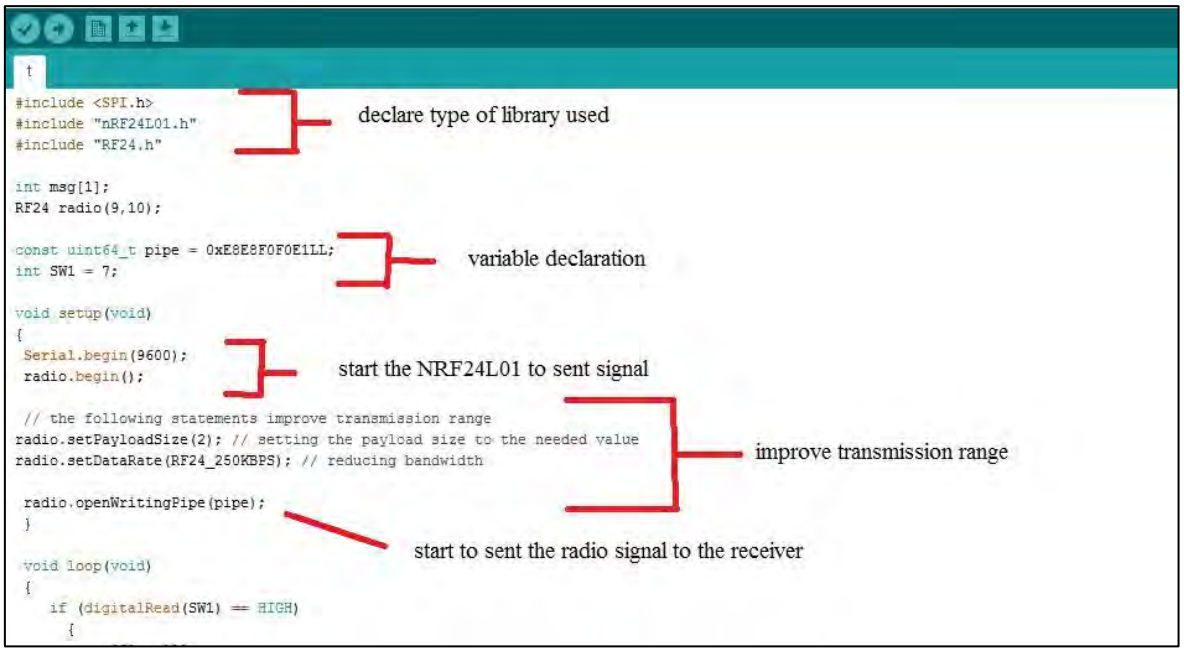


Figure 3.4: Coding declaration library for wireless system (transmitter).

3.5 Schematic Diagram of The System

3.5.1 Transmitter

In Figure 3.5 shown the schematic diagram for circuit system for the transmitter module. The connection for this circuit will explain about the basic connection for the wireless system that had be used. Using NRF24L01 transceivers module model from Arduino company that had multi-function to transmit and receive the signal based on the instruction write using software programming. The connection start with the 12 Volt power supply from battery to the Arduino Uno R3 board. The connection from Arduino Uno R3 to the NRF24L01 transceiver as in Figure 3.6 that have total eight wires and only use seven wires to connect to the Arduino Uno R3 board. VCC connect to 3.3V, GND pin connect to ground pin on the Arduino Uno, CE pin connect to pin 9, CSN pin connect to pin 10, SCK pin connect to pin 13, MOSI pin connect to pin 11, MISO pin connect to pin 12 and last pin IRQ are not connect to any pin on the Arduino Uno.

Other than that, switch is install to give the input to the system to send the instruction to the receiver. From the power source from Arduino Uno, 5V pin connect directly to the switch. From the switch, separate two wires will firstly connect to digital pin input at pin 7 and another connection will connect to 1kΩ resistor to the ground pin.

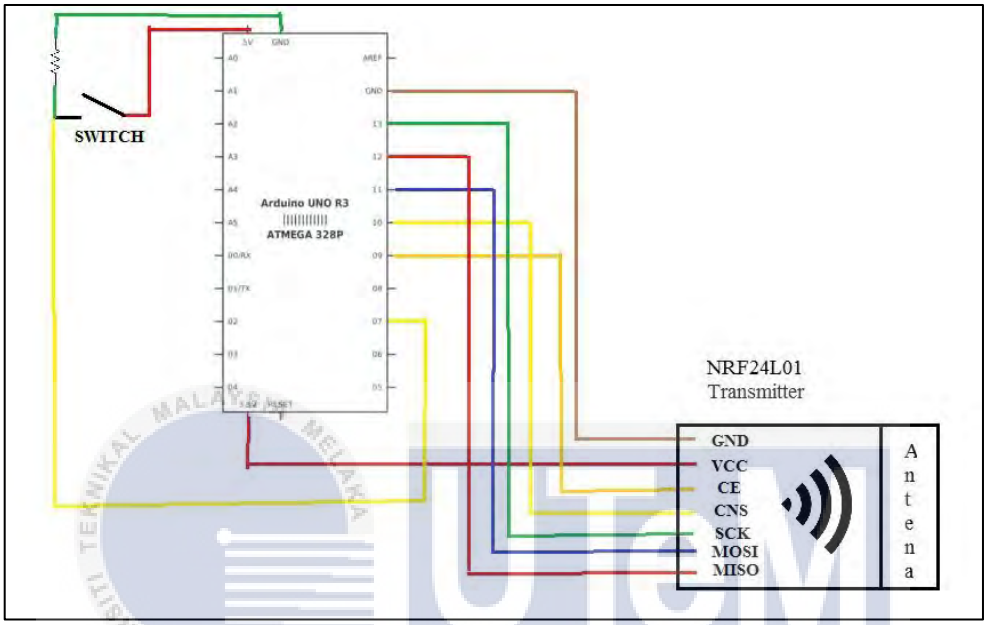


Figure 3.5: schematic diagram for transmitter circuit system.

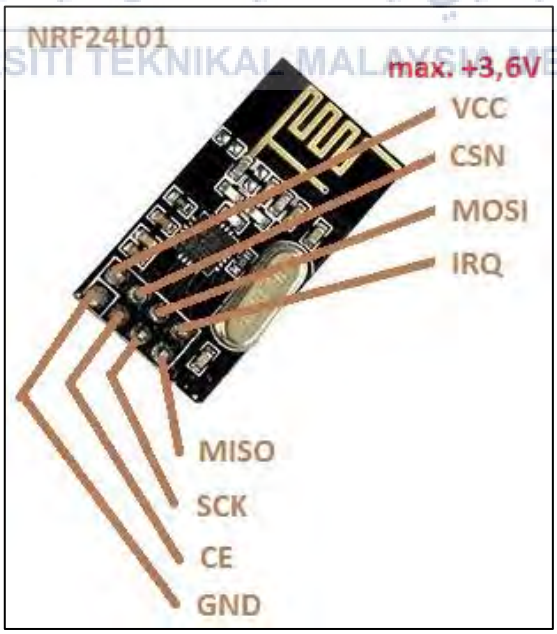


Figure 3.6: NRF24L01 Arduino transceiver module.

3.5.2 Receiver.

Figure 3.7 show the schematic diagram for the receiver system that install to the helmet. The connection for the wireless system same as the transmitter, the difference only this board are using Arduino Nano that have the same function as Arduino Uno. For the light control, the 12V power supplies from the battery connect to the Arduino Nano and another usage are connecting to power up the LED light. From the positive terminals connect to the positive LED strips. From negative terminals of the LED connect directly to the MOSFET at drains channel (D-channel). Then, from negative terminals from battery separated two connection that will directly went to GND pin on the Arduino Nano and the other connection will connect to the Source channel (S-channel) MOSFET. For the controlling the electric current flow to the LED strips, pin 20 or digital pin 3 connected to the Gate channel (G-channel) on the MOSFET.

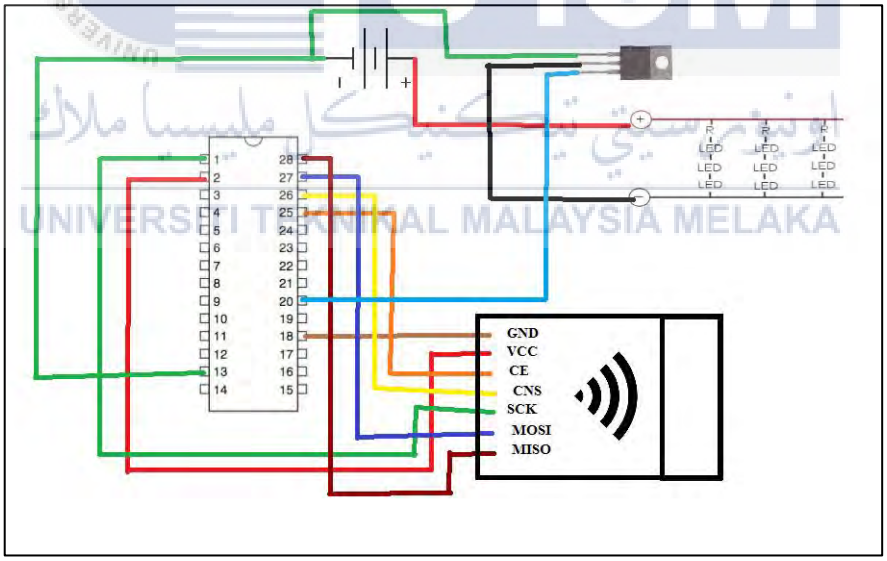


Figure 3.7: Schematic diagram for receiver circuit system.

3.6 Fabrication Process

This process fabrication must know the basic component and how to connect the circuit. By refer to the schematic circuit that was build using Proteus 8 software, connect all the component and make sure all the components work properly without any error. Testing the current and connectivity of the circuit using multi-meter to make sure all the LED operate perfectly. Properly install the detector (input) from the applied brake and signal turn at the motorcycle to make the circuit complete and signal sent to the helmet directly using RFID signal to the safety helmet.

At the helmet, design part to put the circuit and the stripe of LED to be used that had limited and compact space. To make sure the battery and all the components can be install to the helmet, the other compartment was design and can be easily to install on the helmet.

Start the fabrication process by testing the circuit on the breadboard using male to male shown in Figure 3.8 or male to female jumper wire because it is easy to learn and testing to find the most suitable connection. Connect the wires to the Arduino Uno to breadboard to perform the simple circuit using LED as the output process, and coding for simple blinking to test for the system in Figure 3.9 below.

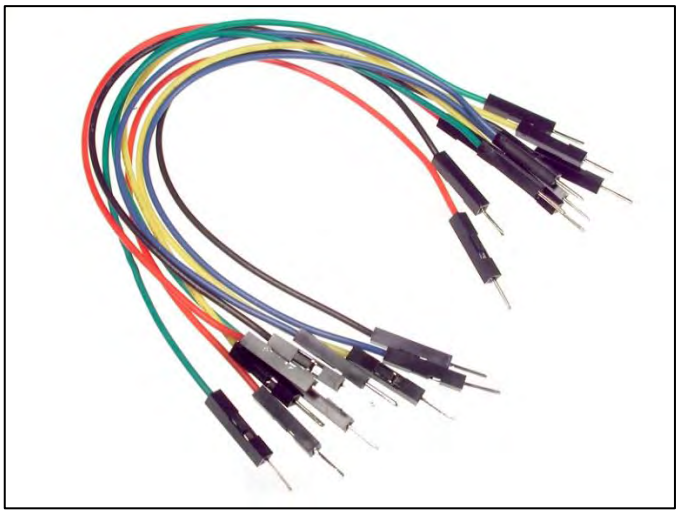


Figure 3.8: male to male jumper wire.

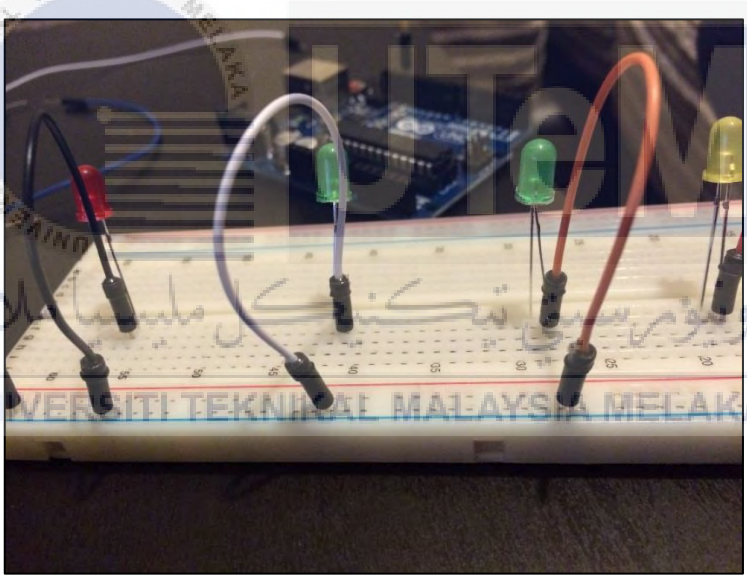
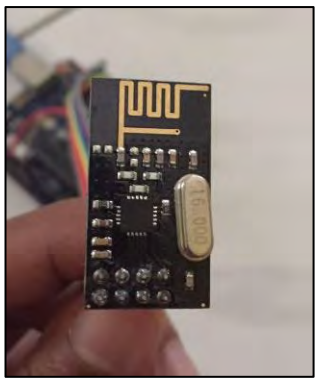


Figure 3.9: Testing for blinking system.

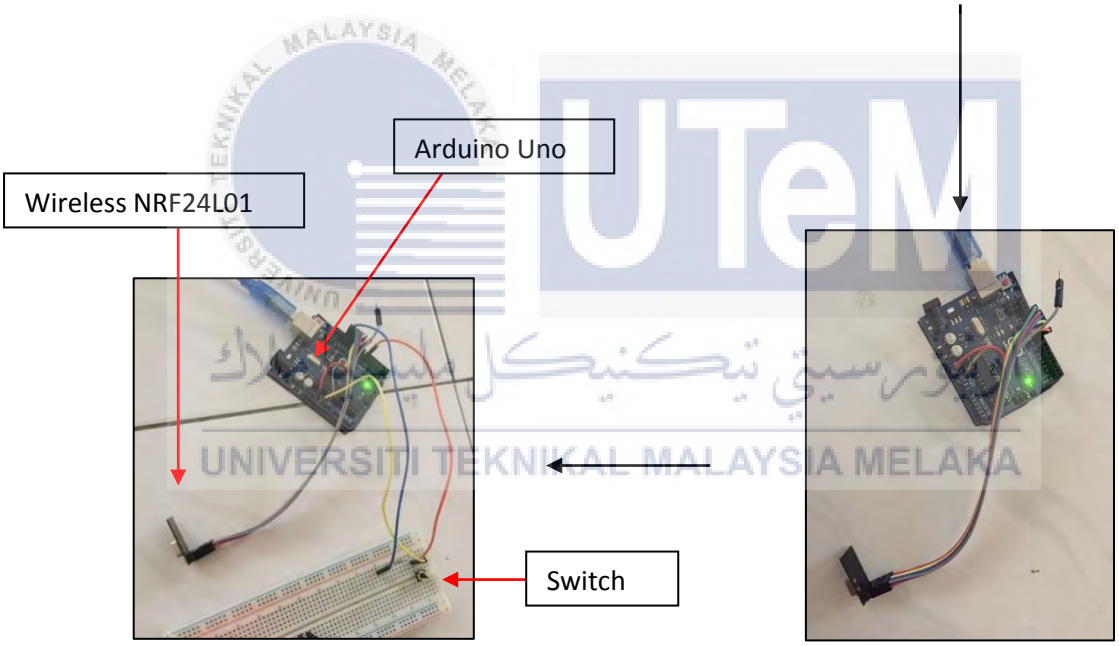
3.6.1 Transmitter

Fabricate for the transmitter system



NRF24L01 wireless transceiver

Install connecting wires to NRF24L01

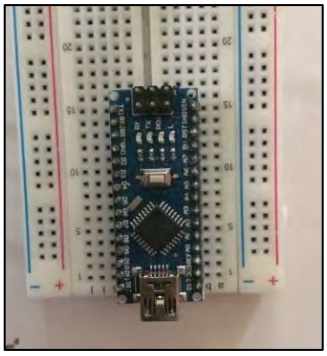


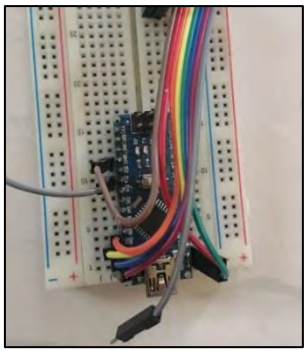
Complete the circuit adding switch

Connect wireless module to Arduino

Figure 3.10: flow chart transmitter fabrication.

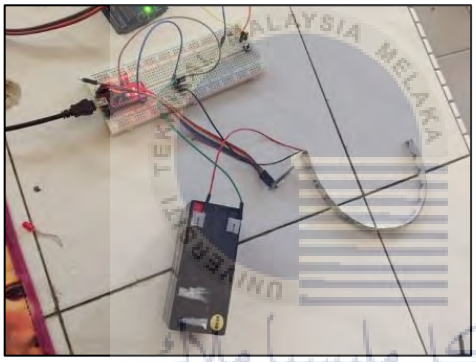
3.6.2 Receiver

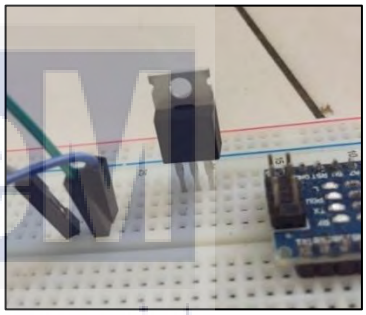




Install Arduino Nano on the breadboard

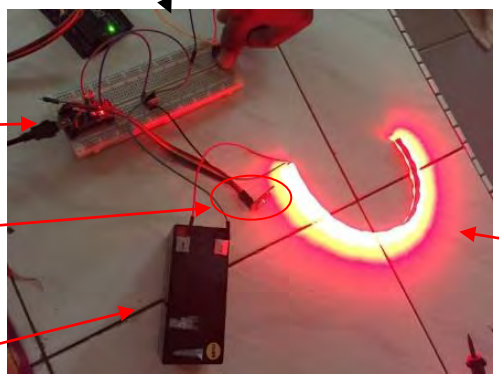
Connect the wires to the NRF24L01





Complete the circuit

Connect MOSFET to circuit.



Testing the system.

Figure 3.11: flow chart receiver fabrication.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Understand the Wireless System.

In this chapter, the product had been tested the function and operation to make sure can working properly especially for the wireless system. For the wireless system, Figure 4.1 show the overall system about wireless system that will be used in this project. The input come from brake and radio wave signal sent from motorcycle by transmitter. Signal sent will receive by the receiver on the helmet to turn on the LED brake light on the smart safety helmet.

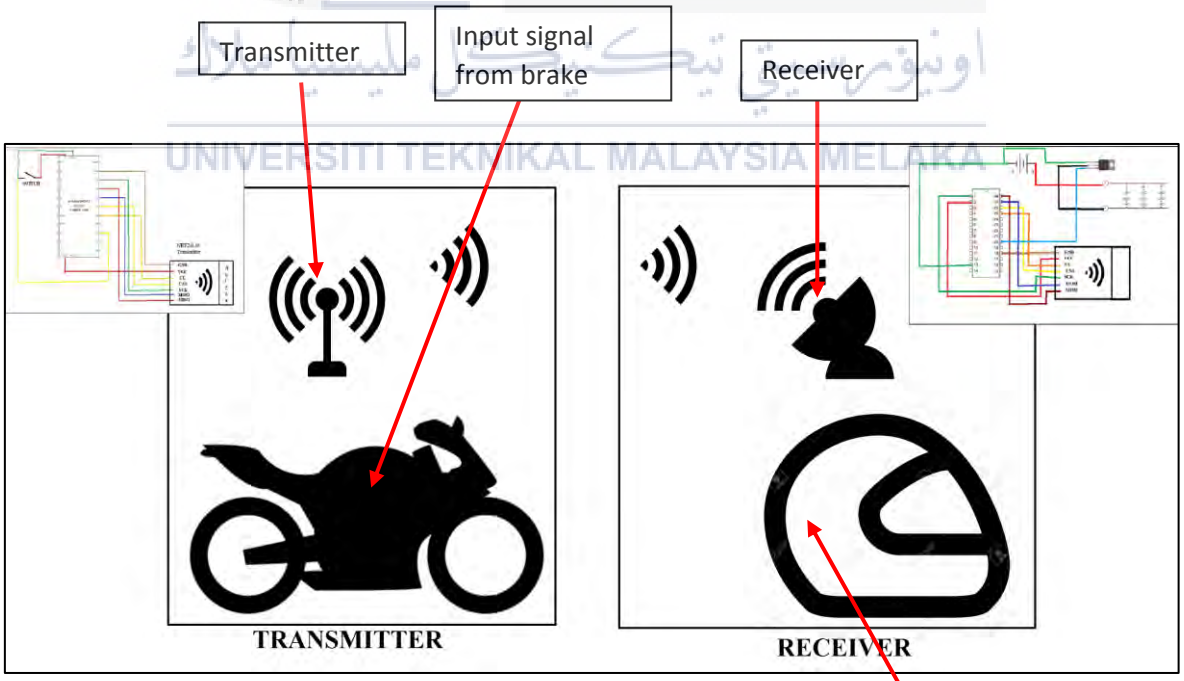


Figure 4.1: Illustrated wireless system.

Coding and write the program in Arduino software for the wireless system. Wireless test, by using coding Arduino to detect the signal receive or not by the receiver. Figure 4.2 shows 'No radio available' massage shows that no signal received by the receiver and nothing will be performing at the output. When the massage '111' as shown in Figure 4.3, the meaning of the massage is radio signal received the instruction from the transmitter.

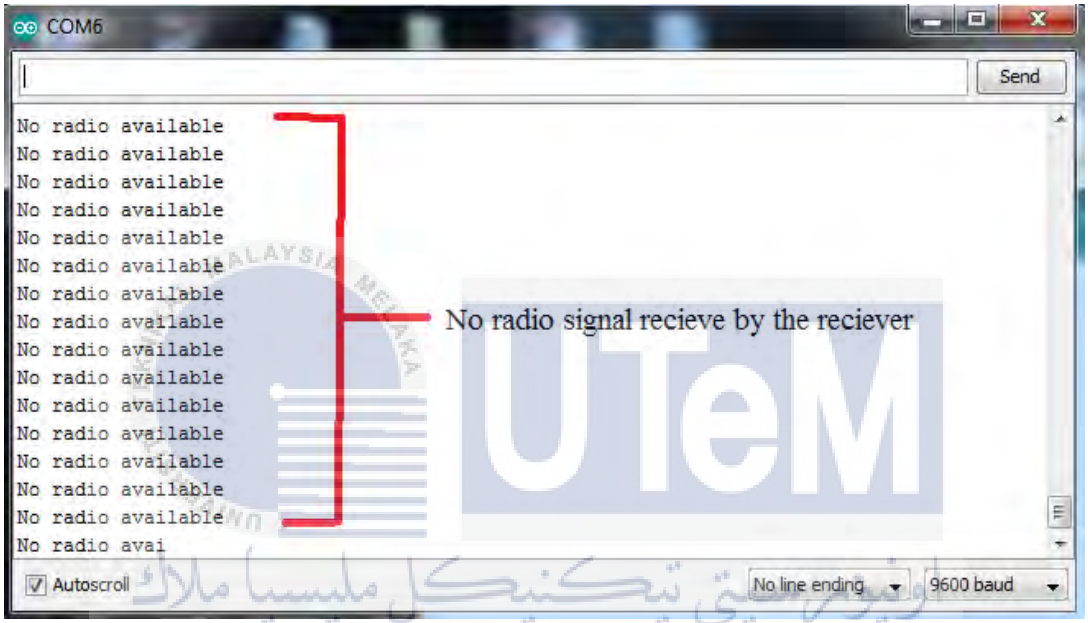


Figure 4.2: The "No radio available" massage show the receiver not get signal.

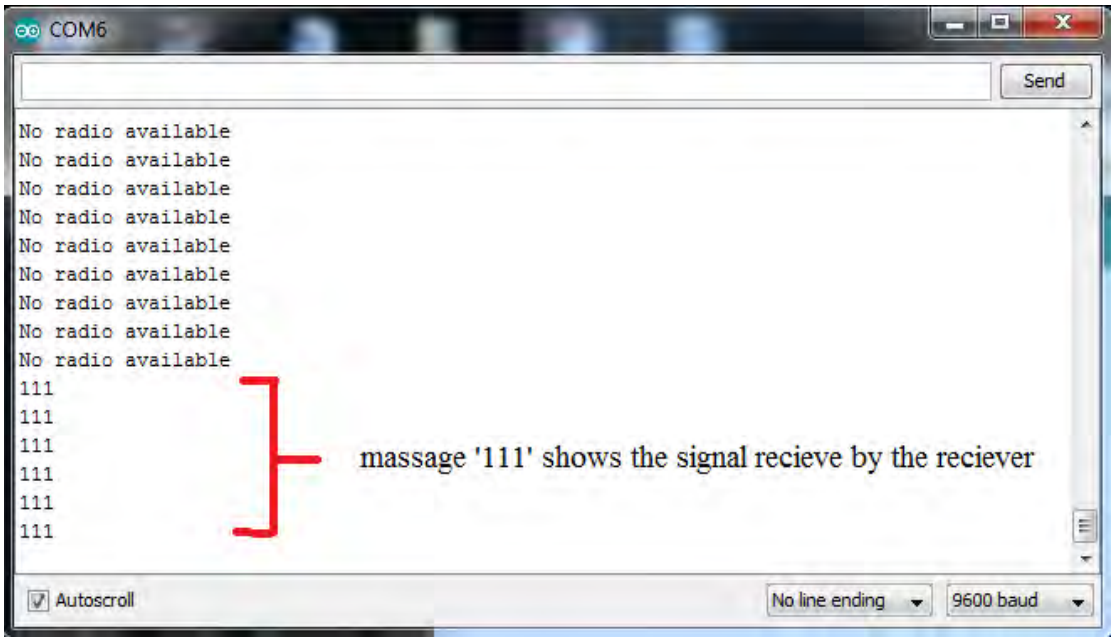


Figure 4.3: Massage “111” show the signal reach the receiver.

For the blinking LED system, Figure 4.4 show the coding is used to control blinking rate in the Arduino software. When the receiver received signal from transmitter, it will complete the circuit and turn on the LED by using MOSFET Z44N type transistor. MOSFET will become switch to connect the high voltage LED with command from Arduino. Testing for blinking rate to make sure the blinking suitable and attract more attention to the other vehicle on road.


```
if (msg[0] == 111)
  {
    delay(10);
    digitalWrite(LED1, HIGH);
    {
      digitalWrite(LED1, HIGH);
      delay(500);
      digitalWrite(LED1, LOW);
      delay(500);
    }
  }
```

looping used to make LED blinking

Figure 4.4: Coding for blinking system.

4.2 Wireless NRF24L01

The wireless signal used to send the signal from motorcycle to the helmet, NRF24L01 radio wave signal were used. NRF24L01 have 8 ports that connect to the Arduino consist of ground (GRN), power supply (VCC), CE and CSN pin connected to any digital pin, MOSI, MISO, SCK, and SS (not used).

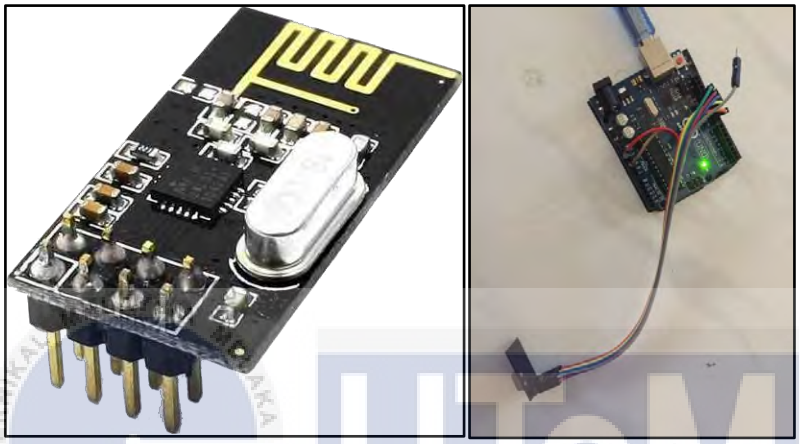


Figure 4.5: NRF24L01 radio transceiver and (right) NRF24L01 connect to Arduino.

4.3 Coding and Program of Arduino (UNO and NANO)

Arduino Microcontroller is simple and easy to use that only using direct command coding. Figure 4.6 show the interface of the Arduino software installed in the computer. Coding write in the dialog box with correct command. The complete coding can verify the error at any line the mistake happen. Completed code upload to the Arduino board using USB (Universal Serial Bus) cable.

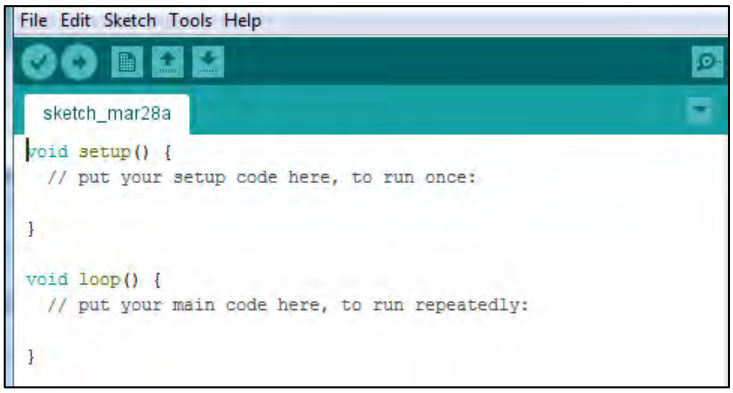


Figure 4.6: Arduino Software interface.

Figure 4.7 shows the coding of declaration for the switch and the radio signal to read by the software and microcontroller to transmit the data. Transmitter coding using radio library. Writing the transmitting coding to send to specific receiver to make sure the receiver will receive the correct signal. Figure 4.8 coding to send the commend to the transmitter, when pressing the switch the radio will sent signal to the receiver.

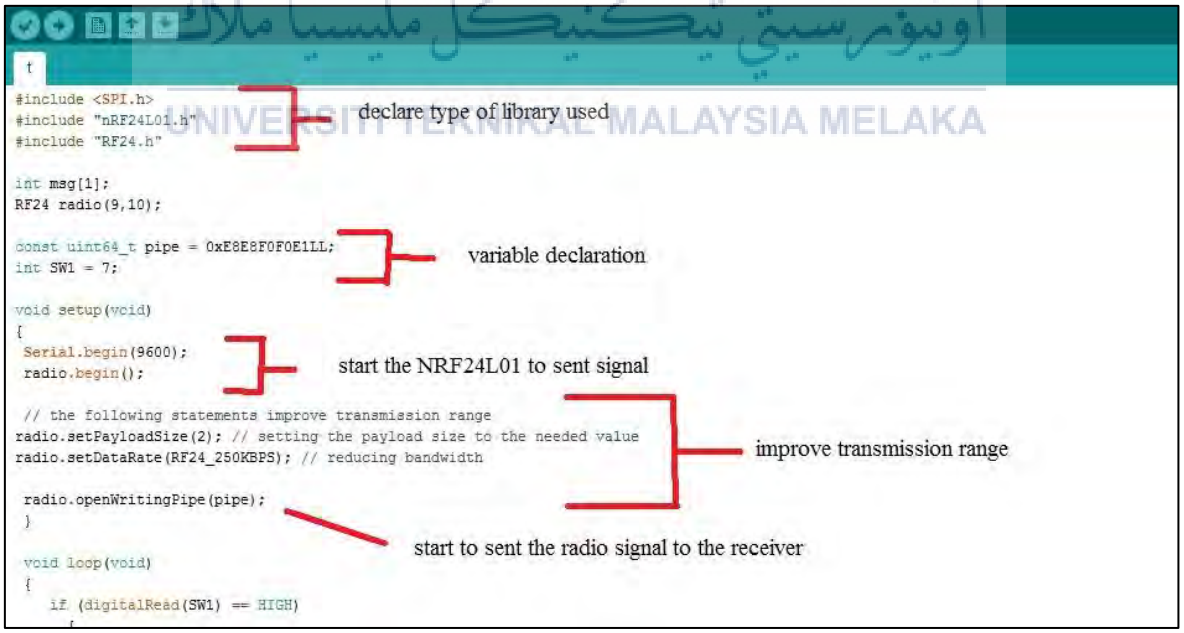


Figure 4.7: Writing radio library and coding for sending signal.

```
void loop(void)
{
   if (digitalRead(SW1) == HIGH)
     {
       msg[0] = 111;
       radio.write(msg, 1);
     }
   else;
   {
     digitalWrite(SW1, LOW);
     }
}
```

Figure 4.8: Coding to receive command from switch.

Figure 4.9 show the coding for the receiver operation receiving signals from transmitter. Upper paragraph of the coding shows the declaration of the library or function to use in the program. Library for radio signal declare as shown in the Figure 4.9 below. Writing the variable declaration to state the variable to be used in the coding writing such as int, char, doubles and others. The constant value to use for pipe also must be declare and initialize the output pin to use on the Arduino board.

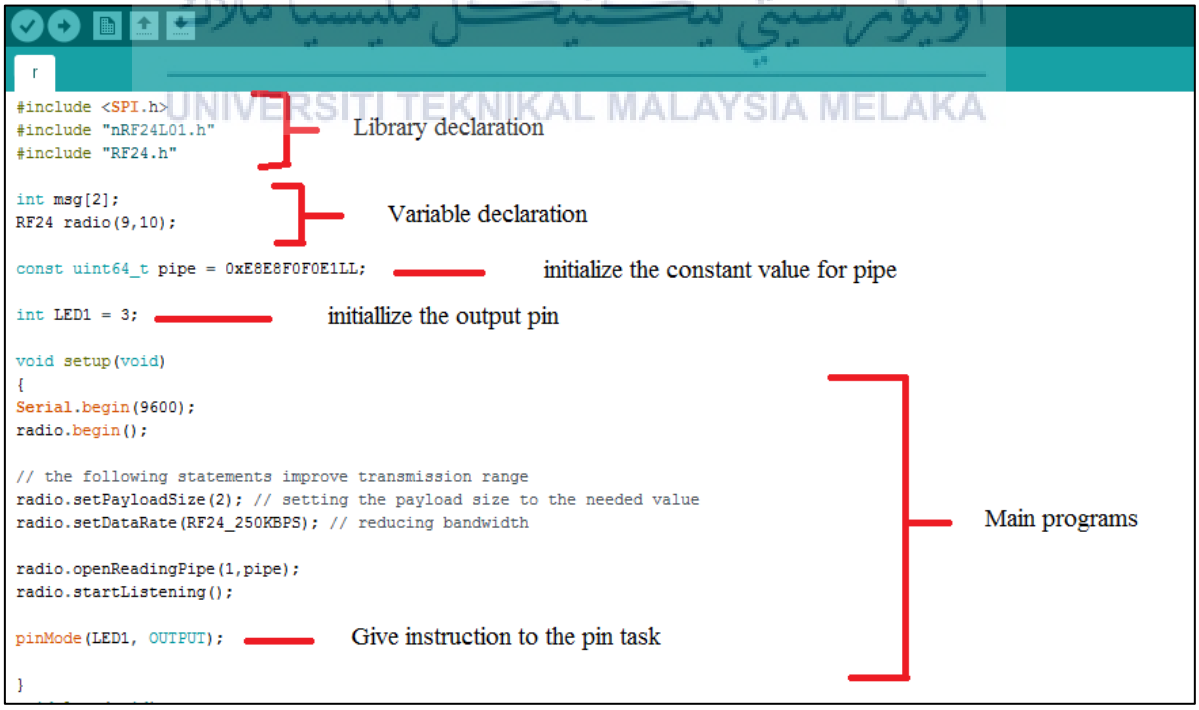


Figure 4.9: writing radio library use and initialize the output pin.

Furthermore, Figure 4.10 shows the looping method had been write twice to make the system works. For the first looping system is writing to read the radio signal continuously that have been receive from the transmitter. If statement for the looping system will operate when input TRUE and stop the operation when input FALSE. If the radio signal receives the system will turn on the PIN and make the complete circuit for the LED light system. To make LED blinking, the looping system wrote to make the LED blink and the blinking rate can be control by using the coding.

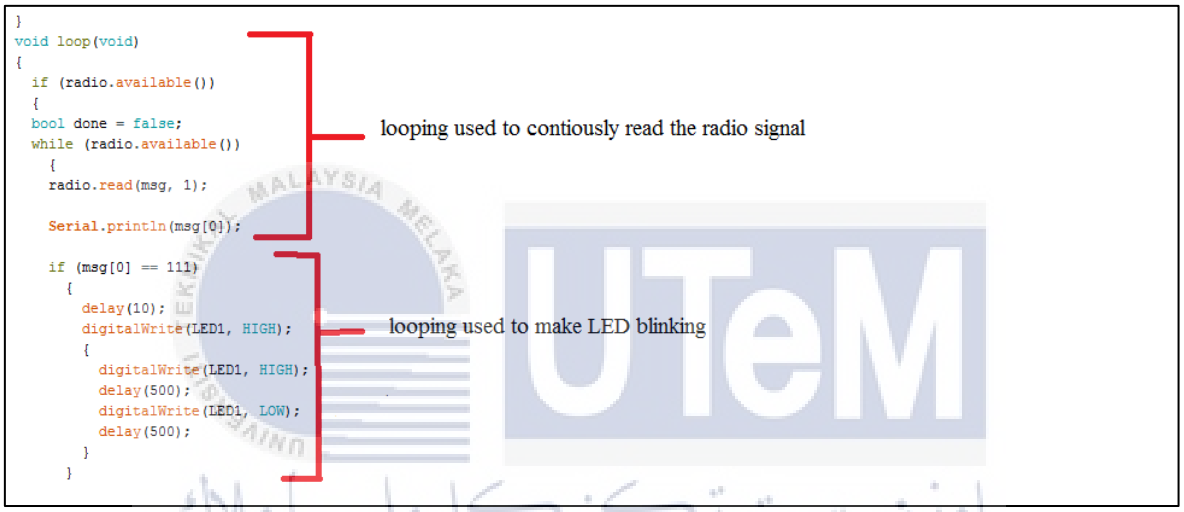


Figure 4.10: declaration output pin and looping method.

Lastly, the massage output for the radio signal print on the computer screen was setting based on the looping system on Figure 4.10 above. From Figure 4.11 show that, If and Else statement used to make the massage output. When radio signal receives, the screen will print '111' massage and when no signal massage 'No radio signal' will appears on the screen. From the massage on the screen, user can know the wireless system for sending and receiving the signal working or not.

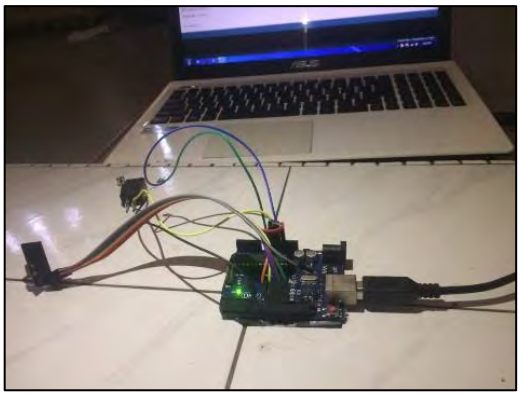
```
    else
      {
      digitalWrite(LED1, LOW);
      }

    delay(10);

    msg[0] == 9;
    }
  }

  else;
  {
    Serial.println("No radio available");
    digitalWrite(LED1, LOW);

  }

}
```

Figure 4.11: performing the output signal and massage.

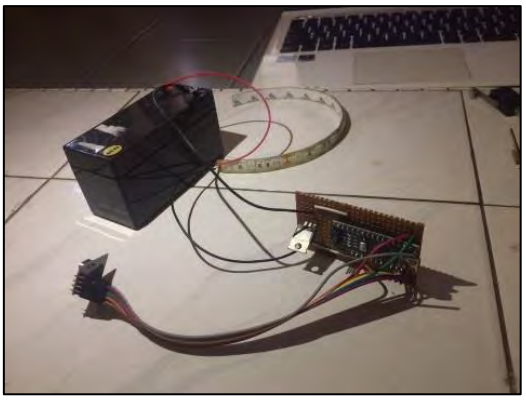
4.4 Prototype of Safety Helmet

In order to make this prototype develop successful and complete, the main system need to be working properly. There are three main system that is wireless system, blinking system and power system. The system will operate or run when the main switch is on, and the circuit will complete to receive the signal from transmitter. When the brake applied, the push on switch will press and complete the circuit to give the command to the Arduino to send signal to the receiver. Figure 4.12 show the final prototype model of the Smart Safety Helmet

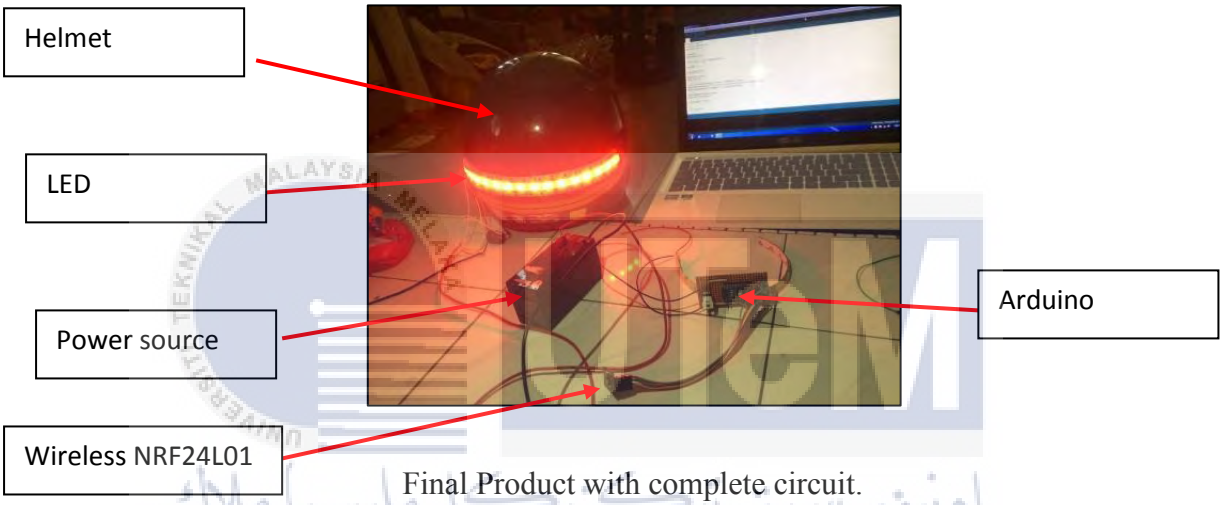
.



Transmitter



Receiver



Final Product with complete circuit.

Figure 4.12: Final Product of the smart safety helmet model system.

Figure 4.13, 4.14 and 4.15 show the design of the safety helmet using CATIA V5 software to get the suitable design for the Smart Safety Helmet installation. The bracket is design to make sure can hold the circuit safety and cannot be steal easily. It was design to make sure the bracket can easily to install to any type of the helmet that have in the market and also smart design to attract the consumer to use the smart safety helmet. The design ideas are focus on the safety purpose without modification of the original helmets. Material selection and construction will focus on the water proof element because using electronic

and electrical system. The other characteristic is, shock absorber and long lasting also considered.

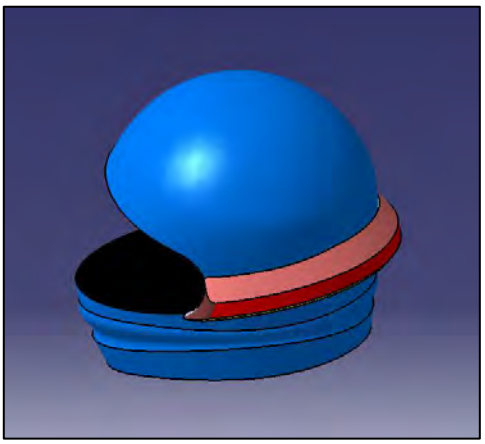


Figure 4.13: Isometric view design of the bracket Smart Safety Helmet.

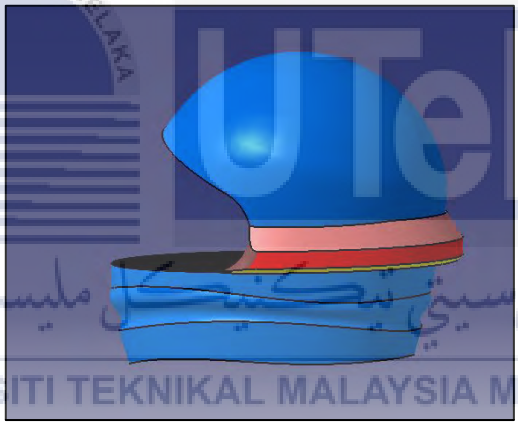


Figure 4.14: Side view design of the bracket Smart Safety Helmet.

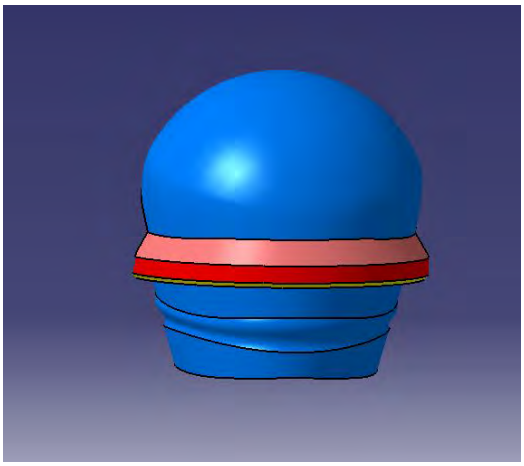


Figure 4.15: Back view design of the bracket Smart Safety Helmet.

4.5 Test of system

Several tests had been made to take the result and comparison of visibilities with without tail light, only tail light, and addition using LED on Smart Safety Helmet. Test had been made using difference condition and time. There are two condition, that is fine weather and rainy condition. Time choose are at noon, dawn, night with road lamp and at night without road lamp. Test distance of visibilities start with 5m, 10m, 20m, 30m, 40m, 50m, 60m and 70m from the observers.

Figure 4.16 show the view from the normal condition motorcycle at night and Figure 4.17 show the view when wearing Smart Safety Helmet. The LED light on the Smart Safety Helmet make the rider more attracted and easy to spot compare to the normal helmets. For the high intensity of light on normal fine weather, test for the visibility shown in Figure 4.20 at 1.30 p.m. noon. Light from sun very high that will make the LED lights are very hard to visible and cannot attract the other vehicles from back.

Figure 4.16: ordinary tail light back view

Figure 4.17: Ordinary tail light with smart safety helmet when brake.

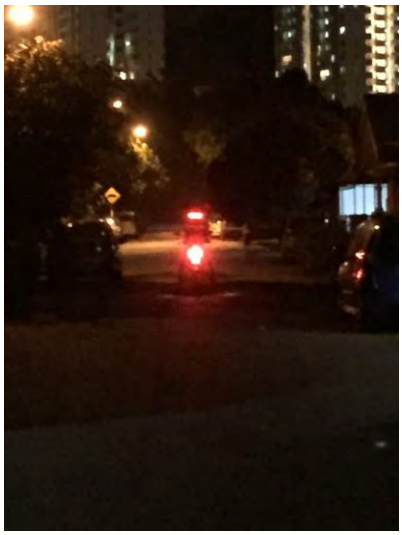


Figure 4.18: Testing visibility at distance 70m (9.00 p.m).

Figure 4.19: Testing visibility at afternoon condition (1.30 p.m)

4.6 Graph of Visibility

Figure 4.21, 4.22, 4.23, 4.24 and 4.25 shows the graph of the distance against visibility of the motorcycle on the road based on 3 average respondents view. The difference condition and light intensity gives the result about the visibility of the normal eyes marking from the highest visibility 10 – 0 lowest visibility. From the graph, motorcycle with ordinary or normal brake light used as the benchmark or datum to measure the differences of the visibility when using Smart Safety Helmet.

The test held at the same place with same observers to get the fair result of the visibility. Difference distance to take the reading start from 5m, 10m, 20m, 30m, 40m, 50m, 60m, and 70m from the observers. Time of the experiment and weather condition are difference which is fine weather during afternoon, evening, night with extra light from road lamp and without road lamp also during rainy condition at night.

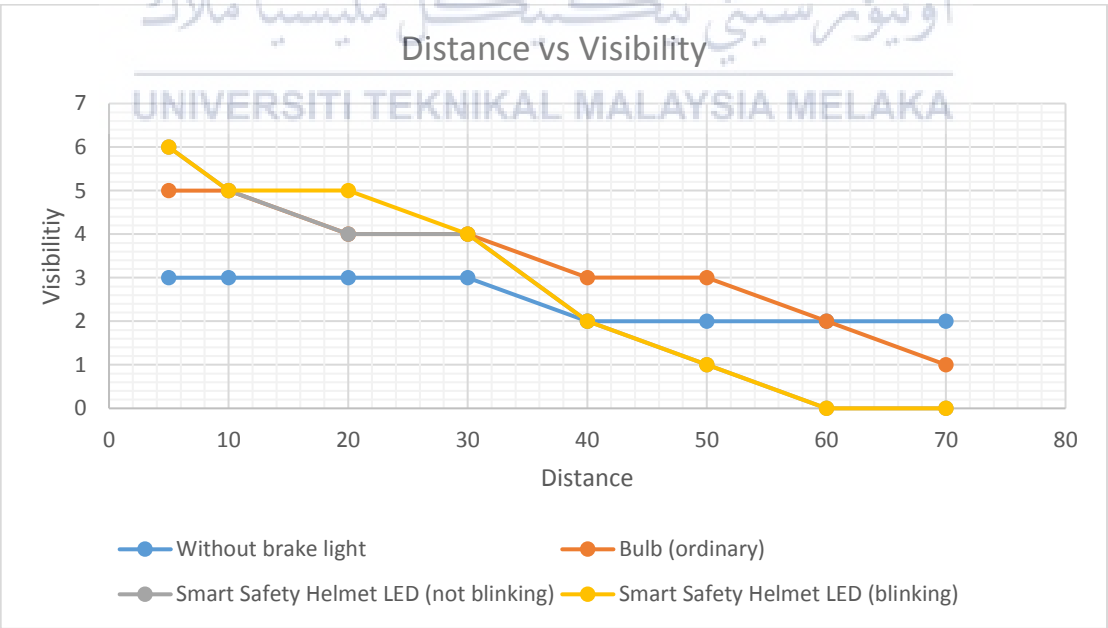


Figure 4.20: Graph distance vs visibility based on normal naked eye fine condition at afternoon (1.30 p.m).

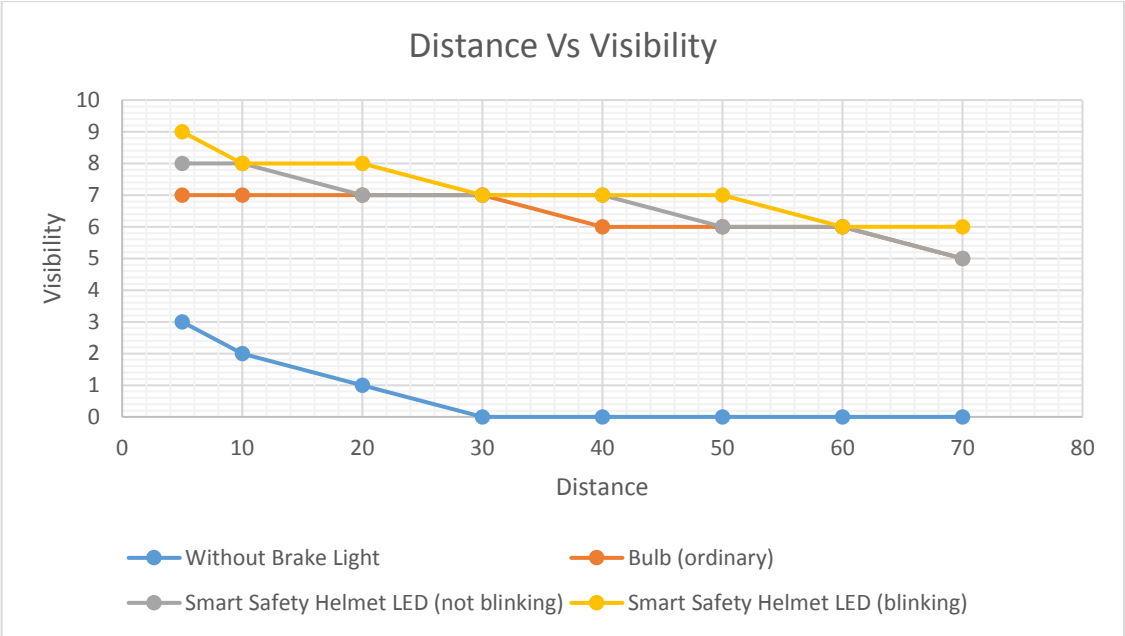


Figure 4.21: Graph distance vs visibility based on normal naked eye fine condition at evening (7.00 p.m)

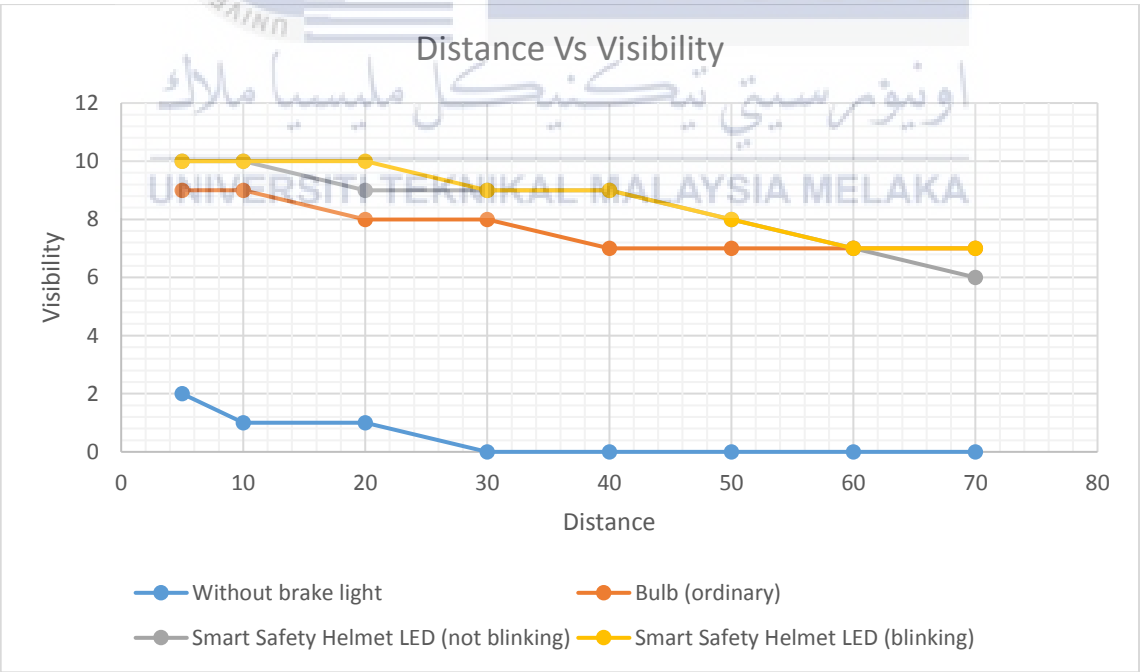


Figure 4.22: Graph distance vs visibility based on normal naked eye fine condition night with road lamp (9.00 p.m).

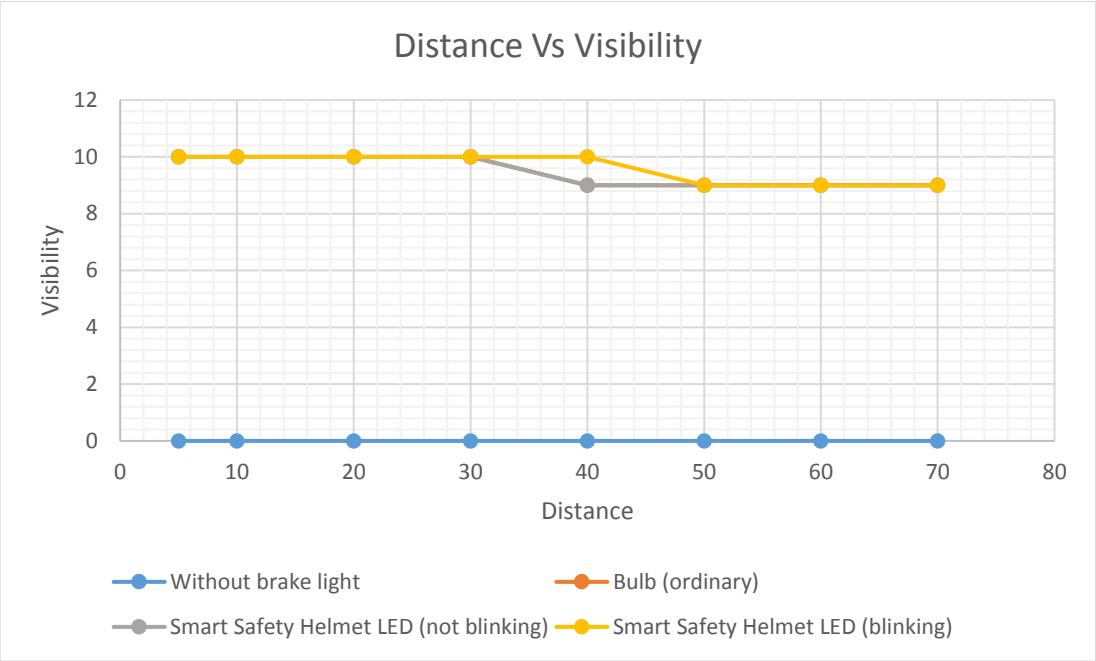


Figure 4.23: Graph distance vs visibility based on normal naked eye fine condition at night without road lamp (10.00 p.m).

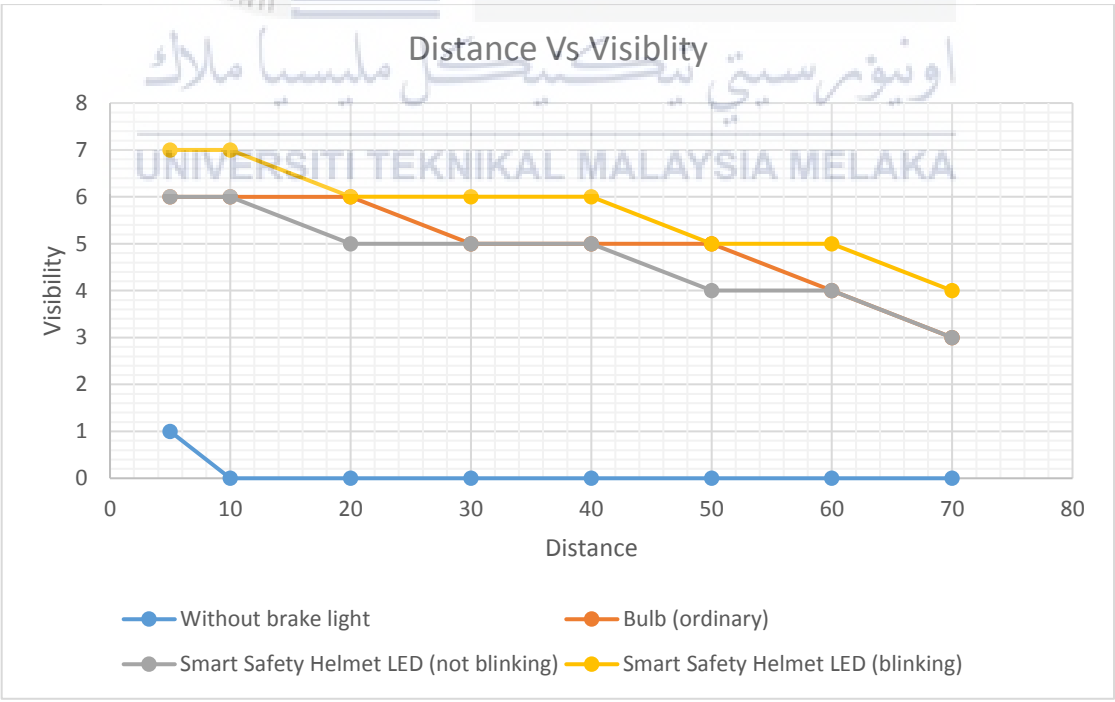


Figure 4.24: Graph distance vs visibility based on normal naked eye rainy condition at night (9.00 p.m).

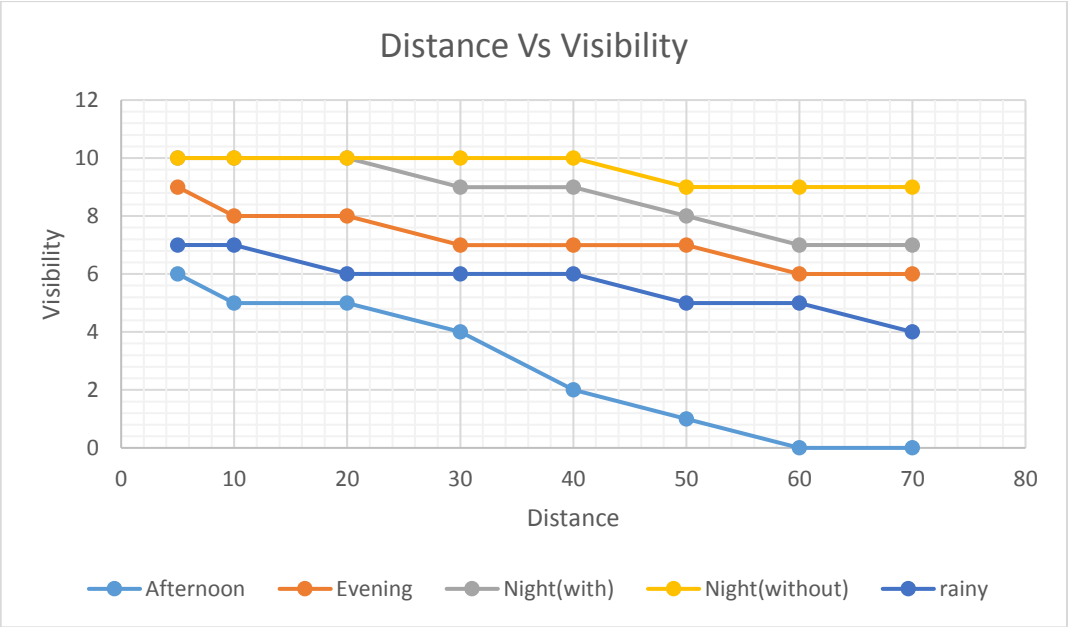


Figure 4.25: Graph Distance Vs Visibility for overall conditions based on normal naked eye.

4.7 Discussion and Analysis

This will present the outcomes data analysis of the development of safety helmet with wireless LED brake light. The result of this project is the light distance analysis using two respondents with normal naked eye. The analysis of the visibility is measure from difference condition and time with same place, distance and respondents.

The graph in figure 4.20 show that, the visibility of the LED light on Smart Safety Helmet not clear and cannot improve the visibility during afternoon fine weather condition. Based on the graph result at afternoon fine weather, at the initial distance, the blinking LED show the highest result but decreased uniformly when distance increased. Normal brake tail light is 20% higher value of visibility compare to the smart safety helmet at the distance 50m and 60m. Visibility of the blinking LED become 0 when the distance of the observer greater than 50m.

Furthermore, in Figure 4.21 show the difference result when test held at evening almost dark. The visibility without any light drop to almost 0 when the distance 30 m from the observer. Result for the LED and ordinary bulb increased because the surrounding light become lower. The result of the bulb or ordinary tail light almost same but the blinking LED 10% higher in results for the first 20m distance. Comparisons between blinking and not blinking LED also gives difference result to attract attention of the observer. Blinking LED gives 10% higher visibility result compare to not blinking LED at the 10m and lower at 70 m distance.

Figure 4.22 shows graph of the distance against visibility at night condition with present of the extra light from road lamp. The graph show Smart Safety Helmet gives 10% higher result in visibility at initial distance 5m to 10m compare to the original tail light and the same result in visibility when distance is greater than 60m from observer. The highest value when using blinking LED light because it can attract attention compare to without using blinking LED. Same result goes to graph 4.23 but with result show increasing 20% value of the visibility because surrounding is almost completely dark condition. The value of the three source of light show same results almost 100% visibility.

Besides that, test for rainy condition only held at night because the LED lights can be spot easily during low intensity of light. Based on Figure 4.24, the graph show the most attractive and easy to spot in rainy condition is Smart Safety Helmet with blinking LED. LED without blinking system 10% lower in visibility compare to the blinking system. Ordinary tail light lower in visibility and attraction almost 10% compare to blinking LED but higher 10% at certain distance compare to LED brake without blinking system.

Lastly, comparison for the difference condition only for the Smart Safety Helmet show that the highest visibility of the LED light is at night with good weather condition

with the visibility value almost 100%. The most lower is during afternoon during fine weather condition with the visibility gives the decreasing result by distance travel with 60% value drop from initial to distance 60m. Result during rainy condition show the average value 57.5% for the overall result. After that, during evening condition the result 15% higher to the rainy condition with overall result 72.5%.

CHAPTER 5

CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH

5.1 Conclusion

From the studies and some researches made based on the internet and journals, the fatal road accident happened mostly include the motorcycles and bicycles. There are many factors of the accident such as driver's attitude, road conditions, weather and light conditions. The main idea and suggestion to lower the risk of the accident is using some extra light on the helmet. Develop new prototype of the smart safety helmet using LED as source of light that have the bright and sharp light that can easily catch attention when using at night.

In this project, using radio wave from NRF2410I radio wave signal to send and receive the signal or instruction from brake to turn on or off the brake light. The radio wave selected because it can cut the cost of the manufacturing and easily to be handle with low side effect. Although every motorcycle had been equipped with the tail light, but the effectiveness of the ordinary brake light not enough to attract attention of the other vehicle from behind. The Smart Safety Helmet prototype can be helped the motorcycle rider to be more attractive and increased the visibility especially at night and worse weather condition. Based on the idea and knowledge from the internet the LED brake light had been develop and used for the new vehicles.

The result from analysis show that using blinking LED light on the helmet at night can improve the visibility of the other road user and can make the motorcycle can be easily spot at night and rainy condition. Can improve the safety of the rider and prevent the accident from happen especially during night and low light condition.

5.2 Recommendation

Smart Safety Helmet is very importance to improve safety of motorcycle and bicycle user. In future work, it can be change the wireless connection and also type of the LED light to make the system can improve the visibility during daylight.

It can be improved by using difference wireless connection such as Wi-Fi and Bluetooth that will improve the time respond of the system. By testing and selected the most suitable wireless system that will work properly in any weather and condition. Besides that, the system also can improve by using LED display to communication safety with more attractive sign or warning massage at the helmets.

After that, using more lightweight battery will decreased the space and weight of the Smart Safety Helmet. Improve the design model or prototype to make it more attractive and interesting that can attract the consumer to used it. The bracket installation storage must make from durable materials to make the bracket long-lasting and waterproof.

REFERENCES

Algainn, T., Leds, I., Properties, B., Devices, H.-E., & Efficiencies, D.. Light emitting diodes 1., 1–31.

Buckley, L., Bingham, C. R., Flannagan, C. A., Carter, P. M., Almani, F., & Cicchino, J. B. (2016). Observation of motorcycle helmet use rates in Michigan after partial repeal of the universal motorcycle helmet law. *Accident Analysis and Prevention*, *95*(March), 178–186.

Chen, Y. (2011). D ESIGN OF A LOW -CURRENT VOLTAGE DIVIDERS Faculty Advisor : Graduate Student Advisor : Professor David Blaauw.

Components, G. (n.d.). Electrical Circuits, 1–74.

Denton, T. (2004). Automobile Electrical and Electronic Systems. *Vasa*. Retrieved from http://books.google.com/books?hl=en&lr=&id=Jyaawcu_SpoC&oi=fnd&pg=PR3&dq=Automobile+Electrical+and+Electronic+Systems&ots=7itV0pMbSH&sig=3hek7TXGljjwvQvYsrc2okquDaY

Erhardt, T., Rice, T., Troszak, L., & Zhu, M. (2016). Motorcycle helmet type and the risk of head injury and neck injury during motorcycle collisions in California. *Accident Analysis and Prevention*, *86*, 23–28.

Hongsen Ma (2005). Fundamentals of Electronic Circuit Design.

Hiscocks, P. D. (2011). Measuring Light, (December 2008), 1–9.

Lee, J., Su, Y., & Shen, C. (2007). A Comparative Study of Wireless Protocols : *IECON Proceedings (Industrial Electronics Conference)*, 46–51.

Liu, B. C., Ivers, R., Norton, R., Boufous, S., Blows, S., & Lo, S. K. (2008). Helmets for preventing injury in motorcycle riders. *Cochrane Database of Systematic Reviews*.

Morkoç, H. (2009). *Light-emitting diodes and lighting*. *Handbook of Nitride Semiconductors and Devices* (Vol. 3).

Recktenwald, G. (2012). Analysis of a Voltage Divider.

Royal, T. H. E., Academy, S., & Sciences, O. F. (2014). Efficient blue light-emitting diodes leading to bright and energy - saving white light sources, *50005*.

Sattlegger, K., & Denk, U. (2014). Navigating Your Way Through the RFID jungle. *Texas Instruments - White Paper*, 1–11.

Statham, S. (n.d.). Radio-frequency Identification.

Tsirmpas, C., Rompas, A., Fokou, O., & Koutsouris, D. (2014). An indoor navigation system for visually impaired and elderly people based on Radio Frequency Identification (RFID). *Information Sciences*.

F.A.O Fernandes. R.J. Alves de Sausa (2013). Motorcycle Helmets- A State of the Art review. *Accident Analysis and Prevention.*

Michael Grimm, Carole Treibich (2016). Why Do Some Motorbike Wear Helmet and Others Don't ? Evidence from Delhi India. *Transpotation Research Part A.*

Brian W. Evans, Massimo Banzi, Hernando Barraggan (2007). 171 Second Street, Suite 300, San Francisco California, USA. Arduino Programming Notebook.

Thomas. L. Floyd. (2010). Electron Flow Version. *Electronic Device ninth edition.* Prentice Hall, 1 Lake Street, Upper Saddle River, New Jersey, U.S.A: Oxford.

Razeghi, M. (2011). *The MOCVD challenge: a survey of GaInAsP-InP and GaInAsP-GaAs for photonic and electronic device applications*. Boca Raton: CRC Press.

Krenz, J. H. (2000). *Electronic concepts: an introduction*. Prentice Hall, 1 lake Street, Upper saddle River, New Jersey, USA: Oxford.

Dimitrijev, S. (2006). *Principles of semiconductor devices*. New York: Oxford University Press.

ARDUINO: programming arduino - beginners guide to get started with internet of things. (2016). S.l.: CREATESPACE.

APPENDIX A

Visibilities

1 (low)

↓

10 (high)

Afternoon (1.30 p.m)

Distance (m)	Visibilities			
	Source of Brake Light			
	Without brake light	Bulb (ordinary)	Smart Safety Helmet Brake Light LED (not blinking)	Smart Safety Helmet Brake Light LED (blinking)
5	3	5	6	6
10	3	5	5	5
20	3	4	4	5
30	3	4	4	4
40	2	3	2	2
50	2	3	1	1
60	2	2	0	0
70	2	1	0	0

Evening (7.00 p.m)

Distance (m)	Visibilities			
	Source of Brake Light			
	Without brake light	Bulb (ordinary)	Smart Safety Helmet Brake Light LED (not blinking)	Smart Safety Helmet Brake Light LED (blinking)
5	3	7	8	9
10	2	7	8	8
20	1	7	7	8
30	0	7	7	7
40	0	6	7	7
50	0	6	6	7
60	0	6	6	6
70	0	5	5	6

Night road lamp (8.00 pm)

Distance (m)	Visibilities			
	Source of Brake Light			
	Without brake light	Bulb (ordinary)	Smart Safety Helmet Brake Light LED (not blinking)	Smart Safety Helmet Brake Light LED (blinking)
5	2	9	10	10
10	1	9	10	10
20	1	8	9	10
30	0	8	9	9
40	0	7	9	9
50	0	7	8	8
60	0	7	7	7
70	0	7	6	7

Night without road lamp

Distance (m)	Visibilities			
	Source of Brake Light			
	Without brake light	Bulb (ordinary)	Smart Safety Helmet Brake Light LED (not blinking)	Smart Safety Helmet Brake Light LED (blinking)
5	0	10	10	10
10	0	10	10	10
20	0	10	10	10
30	0	10	10	10
40	0	9	9	10
50	0	9	9	9
60	0	9	9	9
70	0	9	9	9

Rainy at night

Distance (m)	Visibilities			
	Source of Brake Light			
	Without brake light	Bulb (ordinary)	Smart Safety Helmet Brake Light LED (not blinking)	Smart Safety Helmet Brake Light LED (blinking)
5	1	6	6	7
10	0	6	6	7
20	0	6	5	6
30	0	5	5	6
40	0	5	5	6
50	0	5	4	5
60	0	4	4	5
70	0	3	3	4

Comparison between condition for Smart Safety Helmet

Distance (m)	Visibilities				
	Condition and Weather				
	Afternoon	Evening	Night	Night	Rainy
5	6	9	10	10	7
10	5	8	10	10	7
20	5	8	10	10	6
30	4	7	9	10	6
40	2	7	9	10	6
50	1	7	8	9	5
60	0	6	7	9	5
70	0	6	7	9	4

APPENDIX B

Codding of Arduino (microcontroller) for transmitter

```
#include <SPI.h>

#include "nRF24L01.h"

#include "RF24.h"

int msg[1];

RF24 radio(9,10);


const uint64_t pipe = 0xE8E8F0F0E1LL;

int SW1 = 7;


void setup(void)

{

 Serial.begin(9600);

 radio.begin();


 // the following statements improve transmission range

radio.setPayloadSize(2); // setting the payload size to the needed value
```

```
radio.setDataRate(RF24_250KBPS); // reducing bandwidth


 radio.openWritingPipe(pipe);

}


 void loop(void)

{

  if (digitalRead(SW1) == HIGH)

    {

     msg[0] = 111;

     radio.write(msg, 1);

        Serial.println("Signal Sent");

    }

  else;

  {

    digitalWrite(SW1, LOW);

        Serial.println("No Signal Sent");

    }

}
```

APPENDIX C

Codding of Arduino (microcontroller) for receiver

```
#include <SPI.h>

#include "nRF24L01.h"

#include "RF24.h"


int msg[2];

RF24 radio(9,10);


const uint64_t pipe = 0xE8E8F0F0E1LL;


int LED1 = 3;


void setup(void)

{

Serial.begin(9600);

radio.begin();
```

```
// the following statements improve transmission range
radio.setPayloadSize(2); // setting the payload size to the needed value
radio.setDataRate(RF24_250KBPS); // reducing bandwidth

radio.openReadingPipe(1,pipe);
radio.startListening();

pinMode(LED1, OUTPUT);

}
void loop(void)
{
 if (radio.available())
 {
 bool done = false;
 while (radio.available())
  {
  radio.read(msg, 1);

  Serial.println(msg[0]);
```

```
if (msg[0] == 111)
  {
   delay(10);
   digitalWrite(LED1, HIGH);
   {
    digitalWrite(LED1, HIGH);   // turn the LED on (HIGH is the voltage level)
    delay(500);                 // wait for a second
    digitalWrite(LED1, LOW);    // turn the LED off by making the voltage LOW
    delay(500);                 // wait for a second
   }
  }

else
  {
  digitalWrite(LED1, LOW);
  }
delay(10);
msg[0] == 9;
}
```

```
  }


  else;
  {
    Serial.println("No radio available");
    digitalWrite(LED1, LOW);
  }
}
```

APPENDIX D

Gantt chart PSM 1

Activiti/ month/ week (W)	SEPTEMBER				OCKTOBER				NOVEMBER				DESEMBER	
	W 2	W 3	W 4	W 5	W 6	W 7	W 8	W 9	W 10	W 11	W 12	W 13	W 14	W 15
PSM Title Discussion														
PSM Title Choose														
Literature Review of PSM														
Methodology on development of smart safety helmet.														
Submission progress report														
Submission draft final report														

APPENDIX E

Gantt chart PSM 2

Activities	Month	FEBRUARY				MARCH				APRIL				MAY				JUNE	
	Week	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18
Project progress and study																			
Fabrication and testing																			
Progress Report Submission																			
Discussion																			
Conclusion																			
Report Submission																			
Seminar and presentation																			