DESIGN AND DEVELOPMENT OF AN AUTOMATIC HAZARD EMERGENCY LIGHT FOR ARTICULATED HEAVY VEHICLE

MUHAMAD AMAR BIN ABDUL RAHMAN
B092010311

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical Technology and Engineering

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____

Cop Rasmi:

Ts. MOHD ZAKARIA BIN MOHAMMAD NASIR
PENSYARAH KANAN
JABATAN TEKNOLOGI KEJURUTERAAN MEKANIKAL
FAKULTI TEKNOLOGI DAN KEJURUTERAAN MEKANIKAL
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Name : MUHAMAD AMAR BIN ABDUL RAHMAN

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DEDICATION

I would want to dedicate this work to my family, whose unwavering love and support have carried me through this journey. Your encouragement and belief in me have strengthened my will to work towards my goals and conquer obstacles. I truly appreciate your support and patience as I went through the drawn-out research and writing process. This accomplishment is evidence of my work and our common goals. I want to express my gratitude to all of my friends and mentors for their invaluable insights, knowledge, and wisdom. Your invaluable insights have boosted my comprehension of the topic and changed my perspective. I devote my work to all those who aspire to education, creativity, and perfection.

ABSTRACT

Articulated heavy vehicle is the backbone for Malaysia economy especially on logistic industry. The increase of heavy vehicle on the roads made the rate of accident become higher. Head collision or rear collision are the standard form of accident for heavy vehicle. One of the reasons for rear collision is when the heavy vehicle having an accident, the driver does not have the time to push the emergency button. This is one of thereasons for the rear collision involving heavy vehicle. The fatality rate for an accident involving heavy vehicle is high due to high impact and others factor. The idea of this projectis to create an automatic emergency lighting system to assist crash victims in warning otherroad users as soon as possible after the collision. An LED will glow up as an output from thesystem when the Arduino Uno receives the message from the acceleration sensor mounted on the front body of truck. The right system and circuit are designed using the Fritzing software. Real components used to create the system for automatic hazard light by referring to the fritzing software. The functional system used to carry out testing by using prototype which is toy truck. The LED system blink when the toy truck crash on the wall and when a car crash on to the toy truck. The reading from the crash taken to do the analysis. For frontal crash average highest reading detect by z-axis due orientation of the accelerometer that make z-axis detect front and rear reading. Lastly, the project purpose accomplished as it works and produce data.

ABSTRAK

Kenderaan berat artikulasi merupakan tulang belakang kepada ekonomi Malaysia terutamanya dalam industri logistik. Peningkatan kenderaan berat di jalan raya menyebabkan kadar kemalangan menjadi lebih tinggi. Perlanggaran kepala atau perlanggaran belakang adalah bentuk standard kemalangan untuk kenderaan berat. Salah satu punca perlanggaran belakang adalah apabila kenderaan berat mengalami kemalangan, pemandu tidak mempunyai masa untuk menekan butang kecemasan. Ini antara punca perlanggaran belakang melibatkan kenderaan berat. Kadar kematian bagi kemalangan yang melibatkan kenderaan berat adalah tinggi kerana impak tinggi dan faktor lain-lain. Idea projek ini adalah untuk mencipta sistem lampu kecemasan automatik untuk membantu mangsa kemalangan memberi amaran kepada pengguna jalan raya lain secepat mungkin selepas perlanggaran. LED akan menyala sebagai output daripada sistem apabila Arduino Uno menerima mesej daripada sensor pecutan yang dipasang pada badan hadapan trak. Komponen sebenar yang digunakan untuk mencipta sistem untuk lampu bahaya automatik dengan merujuk kepada perisian fritzing. Sistem berfungsi yang digunakan untuk menjalankan ujian dengan menggunakan prototaip iaitu trak mainan. Sistem LED berkelip apabila trak mainan melanggar dinding dan apabila kereta melanggar trak mainan. Bacaan dari pelanggaran diambil untuk melakukan analisis. Untuk purata pelanggaran hadapan mendapat bacaan tertinggi yang dikesan oleh paksi-z disebabkan orientasi pecutan yang menjadikan paksi-z mengesan bacaan hadapan dan belakang. Akhir sekali, tujuan projek dicapai apabila ia berfungsi dan menghasilkan data.

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LIST OF SYMBOLS AND ABBREVIATIONS

GND	-	Ground
m	-	Meter
mm	-	Millimeter
s	-	Second
m/s	-	Velocity
LED	-	Light Emitting Diode
V	-	Volt

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Transportation is one of the most important things in world for the human population as it can ease their mobility to move from one place to another. Department of Road Transport reported that the number of registered vehicles in Malaysia had reached 33.3 million units, with an increase of a million units annually since 2019. That number, it was said, had overtaken the population of the country, which stands at 32.6 million. Malaysia economy is growing since the transportation technology becoming more advanced as time go by because of the logistic trucking transportation. Since the increasing of vehicles on the road then the accident statistic also increases. The survivability rate of the road accident depends on the size of the transport.

As articulate heavy vehicle transportation continues to grow within Malaysia, crash rate among heavy vehicle remains high and the risk of injury and fatality are worst compared to the light vehicle. One of the unavoidable accidents involving heavy vehicles when other vehicles hit the back of the heavy vehicles. Most of these types of crash happen because of situations where the heavy vehicle is having an accident. Most heavy vehicle driversnormally will use their hazard light when the vehicle having an accident, but it is almost never enough to offer advance warning to oncoming vehicles. Since this problem is involving in life of road user then a solution is needed to reduce this accident and fatality rate.

The solution is to design and develop automatic hazard emergency light for articulate vehicle. This emergency light is position on the back of the heavy vehicles. In some situations where a heavy vehicle has an accident the driver of the heavy vehicle does not have time to press the current emergency light button due to injury or panic attack which will create a dangerous situation for the vehicles behind who is not aware of the situation that is happening to the heavy vehicle. The automatic emergency light will act as emergency signal that can provide vision especially on night and rainy days for another road users to take an action to slow down or change the lane to prevent crash happen,

1.2 Problem Statement

Malaysia's economy relies on the product and the services to customers. Land-based transport, specifically commercial vehicles or articulate heavy vehicles has become the backbone of the goods supply chain. As the demand and supply of the goods are increasing, the numbers of articulate heavy vehicle also increase. Since the increasing of heavy vehicles on the road then the accident statistic also increases. Accidents involving heavy vehicles are increasing every year. The standard form of a crash is an incident between the head and rear end (Figure 1.1). Crashing into the back of a heavy vehicle can be fatal since the chassis for the articulate heavy vehicle is different compared to cars. When a light vehicle like cars hit the back on the heavy vehicle the upper part of the car's cabin crushed as it hit the rear of the heavy vehicle and then the car slid underneath the rear end of the heavy vehicle. Figure 1 show the car crash to the rear of the truck. The effect can be fatal for the passenger of the light vehicle. This accident occurs when vehicles from behind doesn't have clear view either the heavy vehicle is moving or stop.

The average annual rainfall in Malaysia is over 2600 mm, making Malaysia one of the countries that receives the most average rainfall in the world. Rate of accident where a light vehicle hit the rear of the heavy vehicle increased due to heavy rain are high. Bad weather such as heavy rain can be a challenge for a road user, driving or riding in the rain increased the probability for an accident to occur because of the limited visibility. Limited vision will make road users only have limited time to react and take actions to slow down or avoid vehicles in front, especially heavy vehicle. Most of the heavy vehicle drivers normally will use their hazard light when the vehicle breaks down, but it is almost never enough to offer advance warning to oncoming vehicle thus by developing the automatic hazard emergency light can help the upcoming vehicles from crash to the rear of the heavy vehicle.

Figure 1:1 Rear end collision of the heavy vehicle (Dan Scanlan, 2020)

1.3 Research Objective

The objectives of this project are:

- To design an automatic hazard emergency light for articulated heavy vehicle.

- To develop an automatic hazard emergency light that ensure high visibility.

1.4 Scope of Research

To study literature on heavy vehicle road accident and emergency light system. Secondly, to design the LED light system on a warning triangle. Then design on electronic circuit system and program the electronic circuit using Arduino software. Lastly to fabricate prototype model and test functionality.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The chapter is an analysis of the literature around the entire endeavor. A review of the literature is a resource that readers can use to comprehend the theory. The heavy-duty vehicle crash and the safety warning triangle will be the main topics of this chapter. The review of the literature will provide some insight into the project and enable project-related evaluations.

2.2 Transportation

Transportation is literally described as a means of carrying people as well as goods and animals from one location to another. Since the earliest ages, when only wooden carts and animals like horses, donkeys, and bulls were employed, it has existed. The world witnessed countless inventions as time evolved, and as a result, earlier modes of transportation were replaced by the creation of automobiles, buses, trucks, spacecraft, helicopters, ships, airplanes, etc. Transportation can be divided into four types which are road, air, sea and rail transportation (Figure 2.1).

Mode of transport	Typical usage	Advantages	Disadvantages
Road	Door-to-door Ideal for mixed cargo. Typically used for first and final leg	Most flexible for door-to-door, cheap	Limited to continental transport Urban congestion Damage to roads
Rail	For domestic, continental and inter-continental transport	Ideal for heavy goods and long distances Environmental-friendly	Connection to rail system required. Complete trains require large volumes (thus low frequency), otherwise handling in yards (low transport speed)
Air	To ensure fast transport	Fast and safe	Expensive Limits for size and weight Typically as part of multi-modal transport
Sea	bulk shipments, where long lead time is ok	Ideal for bulky and heavy goods Highly standardized sea containers worldwide Less costly than air for inter-continental transports	inflexible routes Long lead time Inflexible timetables (ship will not wait for missing container)

Figure 2:1 Types of transportation (Dmitry Ivanov, 2017)

2.3 Articulated heavy vehicle

A heavy vehicle with a pivot joint is referred to as an articulated heavy vehicle. The reason for the design to be created like that is to ease the cornering for the heavy vehicle. There are numerous different types of articulated heavy vehicles, including lorry, trailer and buses. Buses are used as public transport to transport people from one place to another. While articulated trailers or trucks (Figure 2.2) function as carriers of heavy goods. The logistics industry is one of the industries that focuses heavily on the use of articulated trailer vehicles as transporters of heavy goods.

Figure 2:2 Articulated truck

The rapid growth of the logistics industry in Malaysia, driven by the increasing demand for goods due to a growing population, can have significant implications for road safety. As the number of heavy vehicles on the road increases, there is a direct correlation with traffic issues, which in turn poses a risk to all road users. At the end of the year 2012, the number of registered vehicles in Malaysia was 22,702,221. Of this number, 92.3% of it is private vehicles and the remaining 7.7% are other types of vehicles or non-private vehicles. From these non-private vehicles, 58.7% or 1,032,004 are goods or commercial vehicles (Ahmad Noor Syukri Zainal Abidin et al, 2021).

The expansion of articulated heavy vehicle transportation in Malaysia has resulted in high crash rates and a considerable risk of injury and death for road users. There are more than 6,000 traffic fatalities in Malaysia each year, with approximately 1,000 of these fatalities involving motorists and motorcyclists colliding with rigid and articulated heavy vehicles (Huzaifah, 2010).

Addressing these challenges requires a comprehensive approach that focuses on improving the dependability of the transport network systems, enhancing road safety regulations, and promoting responsible driving practices. By prioritizing road safety measures and investing in infrastructure development, it is possible to mitigate the risks associated with the expansion of the logistics industry and ensure a safer environment for all road users in Malaysia.

2.4 Road accident

Driving, which includes controlling the operation and movement of a car, motorcycle, truck, or bus. Drivers are expected to abide by the established road and traffic laws in the area they are travelling in order to receive permission to drive on public roadways. The etymology of the word "driving" dates back to the 15th century, and it evolved as the scope of what driving included shifted from working animals in the 15th century to automobiles in the 1800s. Since the fifteenth century, driving has also required the development of physical, mental, and safety skills. Driving laws that apply to everyone, not just the driver, have been introduced in tandem with this growth of the abilities necessary to drive.

Traffic rules may vary considerably from one country to another. Right, and left- hand traffic, highest-posted speed limits, Driving laws are made to reduce the accident rate and minimize the fatality rate. Road users need to have a license verified by a driving agency to ensure that a person has the ability to drive efficiently while at the same time complying with the laws that have been set. The accident rate can be decreased by road users following the rules, yet there are certain drivers or motorists who only care about themselves.

These people might believe they are very careful and efficient drivers, but they are not. The probability of an accident on the road will unquestionably grow if just one other road user acts in this manner (Ahmad Farid, 2023).

The lives of almost 1.3 million people are cut short annually as a result of traffic accidents. There are an additional 20 to 50 million people who sustain non-fatal injuries, many of whom go on to develop disabilities. In Malaysia, the accident rate has increased within 10 years (Figure 2.3). Meanwhile, the number of deaths due to road accidents in Malaysia has recorded the highest number for a period of nine years, in 2016, with a total of 7,152 deaths, and the lowest number in 2018 with a figure of 6,284 deaths (Figure 2.4). While in a period of three years (2016-2018) a total decrease of 12.1% was recorded.

Figure 2:3 Rate of accidents in 10 years

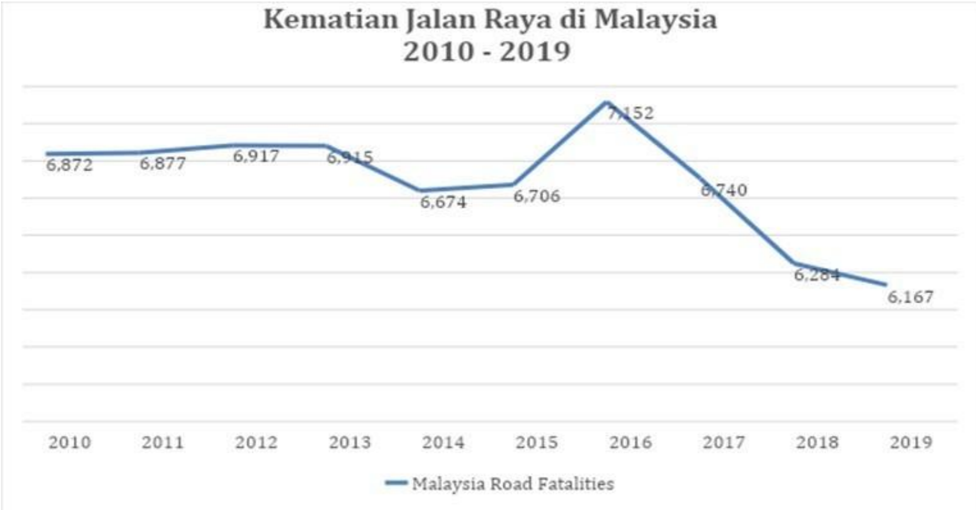


Figure 2:4 Rate of fatality in 10 years

Accidents involving heavy vehicles frequently result in serious injuries because of the high impact. As opposed to heavy vehicle operators themselves, other road users typically die in accidents involving large vehicles. Only 4.40% of all vehicles registered in Malaysia were heavy vehicles, of which 4.20% were heavy goods trucks and 0.20% were buses. The Road Safety Department of Malaysia claims that the 3.67% fatality rate for passengers in large vehicles is low when compared to the overall death toll from traffic incidents. However, information on incidents involving heavy vehicles and the fatalities that occurred as a result of these accidents is limited. 57,430 road accidents in 2014 involving trucks, buses, and taxis. A study indicated that 1,000 deaths annually are related to heavy vehicle accidents. Ofthese, the occupants of the other cars account for 80% of the fatalities (N Manap, 2021). Themajority of heavy vehicle collisions involving lorries (58.3%) result in the biggest number of fatalities (51%), serious injuries (61.7%), minor injuries (38.2%), and property damage (58.6%). Trailers account for 28.1% of incidents, which result in 32.2% of fatal cases, 26.4%of serious injuries, 20.4% of mild injuries, and 27.8% of property damage were caused by accidents. Less than 6% of all accidents include other kinds of large vehicles (Figure 2.4).

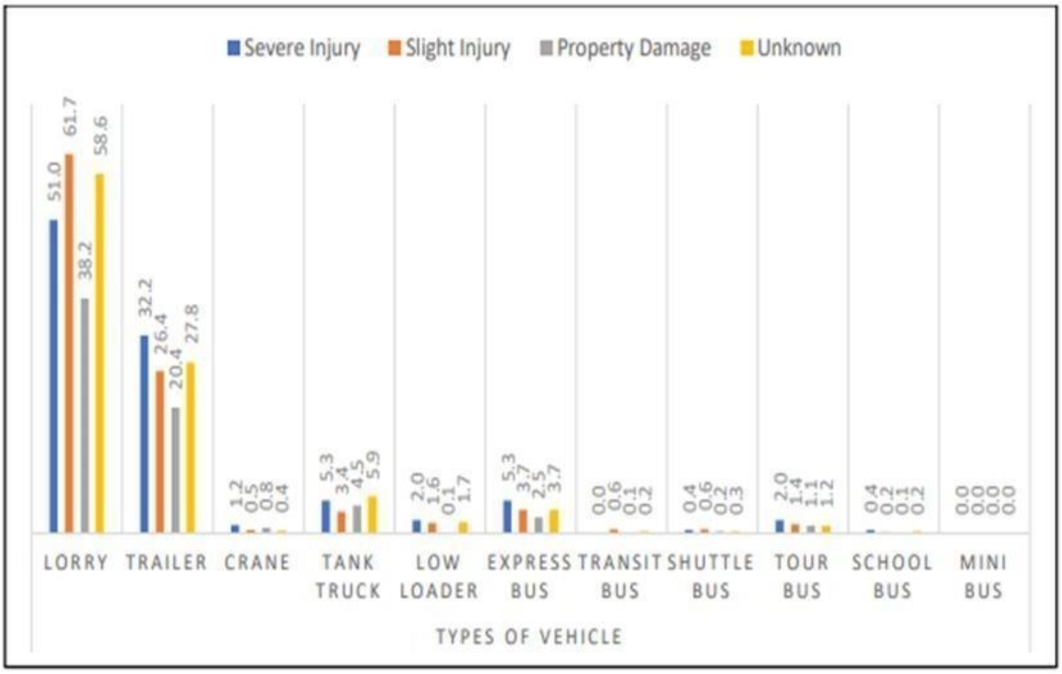


Figure 2:5 Accident severity by type of heavy vehicle (N.Manap, 2021).

2.5 Road development

There are three main roads in Malaysia which are federal, expressway and state road. Before 1957, the majority of the federal roads in Peninsular Malaysia were constructed during the British colonial era. The British government constructed the highways at that time to make it simpler to carry products and commodities. The Ministry of Works (MOW) in Malaysia is responsible for overseeing all Federal Roads. The MOW is in charge of planning, constructing, and maintaining all Federal Roads that have been 21ackson under the Federal Roads Act 1959, in accordance with the Ministerial Functions Act of 1969. The core backbone network of Malaysia's national roads is made up of a network of national controlled-access expressway known as the Malaysian Motorway System. The Tanjung Malim-Slim River tolled road, subsequently known as the North-South expressway (NSE), was first opened to traffic on March 16, 1966, serves as the foundation of the network.

Private construction firms construct Malaysia’s expressway under the direction of the government’s highway agency, the Malaysian Highway Authority. State road are Malaysia’s secondary highways, which as of December 2021 have a combined length of 247,027.61 km. State governments in Malaysia provide funding for and manage the management of Malaysian Public Works Department (JKR) of each state’s state roadways building and maintenance projects. The only difference between the standards of state highways and federal roads is the coding system (Figure 2.6), which is different for state roads and starts with state codes followed by route numbers.

JALAN NEGERI	NOMBOR JALAN	CONTOH	JABATAN BERTANGGUNG JAWAB
Selangor	Bermula Huruf ‘B’	B5	JKR Selangor
Perak	Bermula Huruf ‘A’	A4	JKR Perak
Melaka	Bermula Huruf ‘M’	M10	JKR Melaka
Sembilan	Bermula Huruf ‘N’	N26	JKR Negeri Sembilan
Johor	Bermula Huruf ‘J’	J17	JKR Johor
Pahang	Bermula Huruf ‘C’	C6	JKR Pahang
Terengganu	Bermula Huruf ‘T’	T10	JKR Terengganu
Kelantan	Bermula Huruf ‘D’	D6	JKR Kelantan
Pulau Pinang	Bermula Huruf ‘P’	P11	JKR Pulau Pinang
Kedah	Bermula Huruf ‘K’	K8	JKR Kedah
Perlis	Bermula Huruf ‘R’	R1	JKR Perlis

Figure 2:6 State road code in Malaysia

According to a report from the Ministry of Transport Malaysia (2021), there were 414,421 traffic accidents in Malaysia in 2010 and 567,516 in 2019, which resulted in 6,000–7,000 fatalities each year. Rapid development and motorization are predicted to increase the burden (Musa et al., 2020). Importantly, the increase in the number of crashes associated with commuting that are recorded in the data presents a significant problem (Bin, 2014; Sukor et al., 2018; Zuwairy et al., 2020). From three years' worth of North-South Expressway data on traffic incidents; the overall number of collisions, fatalities, and injuries. 47359 vehicles were involved in 29891 crashes during the course of three years in the study area. 900 incidents result in fatalities, which accounts for 3% of the total, followed by 4348 (14.5%) cases of serious injury, 4434 (14.83%) cases of minor injury, and 20230 (67.7%) cases of property damage.

For lorry driver casualties (Figure 2.7), the distribution of lorry driver casualties by type of road has been recorded. Compared to other kinds of roads in the accident statistics, federal roads saw the greatest number of truck driver fatalities. According to data on all road user federal roads have the highest percentage of fatalities when it comes to road type (Ahmad Noor Syukri Zainal Abidin et .al, 2021).

The country's demand for the use of commercial land transport fleet has expanded due to the rapid growth of road development, In order to support the country's expansion in terms of fleet system, an efficient, effective, dependable, and safe commercial transportation system is required.

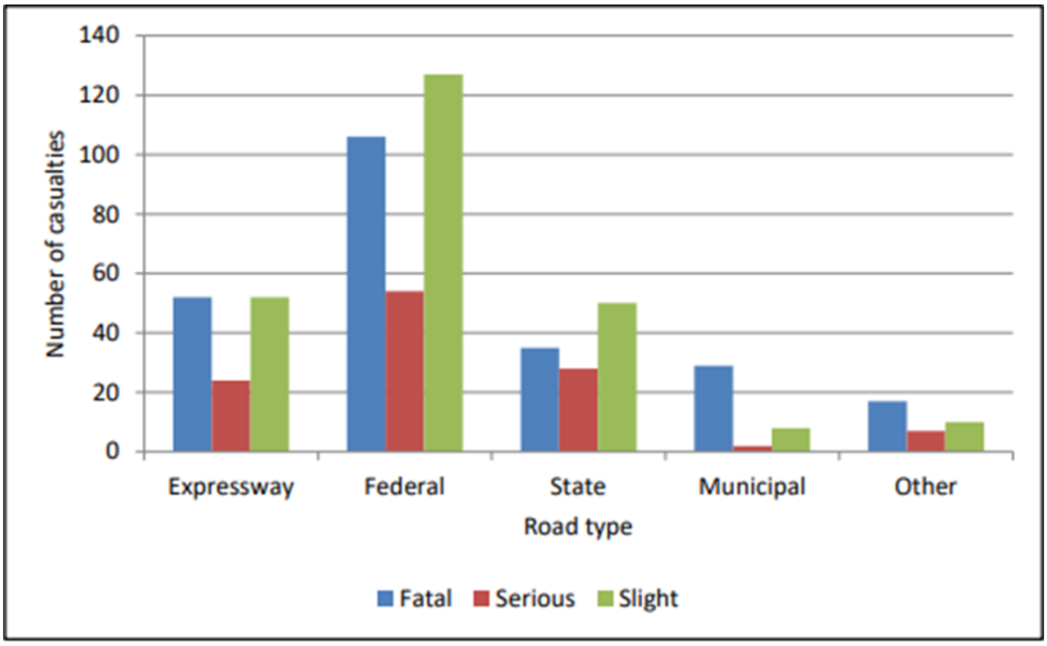


Figure 2:7 Lorry driver casualties in different type of roads

2.6 Rear end collision

Most rear-end incidents happen when the vehicle in front is stationary or driving extremely slowly. Most of rear-end collisions happened when the leading vehicle was entirely stopped or the behind vehicle following closely to the front vehicle.

Data from actual crash investigations also showed that in more than 88% (39 incidents) of the rear-impact collisions involving heavy commercial vehicles, the HCGV was struck from behind by another vehicle rather than being struck by its crash companions. Passenger cars made up the largest portion of that total (46.2%). Slow lanes and emergency lanes contributed to the highest proportions of studied incidents in terms of the lane positioning of the impacted HCGVs, as illustrated in Figure 2.8). In terms of crash partner (Figure 2.9), more than 85% of motorcycle occupants died after rear impact collisions with HCGVs. 75% of the fatalities were caused by lorries, which were second. Nearly 85% of passengers in buses involved in rear-end collisions with HCGVs sustained mild to major injuries.

However, the large number of passengers in buses may have had a substantial impact on such distribution (Ahmad Noor Syukri Zainal Abidin et .al, 2021).

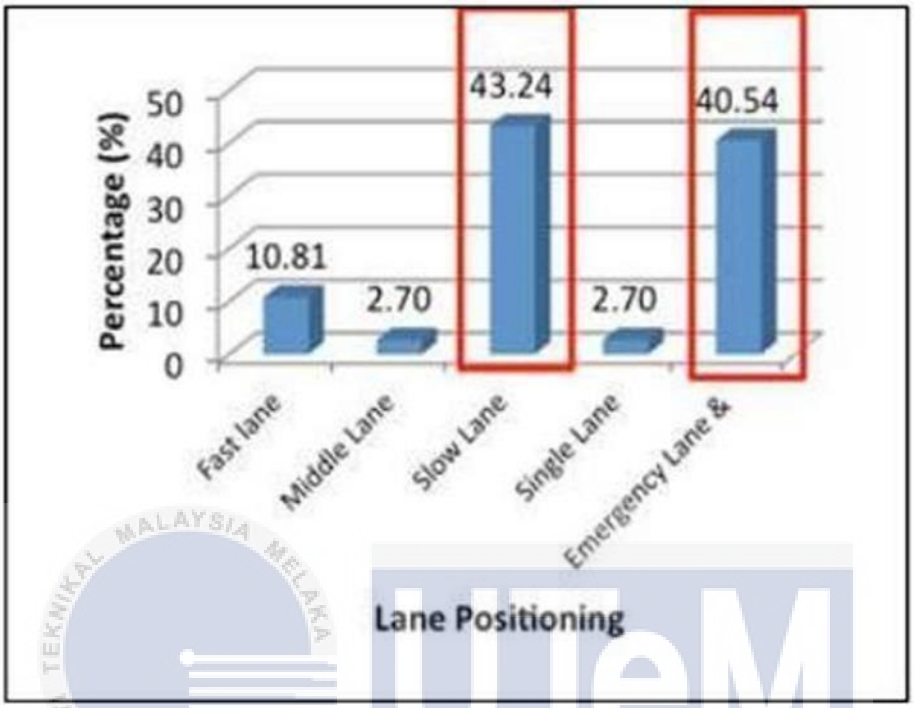


Figure 2:8 Lane positioning rear impact cases

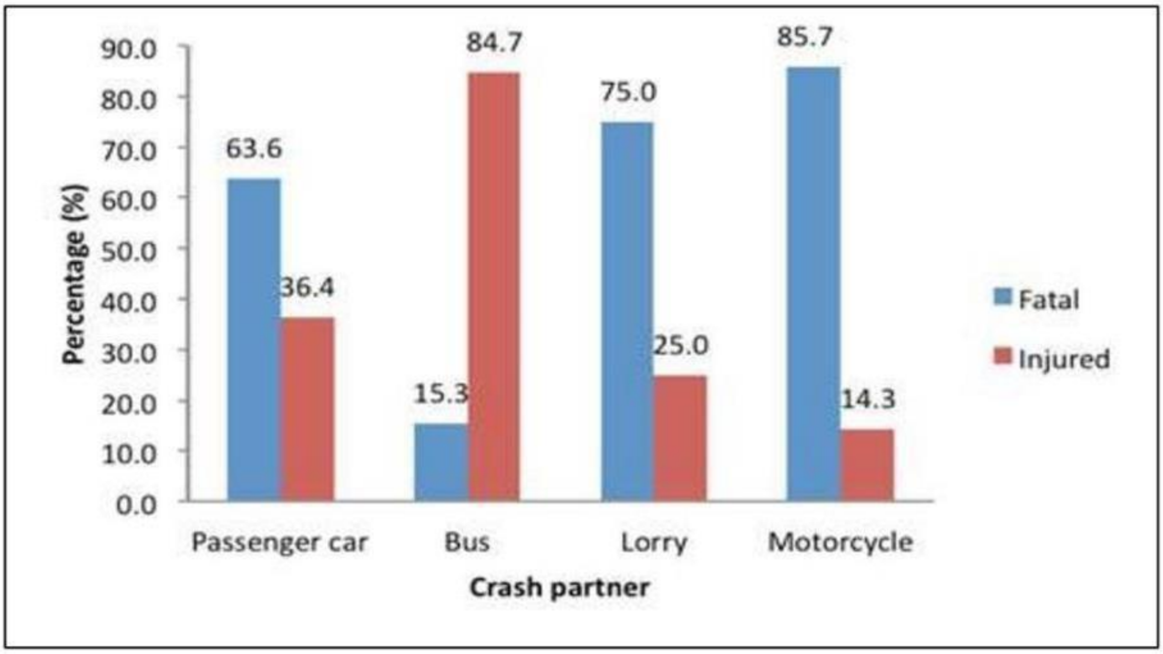


Figure 2:9 Casualties to crash partners in HCGV rear impact fatal crashes

2.7 Warning triangle

A warning triangle is a small red triangle with a highly reflecting surface that is typically constructed of plastic and metal (Figure 2.10). To warn other vehicles and other road users that they are approaching an unexpected stationary vehicle, warning triangles are utilized (Why should your vehicle have a warning triangle, 2022). In the event of an accident or a vehicle breakdown, the safety warning triangle will serve as a road sign. The driver should place a caution triangle on the road at least 45 meters behind the broken-down vehicle on the same side of the road if a vehicle breaks down on a carriageway. It Is crucial to preserve the safety of approaching vehicles from behind and serve as an early warning system for potential road dangers that could cause accidents. Drivers would therefore cautiously avoid such disasters from occurring (Md.Diah J.,2012).

Vehicles from behind are forewarned of potential hazard as they approach by the early warning gadget. When they notice this warning, they can immediately begin to slow down to prevent colliding with the stranded vehicle.

Figure 2:10 Safety warning triangle

2.8 Accelerometer sensor

Devices that convert physical qualities like pressure or acceleration into output signals (often electrical) that are used as control system inputs are referred to as sensors. Growing demand for automotive sensors necessitates a challenging balance between precision, ruggedness, manufacturability, interchangeability, and affordability. Micro-Electro Mechanical Systems (MEMS) sensors are now being developed to continue the development of automobile sensors, which began with mechanical sensors, accident sensors, out of all the automotive sensors, offer important vehicle dynamic parameters that enable the sensing algorithm to assess current and future accident conditions. The predominant types among them fall into two major categories: mechanical and electrical (Md. Syedul Amin et .al, 2014).

In applications for vehicular safety, crash detection sensors are essential. The usage of these sensing systems in occupant restraint systems is one of the main uses. The crash sensors that are available in cars today are more sophisticated. Modern micro-machined accelerometers have mostly superseded earlier sensors like straightforward pressure sensors. These sensors detect the deceleration that occurs following a collision or accident involving a vehicle. They also establish how the car is positioned in relation to the road (Kalwinder Kaur, 2013). Any reliable car crash detection system requires an accelerometer (Figure 2.11) that can measure up to several hundreds of g-force accelerations. High-g accelerometers, which can withstand 400 g-force accelerations and provide important details on the precise type of collision, come into play in this situation.

Figure 2:11 Accelerometer

2.9 Light Emitting Diode (LED)

A semiconductor device called a light-emitting diode (LED) releases light when an electric current flows through it. The current-carrying particles, called as electrons and holes, unite with one another inside the semiconductor material to produce light. LEDs are referred to as solid-state devices since light is produced inside the solid semiconductor material. When compared to other lighting technologies that use heated filaments such as incandescent and tungsten halogen lamps or gas discharge, solid-state lighting which also includes organic LEDs (OLEDs) is used. Applications in display backlighting, communications, healthcare, signs, and general illumination have all contributed to the rising need for light emitting diodes (LEDs). Although LEDs are built fairly similar to microelectronics, their failure modes and mechanisms are distinct due to functional requirements, materials, and interfaces (Moon-Hwan Chang et .al, 2012).

LEDs produce different colors by using various materials which produce photons at different wavelengths. The electrons and holes in the semiconductor material of the LED are confined within energy bands. The energy of the photons that the LED emits depends on the distance between the bands, or bandgap. The wavelength and color of the light that is emitted are both determined by the photon energy. Different semiconductor substances (Figure 2.9) with various bandgaps generate various colors of light. By changing the makeup of the light-emitting, or active, area, the specific wavelength (color) can be changed.

LED material	Color produced
Indium gallium nitride (InGaN)	Blue, green and ultraviolet high-brightness LEDs
Aluminum gallium indium phosphide (AlGaInP)	Yellow, orange and red high-brightness LEDs
Aluminum gallium arsenide (AlGaAs)	Red and infrared LEDs
Gallium phosphide (GaP)	Yellow and green LEDs

Table 1 Different semiconductor substances (What is an LED?, 2004)

2.10 Arduino

The Arduino microcontroller was first developed in 2005 as a learning tool for a class assignment at the Interaction Design Institute in Ivrea. The Arduino was created to stimulate creative and design-focused thinking (Alicia M.Gibb, 2010). Now the Arduino has been used in many fields of work. The platform of an Arduino has become very famous with designers or students just starting out with electronics, and for an excellent cause. The open-source Arduino platform is used to create electrical projects. With Arduino, you can write and upload computer code to a physical programmable circuit board (commonly called a microcontroller) using a piece of software called the IDE (Integrated Development Environment), which runs on your computer.

With those just getting into electronics, the Arduino platform has grown rather popular, and for good reason. The Arduino does not require a separate piece of hardware (referred to as a programmer) in order to load fresh code onto the board; instead, you can do so by using a USB cable, in contrast to the majority of earlier programmable circuit boards. Additionally, the Arduino IDE employs a condensed form of C++ that makes learning to program simpler. Finally, Arduino offers a standard form factor that separates the micro- controller's functionality into a more usable packaging. The market is filled with a variety of Arduino boards, including the Arduino UNO, Red Board, Lily Pad Arduino, Arduino Mega, and Arduino Leonardo. All of these Arduino boards (Figure 2.12) have varied features, functions, and specifications, and they are used in many types of electronic projects.

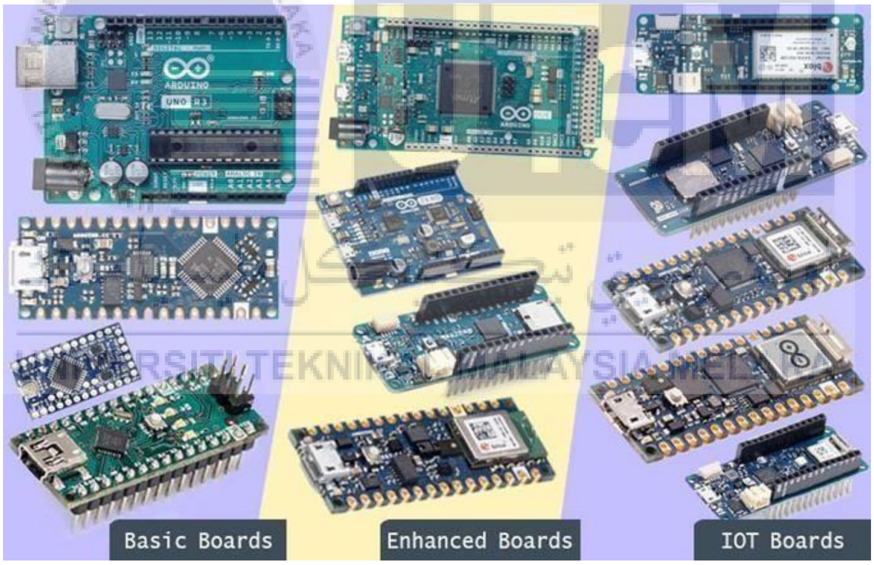


Figure 2:12 Different types of Arduino

CHAPTER 3

METHODOLOGY

3.1 Introduction

The study process for the creation of automatic light hazards for heavy-duty trucks will be briefly explained in this chapter. The research process starts with problem identification and is followed by a review of the literature, including past scientific journals, books, papers, and articles to gather as much information and feedback for this project. Then, a survey was distributed to Malaysians for the prototype's construction and testing in order to collect random data.

The questionnaire was distributed using social media platforms like WhatsApp, email, and other. The respondent's age, gender, and questions regarding their experience with accidents are all part of the survey. The questionnaire has provided extra information to continue this project.

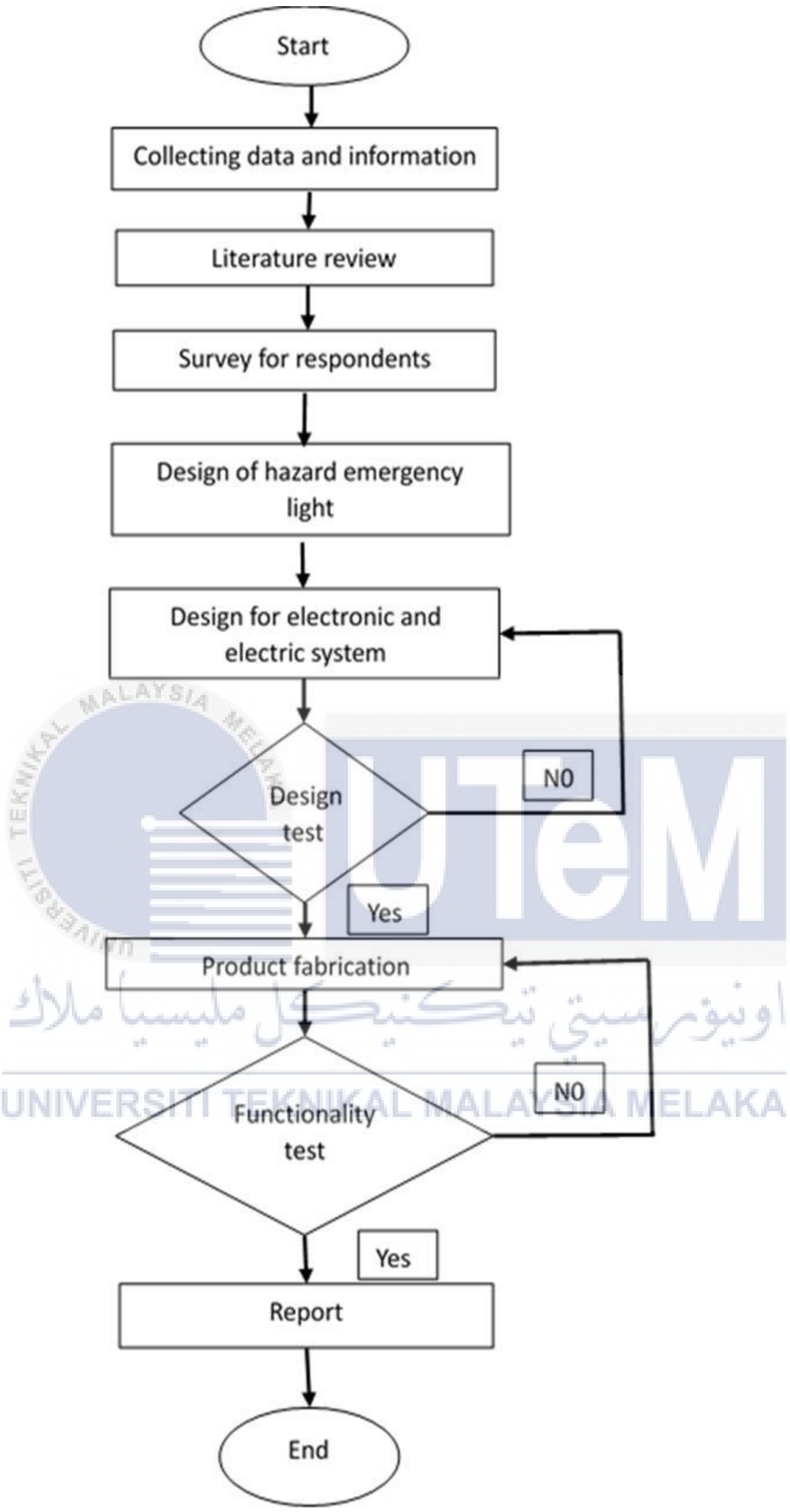


Figure 3:1 The objective and the flow chart of the methodology for projec

3.2 Gantt chart

PSM 1 GANT CHART																
No	**Project Activity**	**Plan / Actual**	**Week**													
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Title selection	Plan														
		Actual														
2	Finding idea and information	Plan														
		Actual														
3	First chapter report	Plan														
		Actual														
4	Second chapter report	Plan														
		Actual														
5	Third chapter report	Plan														
		Actual														
6	Full report submission	Plan														
		Actual														
7	Slide presentation	Plan														
		Actual														
8	Presentation	Plan														
		Actual														
PSM 2 GANT CHART																
No	**Project Activity**	**Plan / Actual**	**Week**													
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Project briefing with supervisor	Plan														
		Actual														
2	Cost evaluation	Plan														
		Actual														
3	Buy the equipment	Plan														
		Actual														
4	Circuit testing	Plan														
		Actual														
5	Prototype testing	Plan														
		Actual														
6	Fourth chapter report	Plan														
		Actual														
7	Fifth chapter report	Plan														
		Actual														
8	Presentation	Plan														
		Actual														

Table 2 Gantt Chart of Project

3.3 System design

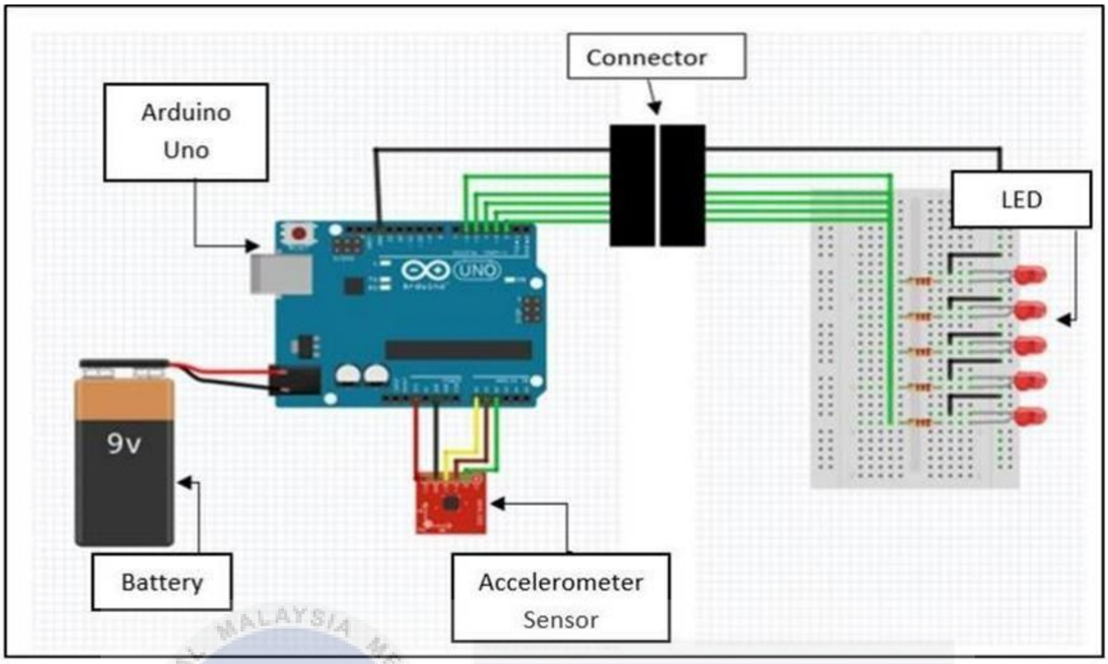


Figure 3:2 System design

The circuit design is also provided by the fritzing programmed, which is depicted in Figure 3.4. The LED and Arduino Uno will be connected using a male and female connector in this design circuit. The Arduino Uno microcontroller houses an accelerometer, capacitor, and LED. The battery is connected to the microcontrollers. The Arduino Uno is then equipped with an accelerometer as a sensor to monitor changes in the accelerometer's speed or tilt.

For this method, the programming is set up in the Arduino software, and the output system is finally an LED. Given that large trucks frequently install their tails and use connectors to connect the air supply and power supply, this design aims to provide an autonomous hazard light.

3.4 Design of the automatic hazard emergency light

From the survey that had been done, one question about the shape of the automatic hazard emergency light which are triangle, square and circle been asked. Out of 50 respondents, 38 of them choosing triangle, 11 of them choose circle while for square shape only got 1 voted. After they survey, triangle shape been chosen as the real design for the automatic hazard emergency light. Triangle shape is world standardized for emergency symbol.

Figure 3:3 Circle design idea

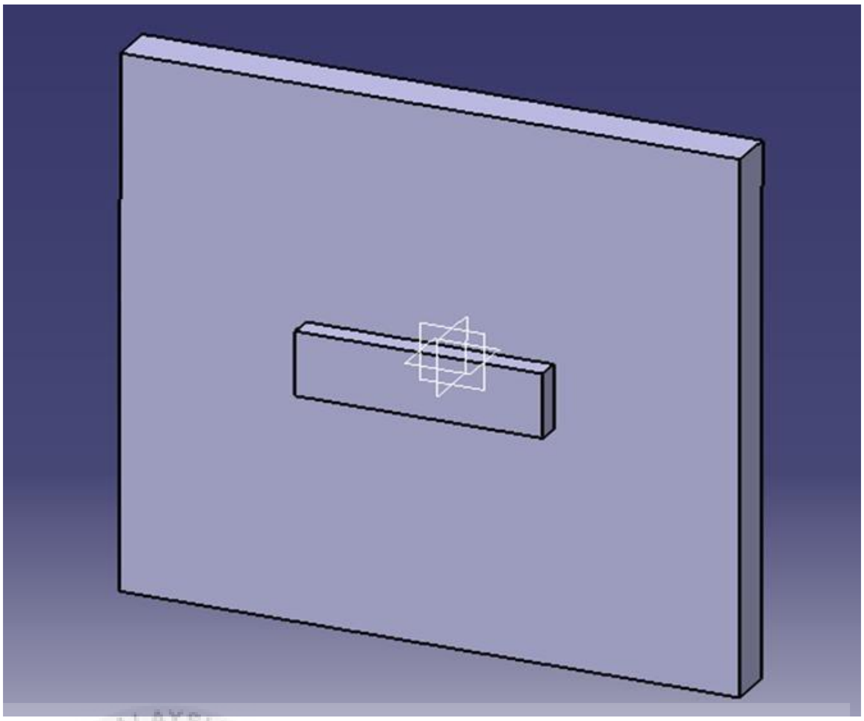


Figure 3:4 Square design idea

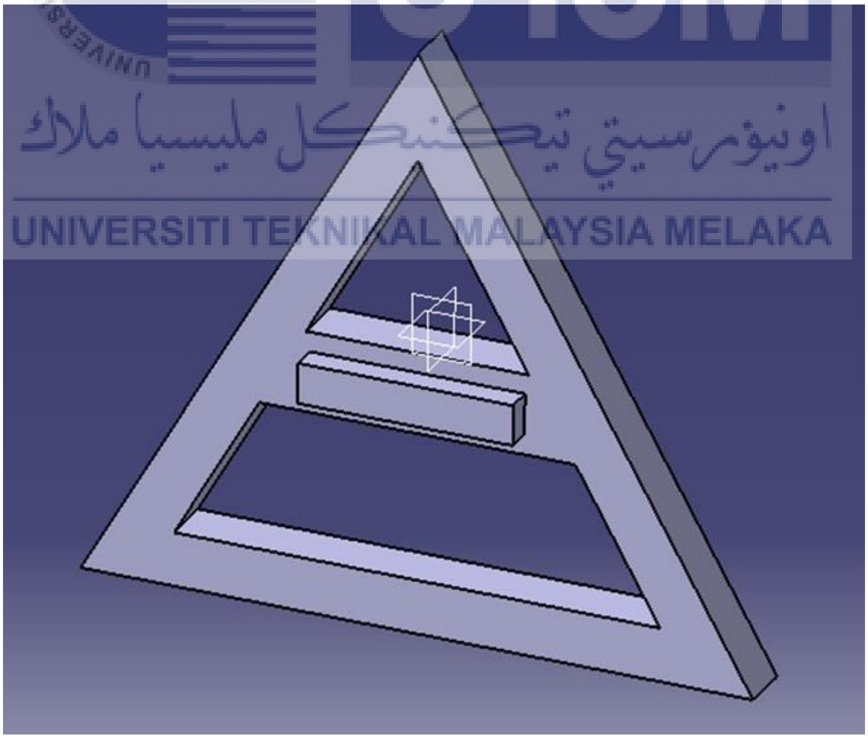


Figure 3:5 Triangle design idea

3.5 Survey for respondent

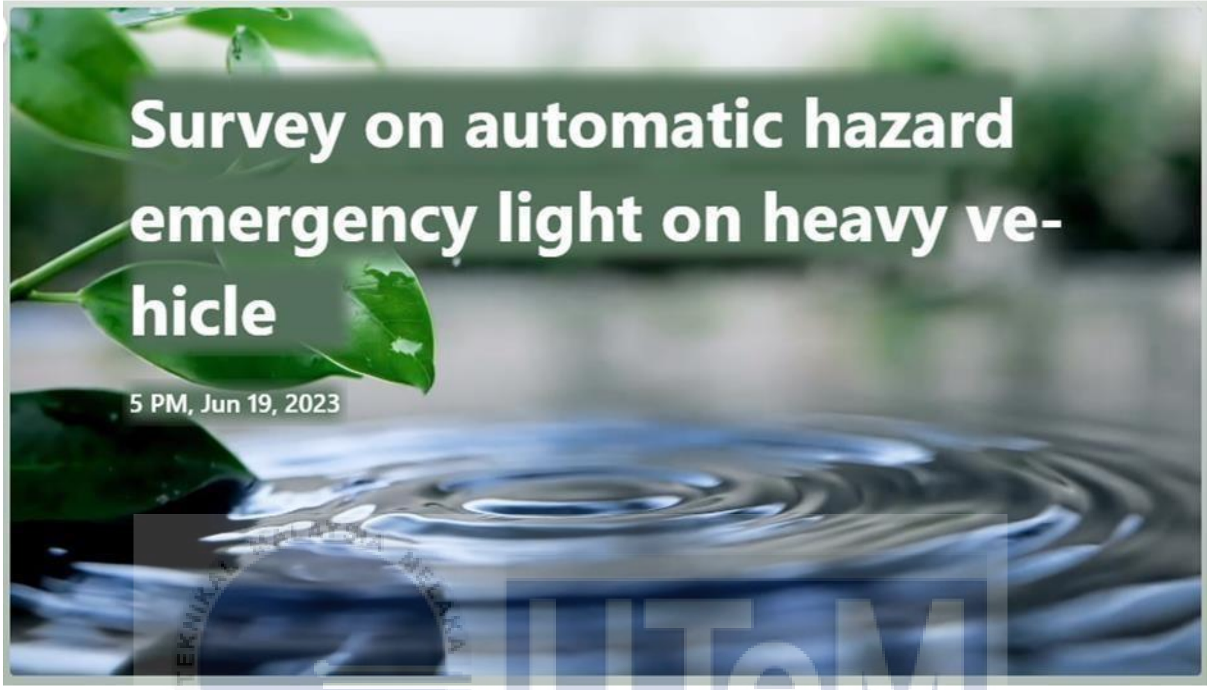


Figure 3:6 Survey for respondent

A survey for automatic hazard emergency light for heavy vehicles had been create using questionnaire form and sent through social media like WhatsApp and Facebook. 13 questions had been asked in the survey about people experienced and suggestion about this project. There are 53 people who joined the survey by answering the questionnaire provided in the survey.

3.6 Illustrated diagram for hazard light system

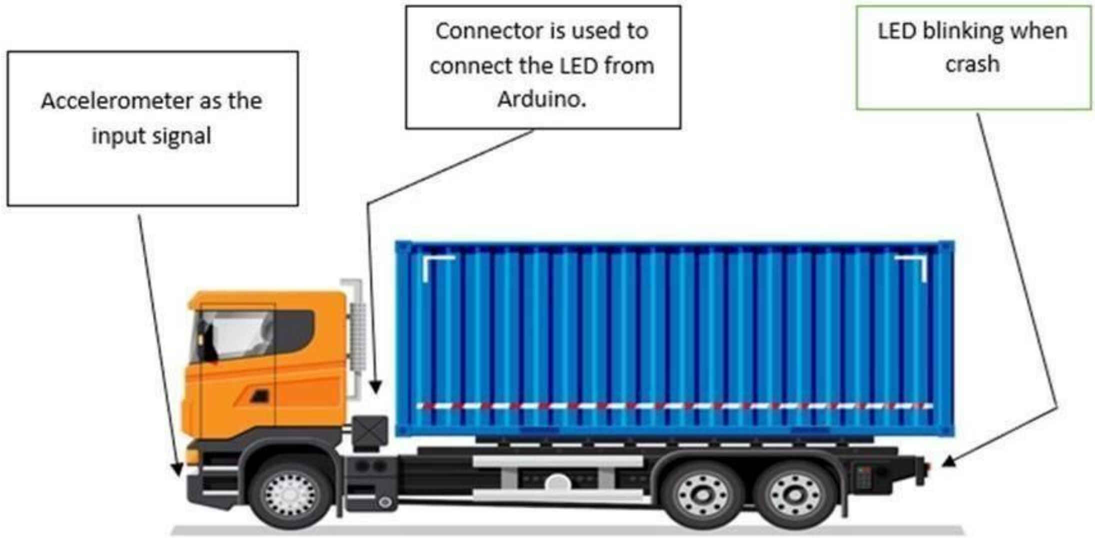


Figure 3:7 Illustrated diagram for hazard light system

The Arduino first receives the input signal once it is sent by the accelerometer sensor after the sensor detected the crash force and then produces an electrical charged. After receiving the data, the Arduino will activate the LED in accordance with the coded programmed.

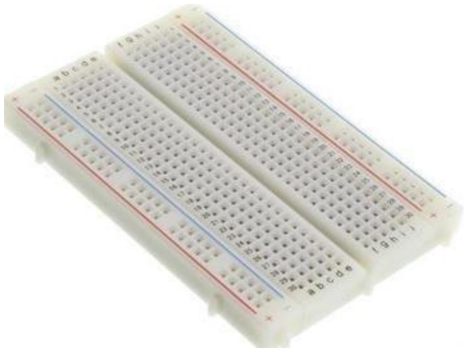
3.7 Components used.

<table>
<tr><th>No.</th><th>Components</th></tr>
<tr><td>1.</td><td>

Arduino uno</td></tr>
<tr><td>2.</td><td>

Battery</td></tr>
<tr><td>3.</td><td>
LED</td></tr>
</table>

4.	 Accelerometer sensor
5.	 Resistors
6.	 Jumper wire
7.	 Wire connector

8.	 Breadboard

3.8 Arduino Software Application

The Arduino framework in this project serves as the primary tool for planning and drawing circuits. The objective is to make the process of creating and programming an electrical device simpler. Because blinking is a requirement for building an emergency lighting system, the blinking system will be used in this project by using red LED. However, this technique also iterates the circuit's loop using the LED array. This was done in an effort to make the LED output more visible.

3.9 Accelerometer sensor

The X, Y, and Z axes of the employed accelerometer sensor are used to calculate any specific axis shifts. The X-axis is oriented in a forward way. The Z-axis' upward direction and the Y-axis' left-to-right orientation. The mounting or placement of the accelerometer will determine this orientation. The accelerometer sensor that will be fitted and placed at the front bumper is shown in Figure 3.8.

Figure 3:8 The accelerometer sensor (ADXL335-5V Ready Triple- Axis Accelerometer, n.d.)

3.10 Wiring System

Referencing the programming code transmitted to the Arduino board will guarantee that all parts' wiring is accurate and suitable for the design product's smooth operation. Jumper wire and wire connector used to complete the circuit.

3.11 Summary

The information and approach for this project are taken from this chapter. The survey question for this study was first given out to random participants. The information gathered from this survey can lead to a project suggestion. Next, construct a system design for further progress. Lastly, the product design has also been developed.

CHAPTER 4

4.1 Introduction

This chapter will introduce the outcomes and the details about the project work. The results findings are based on the work on following the methodology in chapter 3. The finding are the fabrication process, Arduino programming, prototype testing and visibility test.

4.2 Fabrication Process

The term “fabrication processes” refers to a broad range of procedures and methods in the creation, shaping, or assembling of materials into final goods. To create parts, structures, or gadgets, these techniques may entail manipulating materials like metals, polymers, ceramics, and composites. The process of fabrication aims to convert raw materials into functional goods with predetermined dimensions, characteristics, and forms.

The production process begins with learning on the basic information about the components such as Arduino uno, accelerometer sensor and the system output and input also the programming of the Arduino. The work begins with connecting the jumper wire to the accelerometer sensor. 5 jumper wire connected to the 5 pins on the accelerometer begin 5V pin, GND pin, x-axis pin, y-axis pin and z-axis pin.

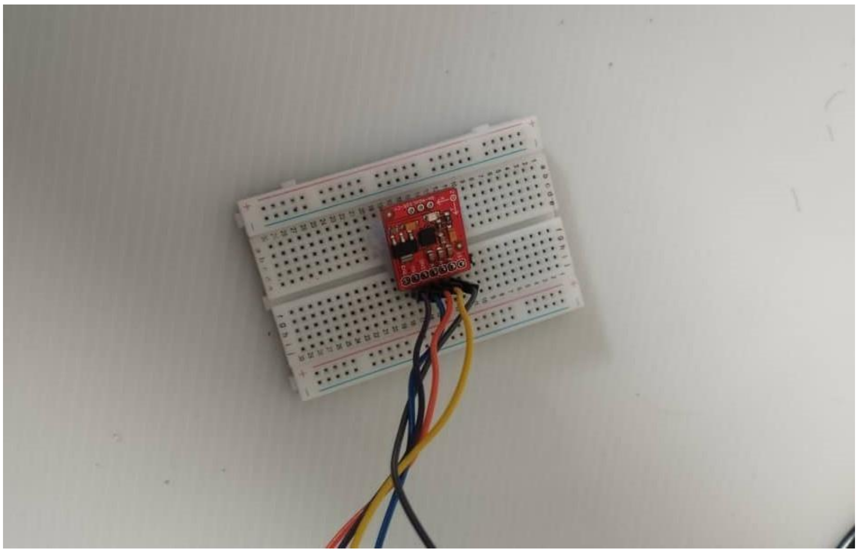


Figure 4:1 The jumper wire connection to the accelerometer sensor

After that, the wire jumper that connected to the accelerometer is connected to the pin on the Arduino Uno. 5V connector wire from the accelerometer has been connected to the power pin 5V on the Arduino while the GND pin from the accelerometer has been connected to the GND on the Arduino. X-axis has been connected to the analog pin A0 on the Arduino. Then, Y-axis has been connected to the analog pin A1 and lastly the Z-axis has been connected to the analog pin A2 on the Arduino.

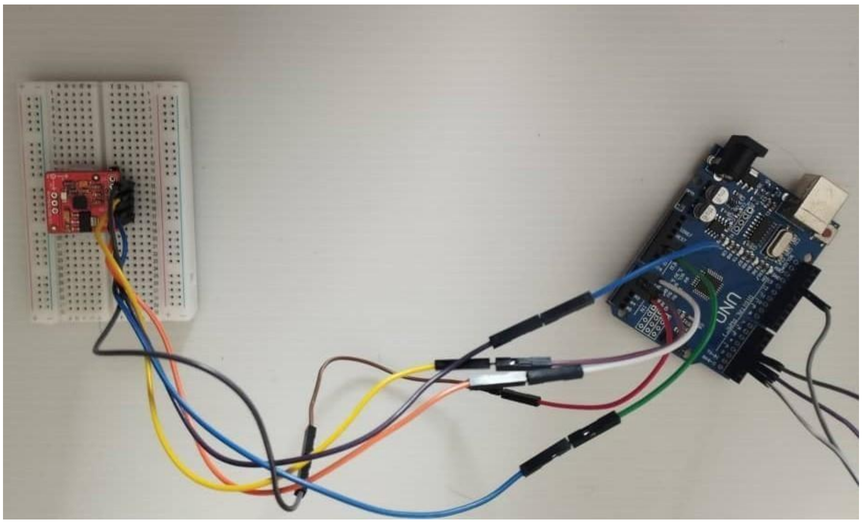


Figure 4:2 The jumper wire connection between accelerometer sensor and Arduino Uno

The LED will work as the output system of the project. The LED system has been placed on the rear of the toy trailer. The LED system connected to the Arduino board with 4 digital pins, 2, 3, 4 pin for the power and signal while the GND pin on the LED system has been connected to the GND pin on the Arduino board.

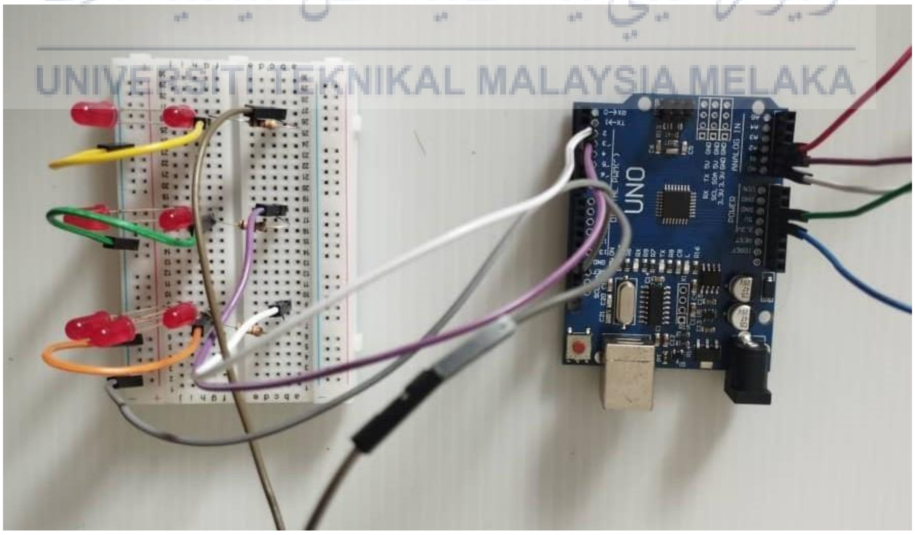


Figure 4:3 The jumper wire connection between LED system and Arduino Uno

The final step for the fabrication part is Arduino programming software. The coding has been written on the Arduino IDE, the system verified the code for error checking and the code upload to Arduino.

Figure 4:4 The complete installation of the system on the toy truck

4.3 Arduino Programming

The computer code is created and uploaded to the actual board using the Arduino IDE (Integrated Development Environment). One of the main reasons Arduino got so popular was arguably its extremely simple Arduino IDE. The coding state that the x, y, z pin on the accelerometer connected to the A0, A1, and A2 pin on the Arduino board. The coding also includes the connection of the LED system and the Arduino board.

```
const int xPin = A0;  // Analog pin for X-axis
const int yPin = A1;  // Analog pin for Y-axis
const int zPin = A2;  // Analog pin for Z-axis

const int ledPin1 = 2;  // Digital pin for LED 1
const int ledPin2 = 3;  // Digital pin for LED 2
const int ledPin3 = 4;  // Digital pin for LED 3

int impactThreshold = 300;  // Adjust this threshold based on your application
```

Figure 4:5 Declaration of the LED and accelerometer pin

The void setup of the Arduino-connecting LED output is shown in Figure 4.6. The setup function ought to comply with the parameter declaration at the outset of the program. It is the first function in the program, used to serial communication or set pin mode, and it is only executed once.

```
void setup() {
  Serial.begin(9600);
  pinMode(ledPin1, OUTPUT);
  pinMode(ledPin2, OUTPUT);
  pinMode(ledPin3, OUTPUT);
}
```

Figure 4:6 Void setup

The loop blank indicates that every pin on the sensor reads an analogue value, as shown in Figure 4.7. After that, the code was coded to print the sensor's name and value. The code to be continuously executed can then be provided and followed by the loop function. This feature is the heart of every Arduino programming; it handles most of the work.

```
void loop() {
  int xAccel = analogRead(xPin);
  int yAccel = analogRead(yPin);
  int zAccel = analogRead(zPin);

  // Calculate the overall acceleration
  int acceleration = sqrt(pow(xAccel - 512, 2) + pow(yAccel - 512, 2) + pow(zAccel - 512, 2));

  // Print acceleration values for debugging
  Serial.print("X: "); Serial.print(xAccel);
  Serial.print(", Y: "); Serial.print(yAccel);
  Serial.print(", Z: "); Serial.print(zAccel);
  Serial.print(", Overall: "); Serial.println(acceleration);
```


Figure 4:7 Void loop

As a modification, this system also uses the If Statement. At this point, the LED was assigned a condition based on each sensor data. When the sensor value exceeds or deviates from the predetermined value, this state will cause the LED to blink. The timer interrupt is for this encoding in order to enable a task to run at a specific moment while the other programmed code is executing. Figure 4.8 displays the LED’s loop feature.

```
  // Check if impact force exceeds the threshold
  if (acceleration > impactThreshold) {
    // Blink all three LEDs for 10 seconds
    for (int i = 0; i < 10; i++) {
      blinkLED(ledPin1);
      blinkLED(ledPin2);
      blinkLED(ledPin3);
      delay(1000); // Delay for 0.2 second
    }
  }
}

void blinkLED(int pin) {
  digitalWrite(pin, HIGH);
  delay(100);
  digitalWrite(pin, LOW);
}
```


Figure 4:8 LED blinking coding

4.4 Prototype Testing

4.4.1 Velocity Calculation

The ratio of an object's distance travelled during a time interval to that interval is used to compute speed. On the other hand, the ratio of a displacement interval during a time to the time taken is used to determine velocity. For this testing, toy truck is placed at rest, and it start move toward until it pass distance require and the time taken for the truck to move from 0 mm to 1500mm is taken.

Velocity = Distance / Time

Distance = 1500mm @ 1.5m

Time = 1.36 seconds

Velocity = 1.5m / 1.36 seconds

Velocity = 1.1m/s

4.4.2 Functionality Test

Functionality test involving frontal crash and side crash. For the frontal crash (Figure 4.9), the trailer will move from static position that marked as 0 or origin until the trailer hit the wall at the distance of 1.5m from starting position. For the side impact (Figure 4.10), the situation is when a car hit the side of the trailer cab.

Figure 4:9 Frontal crash

Figure 4:10 Side crash

4.4.3 Visibility Test

For the visibility test, the implementation of the triangle is used. The LED system is placed on the triangle (Figure 4.11). The purpose of the triangle will act as the safety triangle.

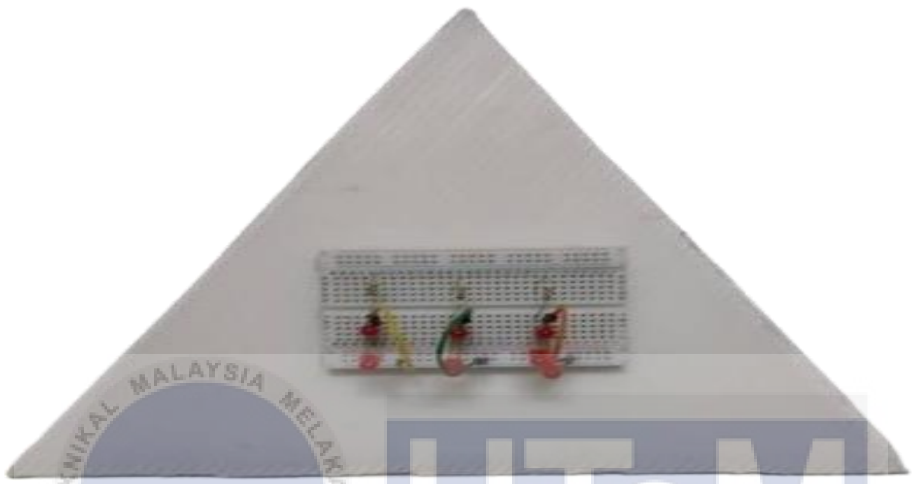


Figure 4:11 Implementation of the safety triangle

The implementation of the safety triangle has been tested for visibility test at night. The visibility test on 2 different distance which are 10 meters (Figure 4.12) and 20 meters (Figure 4.13).

Figure 4:12 10 meters visibility test

Figure 4:13 20 meters visibility test

The visibility test was scale from 1-10 on both distances. For 1, the scale has been considered for poor visibility, significant obstructions. From 2-4 the visibility is considered moderate obstructions, reduced clarity. From 5-7 the visibility is considered to have some minor obstructions. For 8-10 the visibility is considered as clear visibility, no obstructions refer to Appendix A. The table showed the visibility test results (Table 3).

Distance (m)	Visibility rating (1-10)
10	6
20	5

Table 3 Visibility test rating

4.5 Result Testing

4.5.1 Frontal crash result

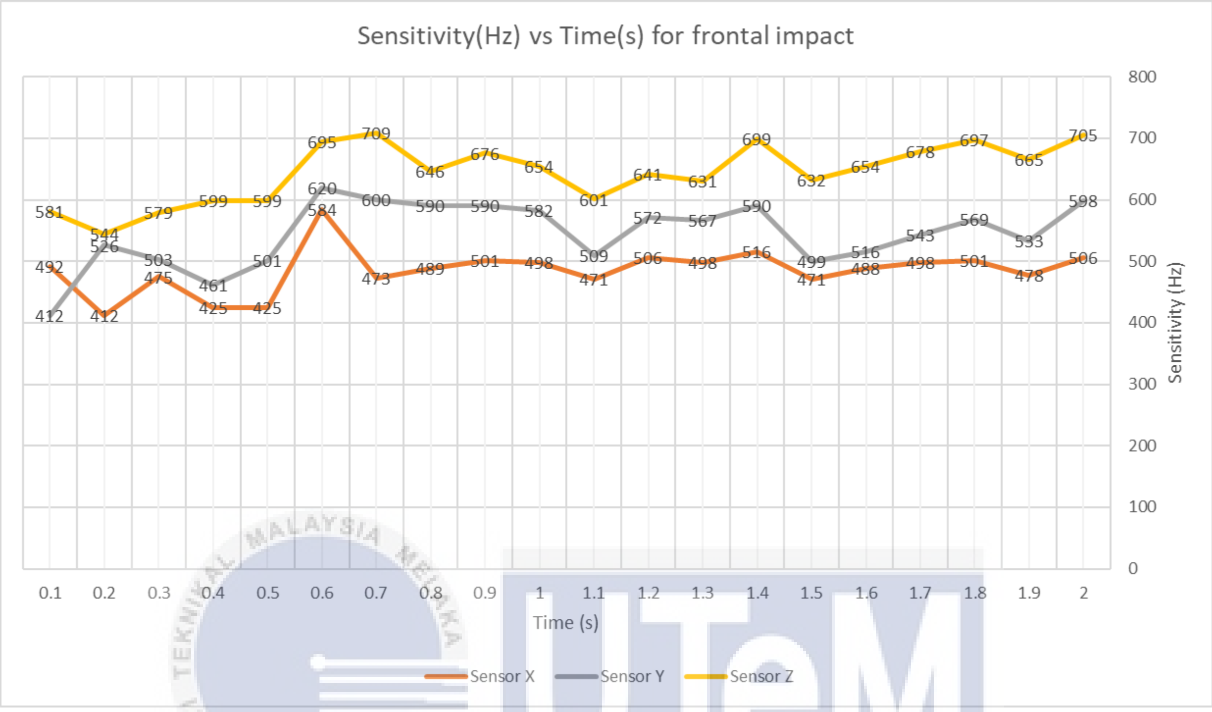


Figure 4:14 Sensitivity (Hz) vs Time (s) for frontal impact

The orientation of the three-axis accelerometer sensor, ADXL335, regarding gravity influences the values on each axis. X, Y, and Z are the three directions in which the sensor registers acceleration.

The ADXL335 sensor's orientation can be adjusted, and this will also affect the acceleration values along the corresponding axes. Since gravity is a constant force, the orientation of the sensor with respect to the gravitational field will be reflected in the sensor values, which measure the acceleration caused by gravity.

From the testing, the orientation of the accelerometer axis has been changed. The z-axis will detect the reading for front and back while the x-axis will detect the reading for left-right side and the y-axis will detect the reading for above and below.

From the graph, the average reading for x-axis is below y-axis and z-axis for 2 second data taken. While for the z-axis the data showed the reading are higher than y-axis and x-axis due to the orientation of the accelerometer that make the z-axis detect the reading data for front and behind. The z-axis reading is the highest due to direct reading for the orientation. Refer the reading on Appendix B.

4.5.2 Side crash result

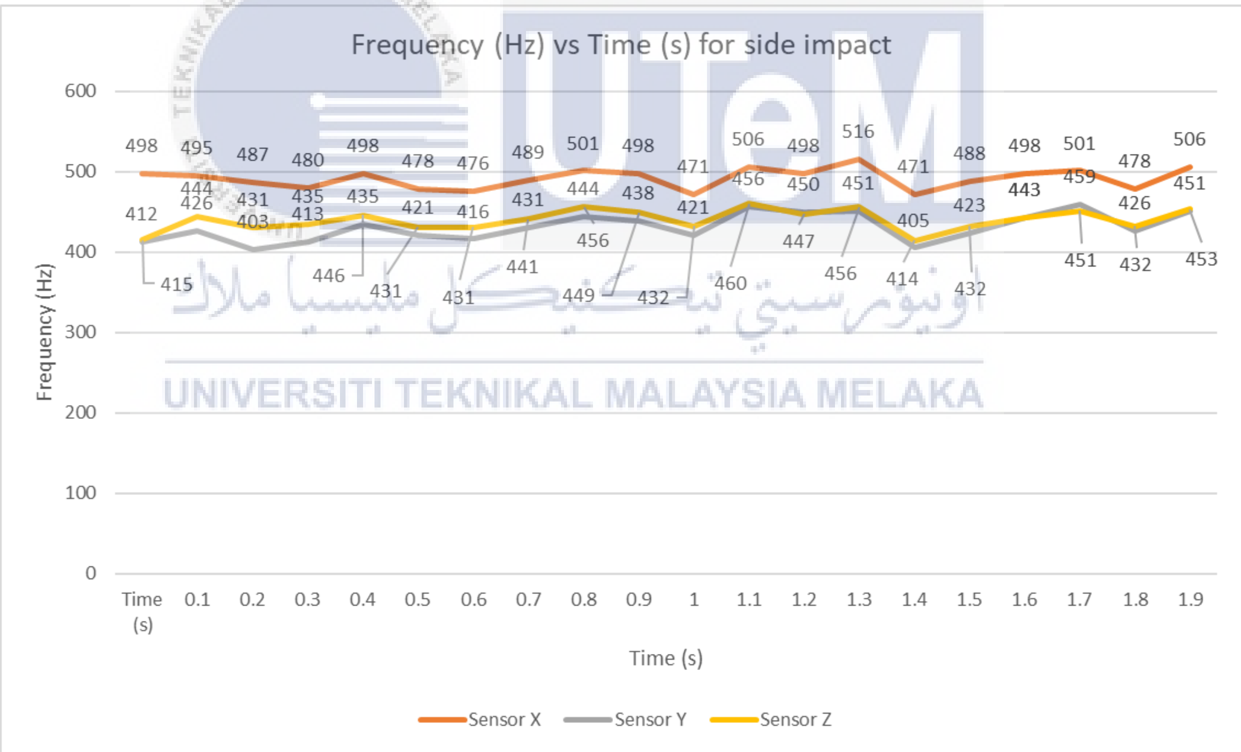


Figure 4:15 Sensitivity (Hz) vs Time (s) for side impact

From the graph showed that the average reading for x-axis is the highest due to the orientation of the accelerometer sensor that make the x-axis detect the reading for left-right side. Refer to Appendix C.

4.5.3 Average data result

Frontal Crash	
Position	Average reading in 2 seconds duration
X-axis	485
Y-axis	544
Z-axis	644

Table 4 Average reading in 2 seconds duration for frontal crash

Side Crash	
Position	Average reading in 2 seconds duration
X-axis	491
Y-axis	431
Z-axis	440

Table 5 Average reading in 2 seconds duration for side crash

From the table for the frontal crash, the data show the average for the reading in 2 second duration that the z-axis has the highest average reading with 644 compared to y and x-axis with 544 and 485 respectively. The orientation of the accelerometer makes the z-axis detect the front and back make the reading measure is higher compared to y and x-axis. While for the side crash, x-axis detect highest reading with 491 compare y and z-axis with 431 and 440 respectively. The orientation of the accelerometer make the x-axis detect the front and back make the reading measure is higher compare to y and z-axis.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As the increase of the articulated heavy vehicle on the road in Malaysia the risk and rate of accident also increased. When an accident involving an articulated heavy vehicle and smaller vehicle happened the result end up severity or fatality for the smaller vehicle users. Most of crashes are when a vehicle crash to the rear of the articulated heavy vehicle to low visibility especially at night and during rain when the articulated vehicle having an accident due to low visibility especially at night and during rain. This type of accident can be reduced by implementing automatic hazard emergency light that automatically blink when the articulated heavy vehicle crash. The information of the articulated heavy vehicle data crash, road conditions, emergency light in Malaysia has been collected by doing literature review. Literature review information gave an idea on how the system design and functionality of the automatic emergency hazard light should work. Fritzing software used to design a correct system and circuit. Real components used to create the system for automatic hazard light by referring to the fritzing software. The functional system used to carry out testing by using prototype which is toy truck. The LED system blink when the toy truck crash on the wall and when a car crash on to the toy truck. The reading from the crash taken to do the analysis. For frontal crash average highest reading detect by z-axis due orientation of the accelerometer that make z-axis detect front and rear reading. Lastly, the project purpose accomplished as it works and produce data.

5.2 Recommendation

Crash prevention is important for every road user. The automatic hazard emergency light also one of the preventions for behind vehicle to change the lane or stop the vehicle if the truck having an accident. This system only works when the truck receives an impact greater than the setting impact in the coding. For the truck that having a broke down on the side road the (IoT) system needs to be applied when a driver of the truck can control the on and off button of the emergency light by using mobile phone.

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APPENDICES

APPENDIX A: Visibility rating

Scale	Visibility evaluation
1	Poor visibility, significant obstructions
2	Moderate obstructions, reduced clarity
3	
4	
5	Minor obstructions
6	
7	
8	Clear visibility, no obstructions
9	
10	

APPENDIX B: Reading Frontal Crash

Times (s)	Pin position		
	X-axis	Y-axis	Z-axis
0.1	492	412	581
0.2	412	526	544
0.3	475	503	579
0.4	425	461	599
0.5	425	501	599
0.6	584	620	695
0.7	473	600	709
0.8	489	590	646
0.9	501	590	676
1.0	498	582	654
1.1	471	509	601
1.2	506	572	641
1.3	498	567	631
1.4	516	590	699
1.5	471	499	632
1.6	488	516	654
1.7	498	543	678
1.8	501	569	697
1.9	478	533	665
2.0	506	598	705

APPENDIX C: Reading Side Crash

Time (s)	Pin position		
	X-axis	Y-axis	Z-axis
0.1	498	412	415
0.2	495	426	444
0.3	487	403	431
0.4	480	413	435
0.5	498	435	446
0.5	478	421	431
0.6	476	416	431
0.7	489	431	441
0.8	501	444	456
0.9	498	438	449
1.0	471	421	432
1.1	506	456	460
1.2	498	450	447
1.3	516	451	456
1.4	471	405	414
1.5	488	423	432
1.6	498	443	443
1.7	501	459	451
1.8	478	426	432
1.9	506	451	453
2.0	500	447	447