POLITEKNIK MALAYSIA
SULTAN SALAHUDDIN ABDUL AZIZ SHAH

MECHANICAL ENGINEERING DEPARTMENT

SESSION 1 2022/2023

ADVANCED LADDER

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This project is submitted in partial fulfillment of requirements for the award of Diploma in Mechanical Engineering

MECHANICAL ENGINEERING DEPARTMENT

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DECLARATION OF AUTHENTICATION AND OWNERSHIP

TITLE : ADVANCED LADDER

SESSION : 1 2022/2023

1. We, **Janu Priya A/P Ramu** **08DKM20F1032**
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   are the final year students of **Diploma in Mechanical Engineering, Politeknik Sultan Salahuddin Abdul Aziz Shah**, located at **Persiaran Usahawan, 40150 Shah Alam, Selangor.**

2. We verify that **Advanced Ladder** and its intellectual properties are our original work without plagiarism from any other sources.

3. We agree to release the project's intellectual properties to the above said polytechnic in order to fulfil the requirement of being awarded **Diploma in Mechanical Engineering.**

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ACKNOWLEDGEMENT

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Thank you.

ABSTRACT

Most economists believe that technological innovation is a fundamental determinant of economic development and human welfare. In order to be a part of the technological innovation, a development in ladder has been introduced in this project which is called Advanced Ladder. Survey and research are done in favor to design the ladder in an ergonomic and comfortable way to overcome common problems faced by users while using ladders such as being tired of getting up and down to move ladders while working and insufficient space to place equipment. Therefore, the project is designed as an ergonomic structure of a ladder that would make people work at ease. The main features of Advanced Ladder are the ability to move from one place to another horizontally and vertically by a mechanical mechanism, enough storage space at different levels of height on the ladder to avoid users overreach to grab tools and finally has ultrasonic sensors at two sides of the ladder to alert the users if there is any obstacles or uneven surfaces. Every component that is used and designed has its own advantages and safety measures in Advanced Ladder to ensure this revolution of ladder be beneficial and admissible.

Keywords: ladder, ergonomic, ultrasonic sensors, mechanical mechanism

ABSTRAK

Kebanyakan ahli ekonomi percaya bahawa inovasi teknologi adalah penentu asas pembangunan ekonomi dan kebajikan manusia. Untuk menjadi sebahagian daripada inovasi teknologi, satu pembangunan dalam tangga telah diperkenalkan dalam projek ini yang dipanggil *Advanced Ladder*. Tinjauan dan kajian dilakukan memihak kepada mereka bentuk tangga dengan cara yang ergonomik dan selesa untuk mengatasi masalah biasa yang dihadapi oleh pengguna semasa menggunakan tangga seperti penat naik dan turun untuk memindahkan tangga semasa bekerja dan ruang yang tidak mencukupi untuk meletakkan peralatan. Oleh itu, projek ini direka bentuk sebagai struktur ergonomik tangga yang akan membuatkan orang ramai bekerja dengan selesa. Ciri-ciri utama *Advanced Ladder* adalah keupayaan untuk bergerak dari satu tempat ke tempat lain secara mendatar dan menegak dengan mekanisme mekanikal, ruang penyimpanan yang mencukupi pada tahap ketinggian yang berbeza pada tangga untuk mengelakkan pengguna terlalu menjangkau untuk mengambil alatan dan akhirnya mempunyai sensor ultrasonik di dua sisi tangga untuk memberi amaran kepada pengguna jika terdapat sebarang halangan atau permukaan yang tidak rata. Setiap komponen yang digunakan dan direka bentuk mempunyai kelebihan dan langkah keselamatan tersendiri dalam *Advanced Ladder* untuk memastikan revolusi tangga ini bermanfaat dan boleh diterima.

Kata kunci: tangga, ergonomik, sensor ultrasonic, mekanisme mekanikal

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION (Janu)

A ladder is a tool that permits vertical access from higher level to lower level, or vice versa. It is normally angled, but if properly secured in place, it can be upright. Ladder consists of two uprights joined by a sequence of parallel horizontal parts known as 'rungs,' which support a person's weight and may be thought of as steps by stepping on one rung after another which causes vertical movement, allowing the user to ascent or descent. Ladders should be designed to make the users feel safe and convenient to use as it is widely used by every kind of jobs, industries and even at home to reach higher areas and perform work.

1.2 BACKGROUND RESEARCH (Janu)

Based on the survey and research made, when using ladders people find it difficult to place their tools and equipment while working on ladder. Furthermore, getting up and down to move the ladder every time when they change platforms to work would be another problem.

The project aims to help the users be convenient and safe when using an ergonomically designed ladder. That is why Advanced Ladder is designed in a way where storage spaces are provided at several heights of the ladder to ensure that the users can reach their tools easily. Our project also can be controlled through Bluetooth of mobile phones to move the ladder horizontally and vertically. Last but not least, ultrasonic sensors are installed at two sides of the project for detecting any obstacles or uneven surfaces to avoid unnecessary accidents.

1.3 PROBLEM STATEMENT (Janu)

Even though ladders are widely used, users find that the existing type of ladders are quite not ergonomic enough. For instance, the common problems faced by the users while using ladders are:

- Wasting time and energy to move the ladder while on work (going up and down repeatedly to position the ladder)
- Lack of space to keep things on the ladder.

1.4 OBJECTIVE OF THE PROJECT (Janu)

There are three objectives should be achieved from this project:

- To develop a mechanical mechanism for horizontal and vertical movement of ladder.
- To design enough storage space to store equipment while using the ladder.
- To fabricate and analyze the prototype of the project.

1.5 RESEARCH QUESTIONS (Mathen)

- What benefits can users gain through a development in ladder?
- What kind of Internet of Things (IoT) technology can make users to work at ease?
- Which mechanism should be used to make the ladder movable?

1.6 SCOPE OF THE PROJECT (Mathen)

- Designed for capacity of 1 person.
- Weight limit of the user is up to 50kg.
- Weight limit of the storage space provided can hold up to 20kg.

1.7 CONTRIBUTION OF THE PROJECT (Yuvan)

Many ladders are presently in use in this era, however mostly current ladders have not improved in terms of technology and for this reason, our project has included a component of IoT which is by providing sensors. As the world is moving forward with Industrial Revolution 4.0, it is a necessary to have technology in innovation and invention to boost economic growth.

1.8 SUMMARY (Yuvan)

In a nutshell, this chapter can be concluded by saying that the study from research have helped to develop this project as stated that it can overcome the common challenges experienced by individuals when using ladder. Although the primary goal of this initiative is to achieve the objectives, the project has also implemented the importance of technology in the creation. This is because technological advancement enables the production of more and better assets in a more efficient way.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION (Mathen)

This chapter aims to use the findings from the Internet to focus on how ergonomic a ladder should be. Review of the literature also supports the conclusion on how Advanced Ladder has been designed to prevent the target users wasting time and energy while doing work and to have enough storage space on the ladder. The purpose of the review is also to evaluate the existing ladder designs by improvising the features to make the users more beneficial.

2.2 HISTORY (Yuvan)

Ladders are a type of technology that has been around for thousands of years. A ladder's aim is to safely reach high locations and points. A ladder is thought to have been invented about 10,000 years ago. This is because there was a ladder that is represented in a Mesolithic rock art from the Spider Caves in Valencia, Spain, that is at least 10,000 years old. The photograph from the Mesolithic period (Middle Stone Age) shows two humans collecting honey from a wild honeybee nest using a ladder. The painting shows a flex ladder that was formed of some kind of vegetation. In 1862, Dayton's John H Basely invented the step ladder. He put hinges on it when he created it so that after someone finished with it, they could fold it away. Rope ladders were utilized in the past and are still in use in some nations. There are also wooden ladders that are quite sturdy and were used during World War II. Because step ladders are composed of metal, they are quite resistant.

FIGURE 2.2.1: The Mesolithic rock art

2.3 PREVIOUS RESEARCH ON LADDER DESIGNS (Janu)

- Step ladder

FIGURE 2.3.1: Step Ladder

Step ladders are designed as a sturdy position with flat base which makes them not movable. Therefore, the users have to go up and down repeatedly to position the ladder. This obviously makes the users feel tired and takes a long time to accomplish their task. Furthermore, there is not enough space given for the users to store their equipment. Due to this, users must keep their tools further from their working platform or perhaps they have to expect help from others to pass the tools.

- Extension Ladder

FIGURE 2.3.2: Extension Ladder

Extension ladders are designed as unbalanced structure this is due to the linear arrangement of two or more portions that move in guides or brackets that allow for length change in the ladder. Due to the non-self-supported formation, users need to place the ladder against wall or a surface to lean the ladder when performing work. Moreover, there is insufficient space to stock tools, so users ought to carry things while climbing the ladder.

- Movable Ladder

FIGURE 2.3.3: Movable Ladder

Movable ladder is a completely stable and safe ladder with wheels or casters, making them easy to move. Even though it is movable, unfortunately it cannot be moved while users are standing on the ladder. Also, the users will only be able to keep things at the top platform of the ladder. Through this, users can only reach for their things when they are kept at a certain level of distance from their working platform.

- Smart Level Ladder

FIGURE 2.3.4: Smart Level Ladder

Smart Level Ladder is a technologically designed ladder where the legs of the ladder can be adjusted according to the surface of the platform. This ladder can be said as an upgraded version of extension ladder so obviously it needs a surface to lean on in order to achieve stability. On the other hand, even though the users can reach more further height than the other ordinary ladders, the insufficient space for storage would be a big problem as per the Bureau of Labor Statistics, people carrying items while they climbed the ladder were responsible for 50% of all ladder-related injuries.

- Rope Ladder

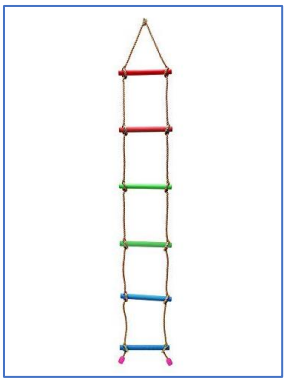


FIGURE 2.3.5: Rope Ladder

Rope ladders are designed as a light weighed ladder. Also, it needs a hook on a wall so that the rope ladder can be hanged in a fixed position, this is because rope ladders do not have a strong and stable structure. Since it is made up of rope, the knot of the ropes may get loosened when the ladder is used often. At the same time, lack of storage space makes it more difficult for the users.

2.4 SUMMARY (Mathen)

In short, Advanced Ladder is designed to be convenient and easy to use. To make the users feel comfortable while using our ladder, we have attentively concentrated on the common problems faced by the users and enhanced some features in the project.

First of all, to tackle the problem where users must go up and down to position the ladder, Advanced Ladder is designed to be able to move horizontally and vertically by a mechanical mechanism where the wheels can be moved in horizontal and vertical direction with an ideal speed to the desired distance by controlling the wheels simply using their mobile phones. The mobile phone will be placed at the phone holder which is adjustable along the handrails.

Secondly, the storage space that is given at several levels of the steps. This is because we want to ensure that the users are able to store their tools and equipment no matter which step they are standing on the ladder. Through this feature, users can have enough space to keep their tools and do not have to overreach to grab their things while using the ladder.

Next, to show that our project is up to date representing the Internet of Things (IoT) aspect, Advanced Ladder has been designed with assistance of ultrasonic sensors at the front and back of the ladder which will alert the users if there is any obstacles or uneven surface when the ladder is on the move. The sound of alert from the sensors is set to work when the ladder is in motion, this is to avoid disturbance that might cause to users.

These are the main features that our project focused on so that Advanced Ladder is a product to boost user's productivity by helping them to stay comfortable while working on the ladder.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION (Yuvan)

This chapter will explain the methods used to do this project. This chapter will also include every component's function that is installed in this project. Total budget of making this project is shown by the end of this chapter.

3.2 DESIGN OF THE PROJECT (Mathen)

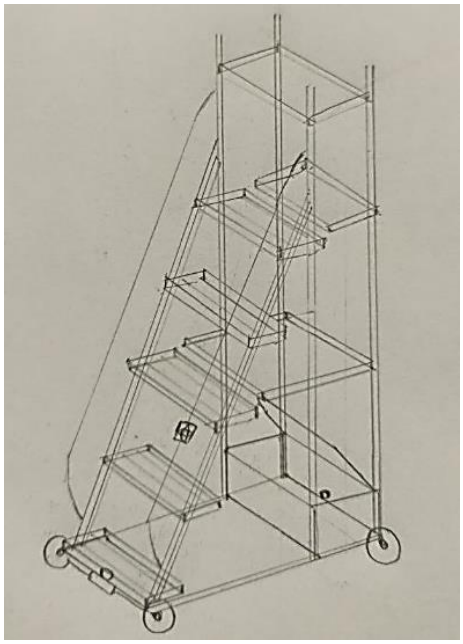


FIGURE 3.2.1: 2D Sketch Drawing

FIGURE 3.2.2: 3D Design Version 1

FIGURE 3.2.3: 3D Design Version 2

The project's mechanism has been modified in order to cut costs. There were previously eight motors, but currently there are only two. There is no change in function by modifying this mechanism, as the advanced ladder can still move in a 360-degree circle. As a result, the overall cost of this project was effectively reduced.

FIGURE 3.2.4: Project front view

FIGURE 3.2.5: Project back view

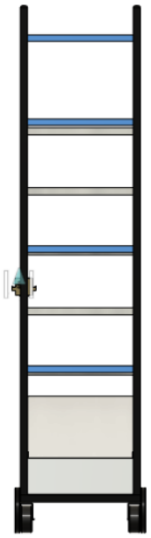


FIGURE 3.2.6: Project right view

FIGURE 3.2.7: Project left view

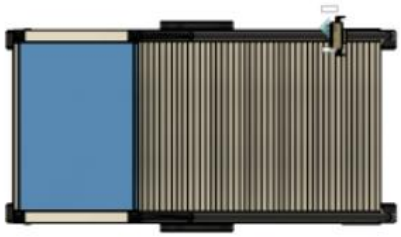


FIGURE 3.2.8: Project top view

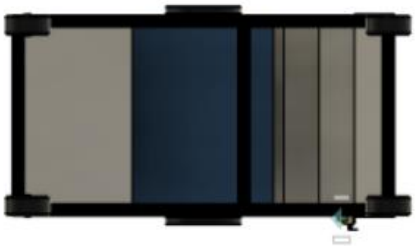


FIGURE 3.2.9: Project bottom view

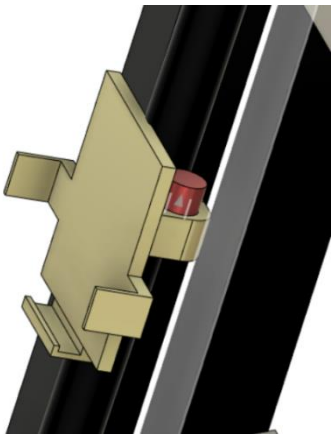


FIGURE 3.2.10: Adjustable phone holder

FIGURE 3.2.11: Storage space

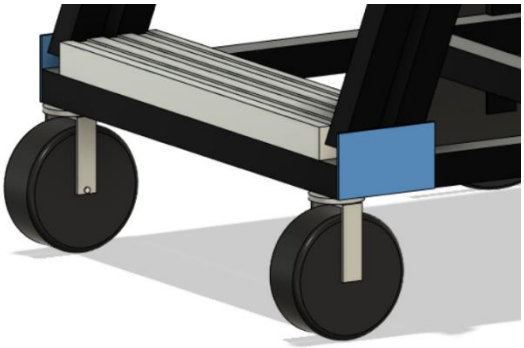


FIGURE 3.2.12: Free move wheel

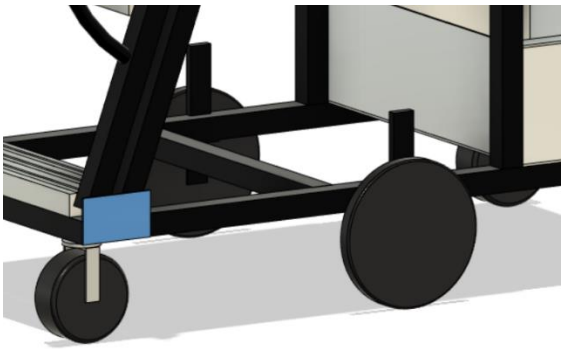


FIGURE 3.2.13: Heavy duty wheel

FIGURE 3.2.14: Hand railing

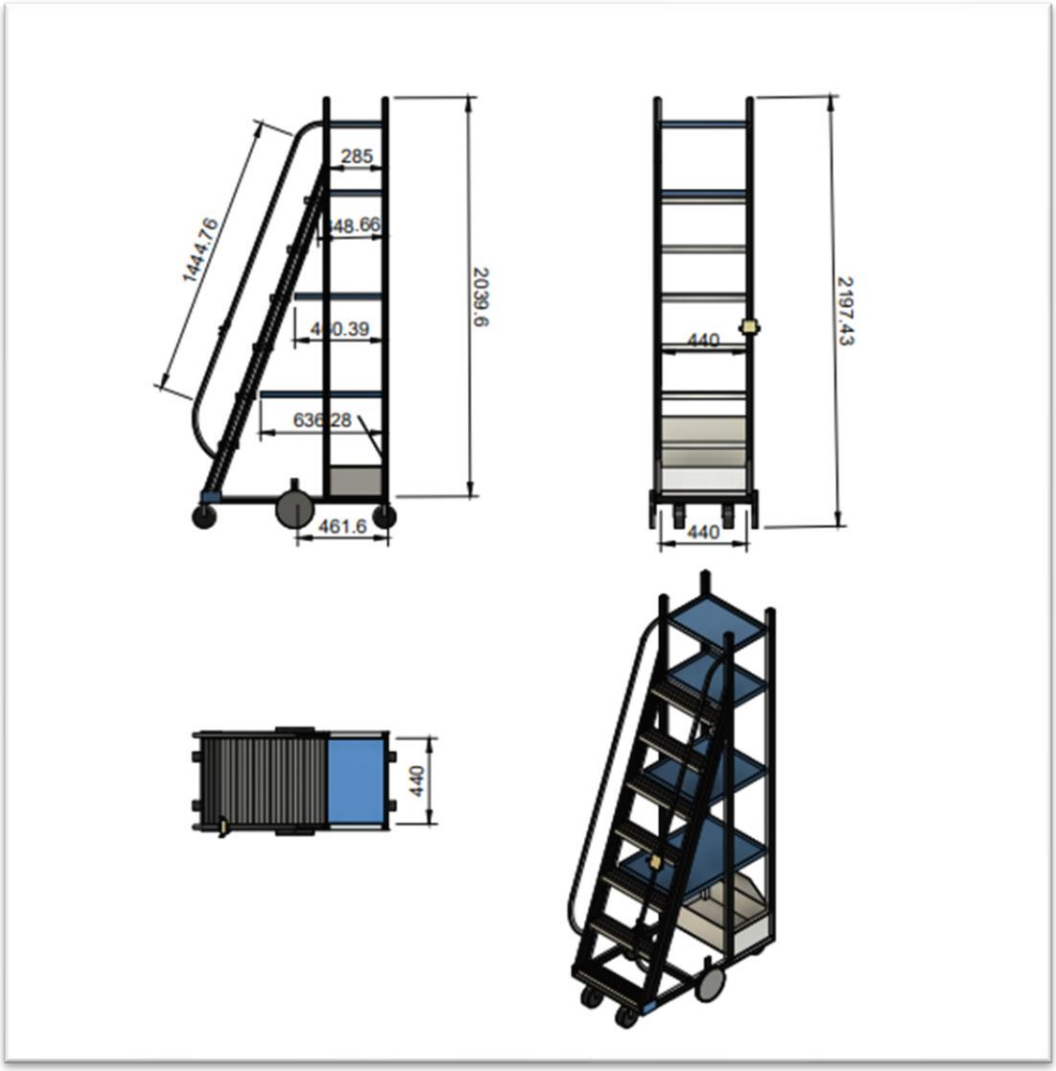


FIGURE 3.2.15: Dimensions of project (mm)

3.3 FLOW CHART (Yuvan)

In the accomplishment of the Advanced Ladder, the flow chart below assists us to complete the project.

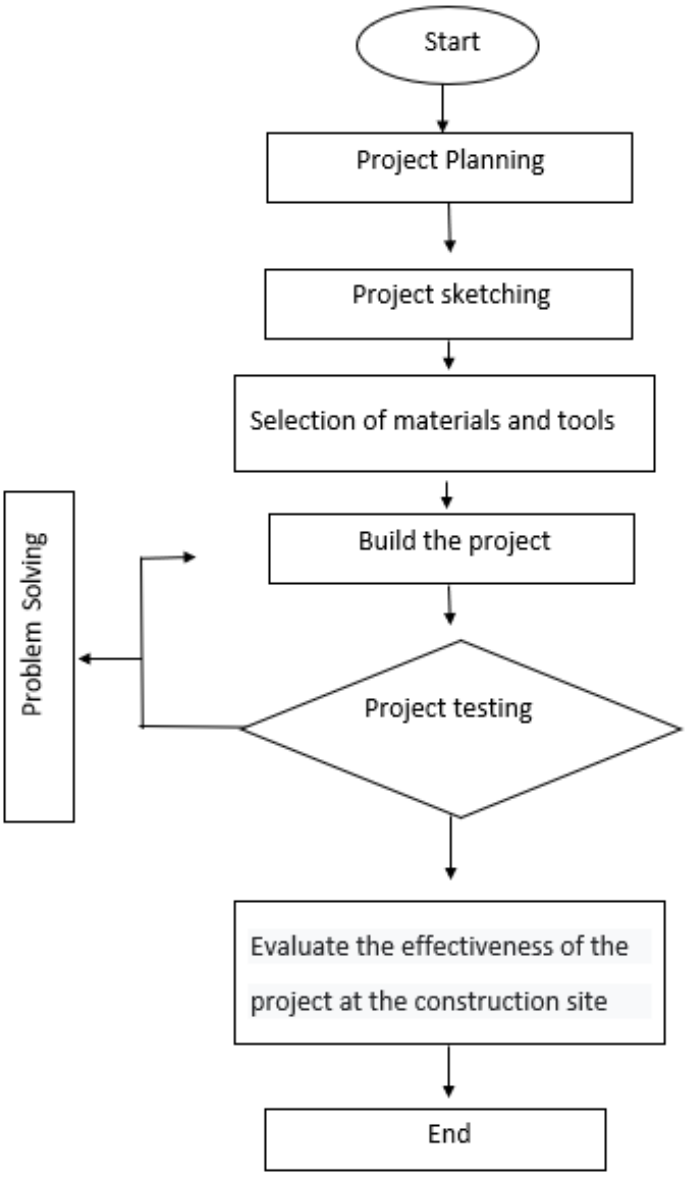


FIGURE 3.3.1: Flow chart

i. Identification of the problem

Identify the problem and find solution to solve it. Problem identification is vital in a project production because it will affect the result of innovation. It clearly found out the cause of a problem and come out with a clear problem statement which point out wasting time and energy to move the ladder while on work (going up and down repeatedly to position the ladder) and lack of space to keep things on the ladder.

ii. Literature review

The purpose of the literature review is to gather information and data from previous researchers in order to understand the background and issues of the Advanced Ladder project. Every problem can be solved by research. As a result, an Advanced Ladder was created to solve the problem which is time wasting and lack of storage space in a ladder.

iii. Details design

Details design is done using inventor application using measurement in (mm) and drawing is produced for documentation purpose. Details design is needed because in the process of fabrication we can refer to the design to prevent mistake.

iv. Material selection

Select the suitable materials to build the advanced ladder to fix the budget of the project.

3.4 MATERIALS AND EQUIPMENTS (Mathen)

FIGURE 3.4.1: Mild steel hollow

Mild steel chosen as the primary structural material because it is harder and less expensive than aluminum. Mild steel is a form of carbon steel with a low carbon content; it is often referred to as "low carbon steel." The quantity of carbon normally found in mild steel is 0.05% to 0.25% by weight, but higher carbon steels are typically classified as having a carbon content ranging from 0.30% to 2.0%. If further carbon is added, the steel will be categorized as cast iron. It builds with the minimum size of 1/2” x 1/2”

FIGURE 3.4.2: 12V DC Motor

12V DC motors are used to convert direct current (DC) electrical energy into mechanical energy, allowing the ladder to rotate 360 degrees.

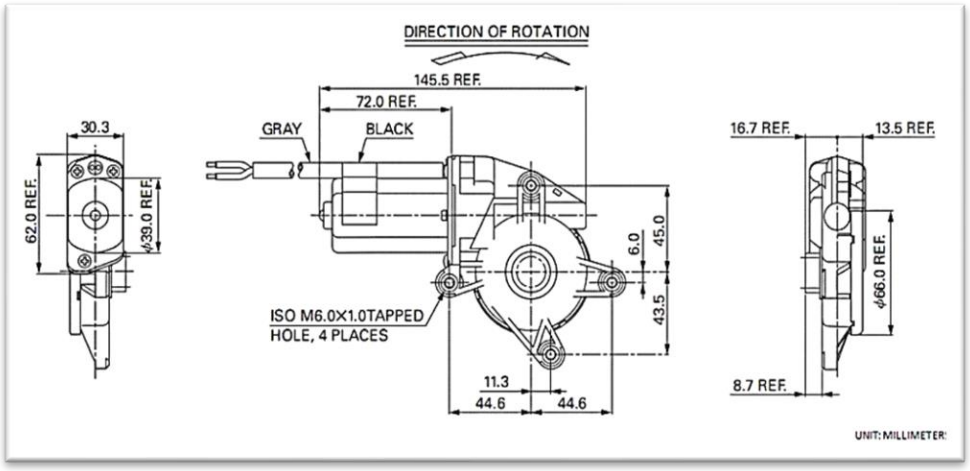


FIGURE 3.4.3: Specifications of 12V DC Motor

- Voltage Rating: 12VDC
- Rated Speed: 60 RPM
- Rated Torque: 2.9N.m (30kgf.cm)
- Rated Current: <15A at 12V
- Stall Torque (Locked): 9.8N.m (100kg.cm)
- Stall Current (Locked): <28A at 12V
- The motor is being tested to drive car's window:
    - Up and down for 8 seconds, survive 10,000 times
    - Not meant for continuous driving without stopping
- Motor dimension (w x l x h): 161.2mm x 30.3mm x105.5 mm

FIGURE 3.4.4: DC Motor Controller

DC motor controller manipulates the position, speed, or torque of a DC-powered motor and easily reverses, so the DC motor drive current runs in the opposite direction. Enjoy higher starting torque, quick starting and stopping, reversing, variable speeds with voltage input and more.

FIGURE 3.4.5: 12V Rechargeable Battery

A rechargeable battery is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use.

- Sealed Lead Rechargeable Battery
- Rating : 12V 7.2Ah
- Made In : Malaysia
- Brand : GP Power
- Warranty : 6 Months
- Size : 94mm(H) x 150mm(L) x 63mm(W)

FIGURE 3.4.6: 5'' Heavy duty wheel

Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines.

FIGURE 3.4.7: Ultrasonic sensor

The HC-SR04 is a compact, low-cost ultrasonic sensor and an easy-to-use packaging that can measure distances ranging from 2cm to 4 meters with consistent performance and high ranging accuracy. This sensor is incredibly simple to connect to an Arduino board or any other microcontroller. The HC-SR04 acts similarly to a rudimentary radar, sending a series of pulse pulses and listening for an echo. To measure distance, send a short trigger pulse to the TRIG pin while simultaneously monitoring the ECHO pin until the output is HIGH and measuring the pulse width.

- Operating Voltage: 5V DC
- Operating Current: 15mA
- Operating Frequency: 40KHz
- Maximum reading distance: 400cm
- Minimum reading distance: 2cm
- Detection Angle: 15°
- Resolution: 0.5cm
- Trigger pulse: >10us TTL pulse
- Output pulse with proportional to distance
- Maximum pulse width: 38ms if no obstacle
- Dimension: 45 x 20 x 15 mm

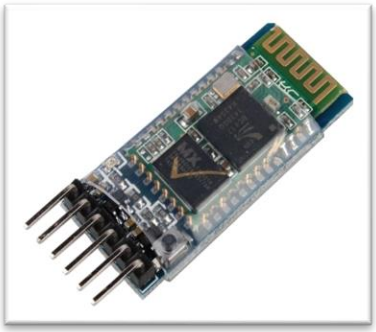


FIGURE 3.4.8: Arduino Bluetooth port (HC-05)

HC-05 is a Bluetooth module which can communicate in two ways. Which means, it is full duplex. We can use it with most micro controllers. Because it operates Serial Port Protocol (SSP).

- Model : HC05
- Operating Voltage (VCC) : 3.6-6V (Suggested using Arduino 5V pin).
- Communication Method : Serial Communication
- Transmission Distance Range : ~10M+- (Open Space)
- Size : 3.57 x1.52cm
- Support standard baud rate : 4800bps~1382400bps
- Default password : 1234 / 0000
- Default baud rate : 9600

FIGURE 3.4.8: Arduino Uno

An open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.

- Input voltage : USB Cable / 7-12V DC Plug
- Output voltage : 5V DC voltage output and 3.3V DC voltage output.

FIGURE 3.4.10: 12V Buzzer

A sounding device that can convert audio signals into sound signals. It is usually powered by DC voltage.

- Diameter : 23mm
- Height : 11mm
- Voltage : 3~24V
- Sound : 100dB

FIGURE 3.4.11: Phone holder

A safe and solid phone mount. This mount has 360-degree rotation for simple switching between portrait and landscape views. Compatible with phones with sizes that range from 4.7" to6.5".

3.5 PROJECT EXECUTION

3.5.1 PROJECT STRUCTURE BUILDING (Janu)

i. Measuring

Measure the mild steel and mark before cutting it to avoid mistake while cutting process.

FIGURE 3.5.1.1: Measuring Process

ii. Cutting

Cut the mild according to the marking using cutting machine.

FIGURE 3.5.1.2: Cutting Process

iii. Fabrication

Fabricate the mild steels using welding proses to get the shape of the project.

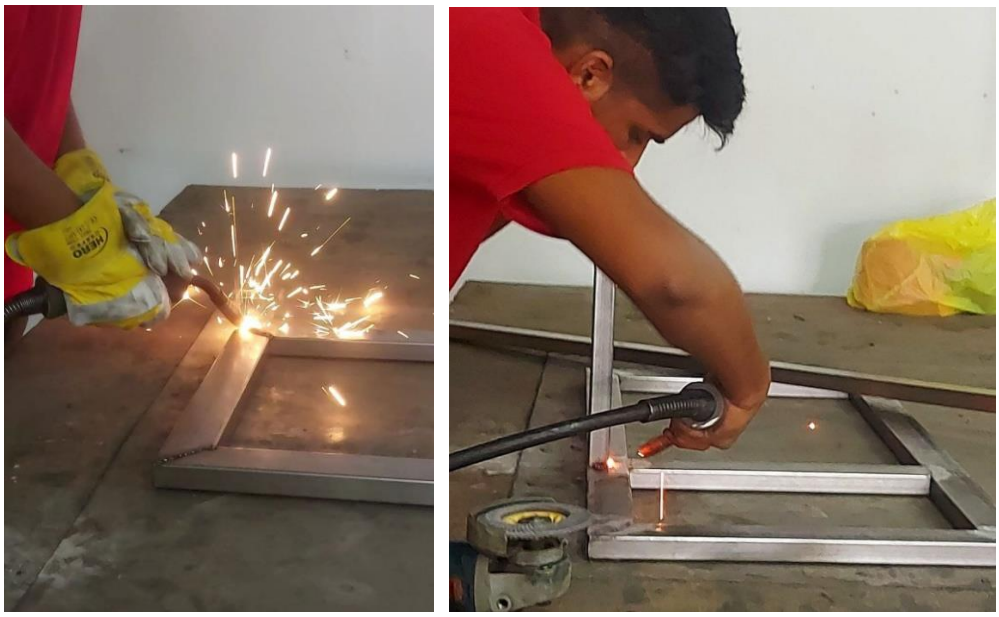


FIGURE 3.5.1.3: Fabricating Process

iv. Grinding

This process is to remove the unwanted work piece from the structure to make it looks clean and safe using grinder machine.

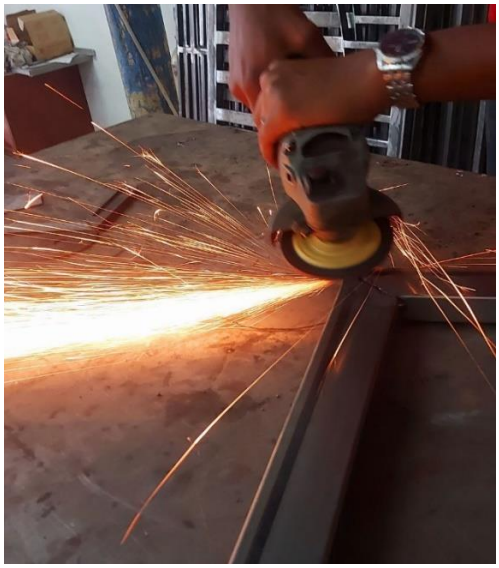


FIGURE 3.5.1.4: Grinding Process

v. Painting

We applied the paint by spraying process to the structure to prevent from rusting and for finishing using compressor machine.

FIGURE 3.5.1.5: Painting Process

vi. Drilling

We fixed the storage space on the structure after the painting dried to avoid from defect using hand drill.

FIGURE 3.5.1.6: Drilling Process

vii. Fixing

Fixing the tyre on the bottom of the structure to make the ladder move by using steel screw which is capable for steel use. Next, fixing the phone holder on the handrail of the structure.

FIGURE 3.5.1.7: Fixing Process

3.5.2 PROJECT MOVING MECHANISM (Yuvan)

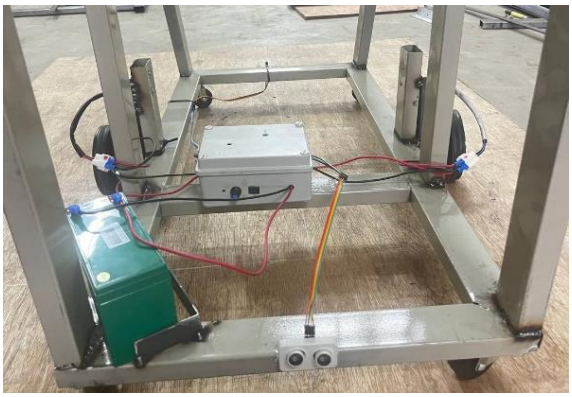


FIGURE 3.5.2.1: Project Moving Mechanism

i. Arduino Uno board

Arduino Uno board plays as the CPU of the whole system of innovation. The Arduino Uno board is a portal to receive and send out signal.

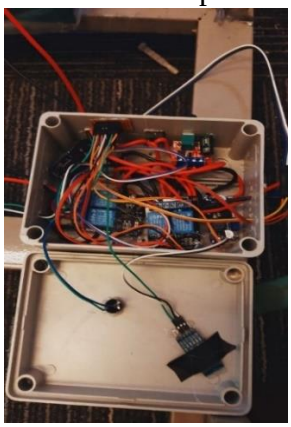


FIGURE 3.5.2.2: Arduino Uno board

ii. Ultrasonic sensor

Ultrasonic sensor is the receiver also the input signal of the system. The ultrasonic sensor will sense the distance of obstacle away from user and send the data back to Arduino Uno. Fixing the ultrasonic sensor at both front and back of the structure.

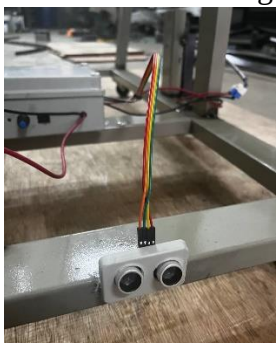


FIGURE 3.5.2.3: Ultrasonic sensor

iii. Buzzer

Buzzer is one of the outputs of signal. The buzzer will starts beeping when it receives signal from the Arduino Uno. As this project is designed to move, so designed it to give signal to the people from hitting anywhere while moving.

iv. Motor

Motor is the most important mechanism for this project as it helps to move the ladder. We used 2 motors for both right side and left side.

FIGURE 3.5.2.4: Motor

v. Power supply

We installed a 12V battery as a power supply to the mechanism. This battery is rechargeable which is can longer for long time. We fixed it right beside the box.

FIGURE 3.5.2.5: Power Supply

3.5.3 CODING AND PROGRAMMING (Mathen)

The process of translating codes from one language to another is known as coding. Because it implements the earliest steps of programming, it can also be considered a subset of programming. It requires writing programmes in a variety of languages as instructed. The machine cannot speak with humans and can only read machine code, sometimes known as binary language. The fundamental task of a coder is to convert requirements into machine-readable language. Coders must be well-versed in the project's working language. They do, however, mostly code in accordance with the project's specifications and directions. This is the initial step in developing a software product. The process of generating a machine-level executable programme that can be performed without error is known as programming. It is the practice of writing formal codes to keep human inputs and machine outputs in sync.

The first stage is to write code, which is then analyzed and implemented to generate the desired machine level output. It also incorporates all the major parameters, such as debugging, compilation, testing, and implementation. Programmers use to analyze and comprehend the various communication components to generate the necessary machine outputs. Arduino programmes are created using the Arduino Integrated Development Environment (IDE). The Arduino IDE is an application that runs on your computer and allows you to generate sketches (Arduino lingo for programmes) for multiple Arduino boards. The Arduino programming language is based on processing, a very simple hardware programming language similar to C. After writing the sketch in the Arduino IDE, it should be uploaded to the Arduino board for execution.

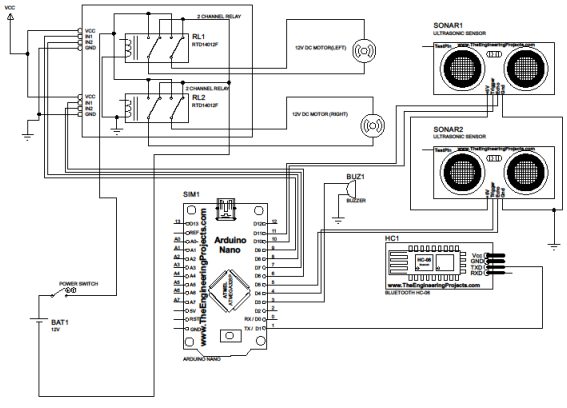


FIGURE 3.5.3.1: Schematic Diagram of ultrasonic sensor

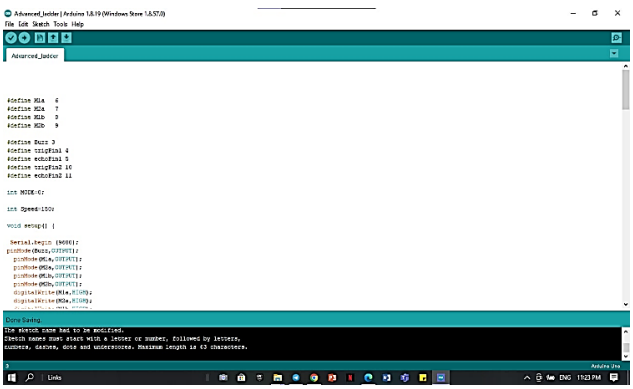


FIGURE 3.5.3.2: Arduino Software

3.5.4 APPLICATION SOFTWARE (Mathen)

MIT App Inventor is a user-friendly, visual programming environment that enables anyone, including children, to create fully functional programmes for Android phones, iPhones, and Android/iOS tablets. Those who are new to MIT App Inventor can create a simple first app in less than 30 minutes. Furthermore, our blocks-based technology enables the development of complicated, high-impact programmes in far less time than traditional programming environments. The MIT App Inventor initiative aims to democratise software development by enabling everyone, especially young people, to transition from technology consumption to technology creation.

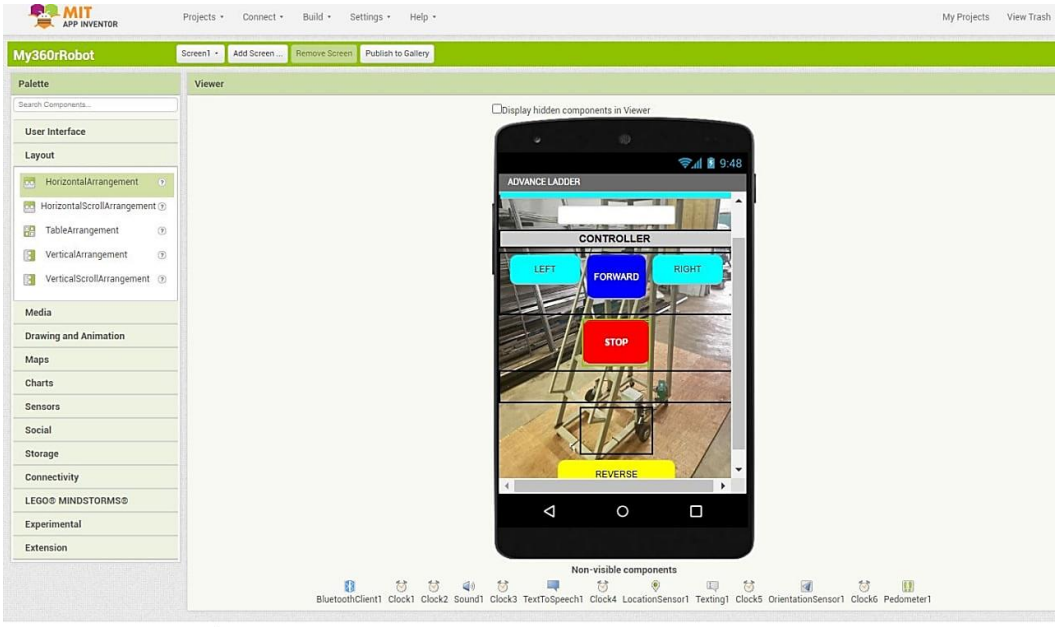


FIGURE 3.5.4.1: Application Software

3.6 THE FINISHING PROJECT (Janu)

FIGURE 3.6.1: Project Finished Look

3.7 PROJECT BUDGET (Janu)

Table below shows the amount of money spent to purchase the materials needed to produce the project.

TABLE 3.7.1: Project Budget

Items	Units	Price
2” x 1” mild steel hollow	1 unit (6m) = RM23.00 x 3	RM69.00
DC motor	1 unit = RM45x 2	RM90.00
DM motor controller	1 unit = RM 55.00 x 1	RM55.00
Battery	1 unit = RM42.90 x1	RM42.90
Heavy duty wheels	1 unit (5”) = RM8.00 x 2	RM16.00
Free move wheels	1 unit = RM20.00 x 1	RM20.00
Ultrasonic sensor	1 unit = RM3.50 x 2	RM7.00
Arduino board	1 unit = RM35.00 x 1	RM35.00
Arduino Bluetooth port	1 unit = RM16.50 x 1	RM16.50
Buzzer	1 unit = RM2.50 x 1	RM2.50
Phone holder	1 unit = RM9.90 x 1	RM9.90
Storage space	1 unit = RM5.90 x 2	RM11.80
Paint	1 unit = RM20.00 x 1	RM20.00
Grand total	-	RM395.60

3.8 SUMMARY (Janu)

At the end of this chapter, a clear picture has been showed on how we made the ladder step by step. The design of the project is made using Fusion 360 software to get the 3D design with accurate measurements. We also did survey before selecting the equipment and materials at Shopee, Lazada and also at some hardware to get the best materials with reasonable project budget.

CHAPTER 4

ANALYSIS DATA & DISCUSSIONS

4.1 INTRODUCTION (Janu)

This chapter will explain about the importance of doing data analysis before planning a project. We have done collecting some data by a survey made to obtain feedbacks from people on their experience while using ladder. Not only that, doing discussion from the analyzed data is also very useful because there is where we learn and improve our thinking to determine the materials for the project. On the other hand, ensuring safety measures is the must element that have been considered while doing the project.

4.2 DATA ANALYSIS

4.2.1 SURVEY ANALYSIS (Mathen)

Data below shows the responses from Google form survey of 20 users' experience while using ladder.

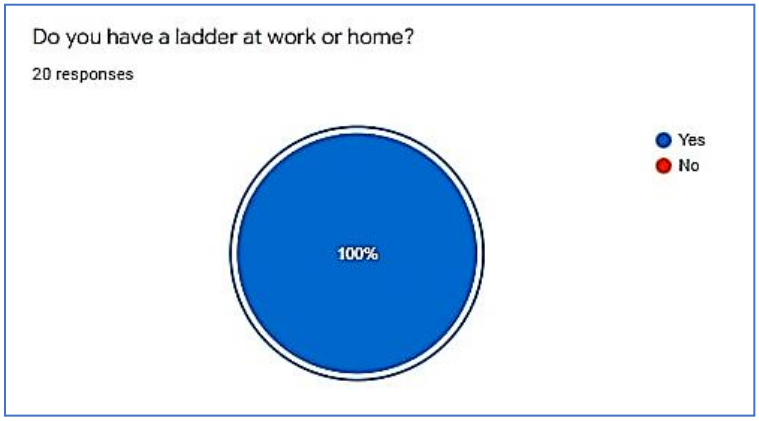


FIGURE 4.2.1.1: Survey Analysis 1

All of the responders had a ladder at work or at home. This highlights how important a ladder is to all of us in our daily lives.

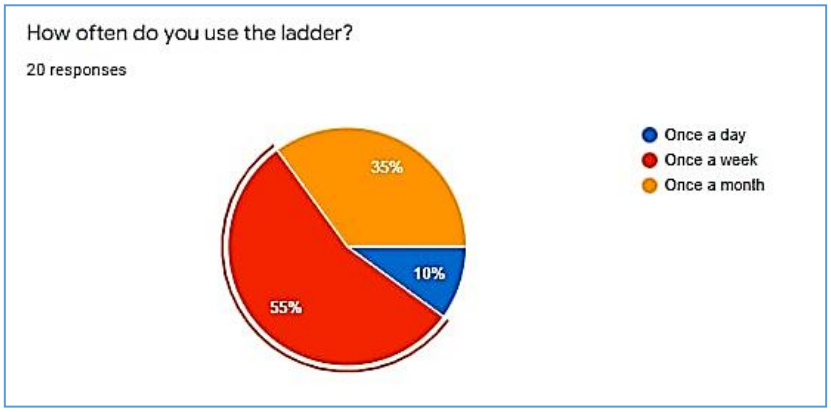


FIGURE 4.2.1.2: Survey Analysis 2

According to the survey, 55% of respondents only use ladder once a month. Next, 35% of respondents said they use ladder once a week. As a result, 10% of respondents use ladder at least once a day.

FIGURE 4.2.1.3: Survey Analysis 3

All respondents who voted agreed that it is a waste of time and energy to move the ladder while working and that there is not enough room to store items on the ladder.

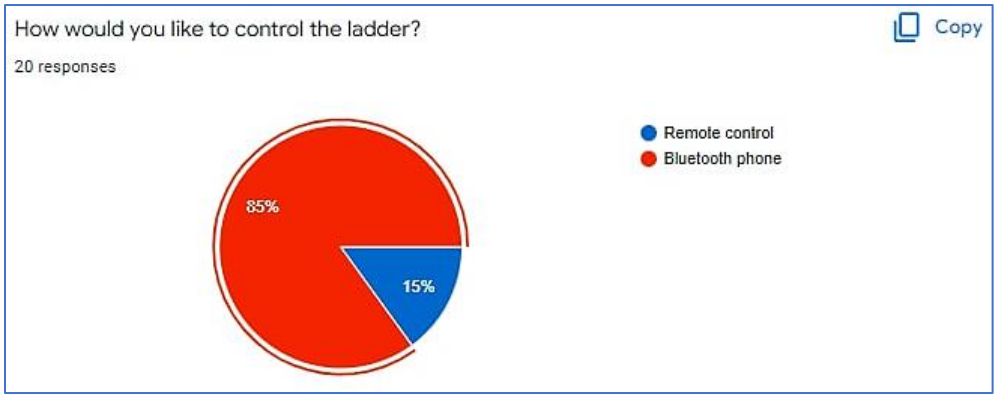


FIGURE 4.2.1.4: Survey Analysis 4

85% respondents like to control the ladder with phone's Bluetooth because that seems easier than a remote controller. This will ensure them to attend and make calls in emergency.

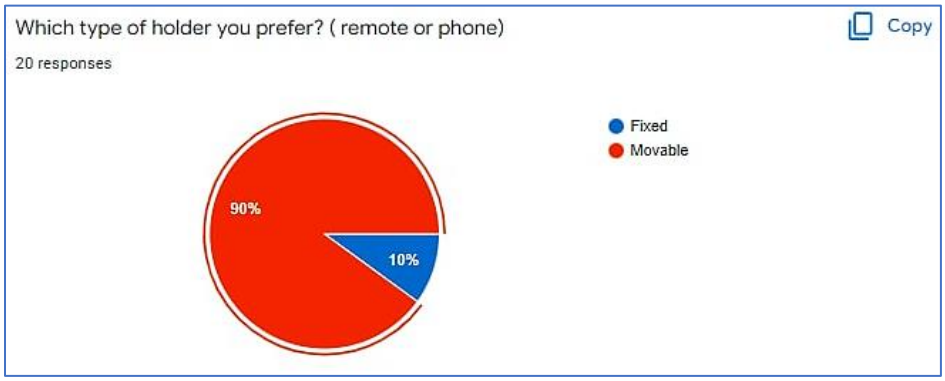


FIGURE 4.2.1.5: Survey Analysis 5

90% respondent prefer moveable holder on the handrail while standing on the ladder. This seems to be easier for them to move it according to the height they stand on the ladder to put their phones in the holder.

4.2.2 PROJECT TESTING ANALYSIS (Janu)

TABLE 4.2.2.1: Project Testing Analysis

Elements	Normal ladder	Advanced Ladder
Picture		
Material	Aluminum	Metal
Weight	10KG	20KG
Price	RM100	RM 480
Battery	-	12V
Motor	-	2 DC 12V
Ultrasonic sensor	-	2
Phone holder	-	1
Storage space	x	✓
Movability	x	✓
Time to complete a work (s)	40	30

4.3 DISCUSSION (Mathen)

a) What are the components and equipment on the Advanced Ladder?

i. Adjustable phone holder

FIGURE 4.3.1: Adjustable phone holder

This adjustable phone holder is to hold the phone which will be the device to control the motion of the ladder. This is also very comfortable because this component is moveable along the handrail.

ii. 5” Heavy duty wheel

FIGURE 4.3.2: Heavy duty wheel

We have installed a heavy-duty wheel which can be able to hold on heavy weighs to avoid accidents at workplace.

iii. Steps

FIGURE 4.3.3: Steps

These steps are made of mild steel plate for a strong place to stand.

iv. Handrails

FIGURE 4.3.4: Handrails

These handrails are for a balance to the people while using this ladder. This is for a safety purpose as people can hold the handrails while the ladder is in motion or also can use it to climb the ladder.

v. DC motor mechanism

FIGURE 4.3.5: DC Motor Mechanism

This basement with DC motor mechanism will make the ladder to move in all direction with help of 12V DC motor controller and DC motor battery.

vi. Storage space

FIGURE 4.3.6: Storage space

This component is to store tools that will be used while doing work on the ladder. This component might less the manpower at workplace.

vii. Cable organizer box

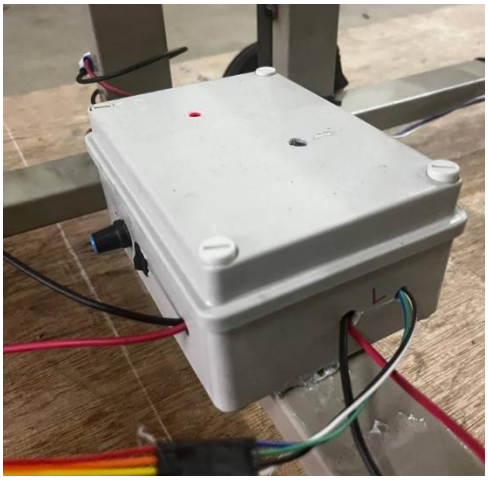


FIGURE 4.3.7: Cable Organizer Box

This box is specially made to store the wires, battery, and Arduino board to avoid it from being exposed on the ladder. This box is also waterproof so that the materials inside won't get damage easily.

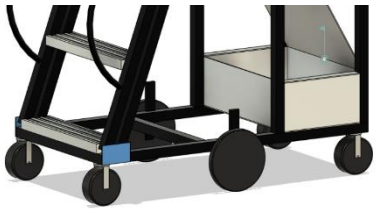
viii. Ultrasonic sensor

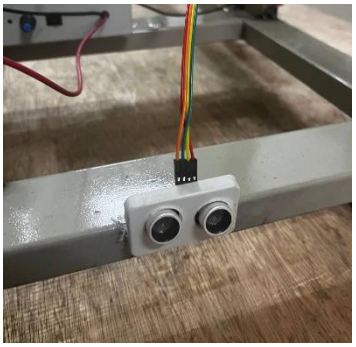
FIGURE 4.3.8: Ultrasonic sensor

This sensor is to indicate the user if there is anything on their way while ladder is moving on a direction.

4.4 SAFETY MEASURES (Yuvan)

TABLE 4.4.1: Safety Measures

Components	Safety measures
 Basement of the ladder	This basement is fully made of thick hollow section to ensure not denting.
 Heavy duty wheel	Heavy duty wheel is to hold on the heavy weights and also to have grip to increase friction.
 Handrails	Handrails will help users from not falling. People will easily hold the handrails if they feel unstable on the ladder.
 Phone holder	This phone holder is the reason why remote is not used as a controller because using a remote will cause wires that might be a danger for the safety of the users.

 Ultrasonic sensor	This ultrasonic sensor will help the users from banging anywhere because this sensor will indicate if there was anything on the direction ladder is moving.
 Storage space	This storage space is drilled on mild steel hollow base which is hard to break on heavy weighs. People usually put the working equipment such as hammer anywhere at the normal ladder that might cause an accident, but our Advanced Ladder have its own space to store any equipment up to 20kgs.

4.5 SUMMARY (Yuvan)

This chapter describes the sources used to collect and analyze the data required to address the research questions. Furthermore, this chapter discussed about the safety measures that are taken into concern in this project. This chapter began with data analysis in survey, follow-upped by discussion about the data analysis in the survey we have done.

CHAPTER 5
CONCLUSION

5.1 INTRODUCTION (Janu)

In this chapter, discussions made by evaluating current design of the project through limitation aspect and upgrade plans in future to have a conclusion on the project. The project limitation aspect is to clarify the ability of the project. The recommendations on upgrade plans are to sustain the importance and benefits of our project to the target users.

5.2 PROJECT LIMITATION (Mathen)

The Advanced Ladder has its own ability and restrictions. This is because we only have installed two motors on it as we have mentioned previously. These are the required limitations:

- People with 50kg and below only (1 person at a time)
- 20kg for storage space
- Phone holder can hold mobile phones with maximum size of 7 inches.
- Speed limitation as it is only designed for industrial usage
- Cannot reach too high since the structure is just 5ft height.

5.3 RECOMMENDATION IN FUTURE (Yuvan)

In future, recommendations to upgrade the Advanced Ladder will be to increase the height of the ladder so that users can reach higher platforms to work with. Thus, the ladder would be having a bigger base to achieve stability and made up of stronger materials to support required load.

Next, recommended plan is to upgrade the moving mechanism of the project. Since there are only 2 motors, the speed of the ladder is very slow which can make the work slower, so it is better to add 2 more motors which is will move the ladder even faster while for the method to control the motion of the ladder is to be controlled by voice command using voice control technology.

The Advanced Ladder is mainly targeted for industrial work, so it is very important to ensure the safety of the mechanism mainly the wiring parts. The basement part of the ladder holds the wires of the mechanism. But the wires fixed externally which is dangerous for the mechanism. So, it is planned to be upgraded to fix the wires internally which is inside the hollow section of mild steel to protect from any accident and also to make it look attractive.

The usage of the Advanced Ladder is at industries as we mentioned, the tyres of the ladder should be able to grip at every surface since not all the surfaces are same. Our advanced ladder is built with heavy duty wheel but not rubber materialled tyre. Choosing a rubber materialled which can have high friction at every surface could be the best option for tyres to work at any surface.

5.4 CONCLUSION (Janu)

In conclusion, our project is focused on designing a ladder with helpful features. Advanced Ladder can overcome the common problems faced by people when using ladders by saving user's time and energy to position the ladder to the working platform needed and also by providing enough storage space to store equipment on the ladder. In addition, by providing ultrasonic sensors, the users can be alert of their surroundings when using our ladder. In order to achieve the objectives of the project, the survey and research on previous ladder designs helped to gain ideas to improvise and innovate from existing features on ladder. Hence, we hope our project could bring an evolution of ladders in the country.

REFERENCES

[1] https://www.designingbuildings.co.uk/wiki/Ladder

[2] https://cf-t.com/blog/choosing-the-right-ladder-for-any-job

[3] https://myengineeringprojects.in/360-degree-wheel-rotating-vehicle/

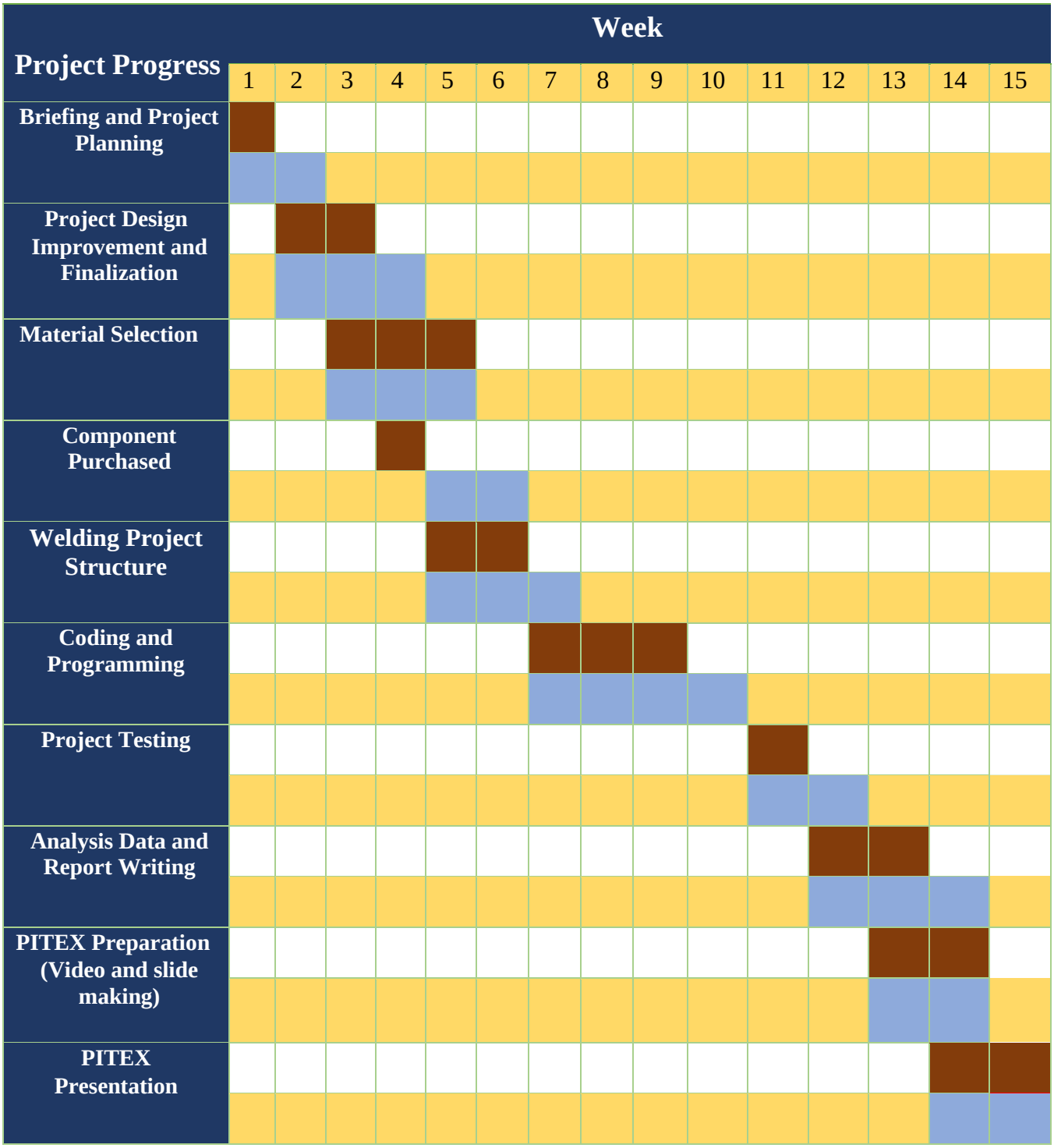
[4] https://create.arduino.cc/projecthub/abdularbi17/ultrasonic-sensor-hc-sr04-with-arduino-tutorial-327ff6

[5] https://appinventor.mit.edu/

APPENDIX

APPENDIX A	**Gantt Chart**
APPENDIX B	**MyIPO Originality Number**
APPENDIX C	**Survey Form**
APPENDIX D	**Coding and Programming of Arduino Software**
APPENDIX E	**Application Software Programming**
APPENDIX F	**PITEC 3 Poster**

APPENDIX A – GANTT CHART



APPENDIX B – MYIPO ORIGINALITY NUMBER

dana
to me

Assalamualaikum & Salam Sejahtera,

Puan,

Nombor pendaftaran hak cipta puan ialah

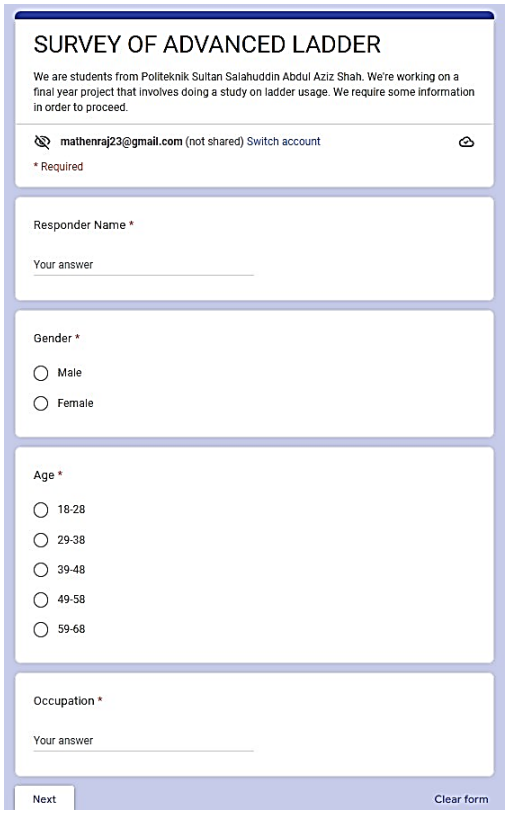
1. **LY2022W04937 - Advanced ladder**
2. **LY2022W04940 - Smart hydromantic**

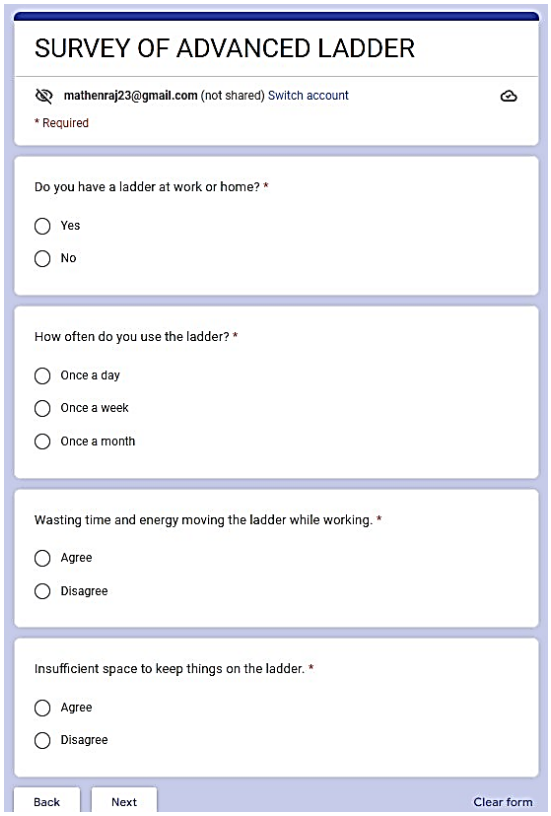
Sijil hak cipta akan diposkan ke alamat tuan/puan setelah siap diproses.

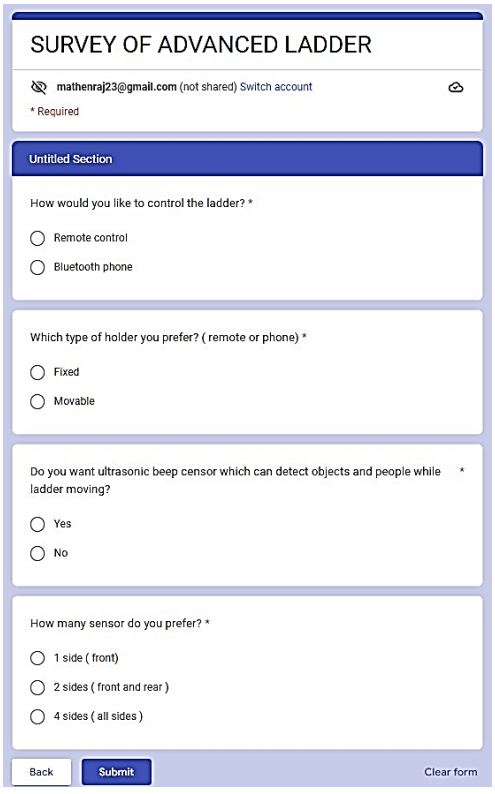
Sekian, terima kasih.

Urus Setia Dana IP 2.0
Perbadanan Harta Intelek Malaysia

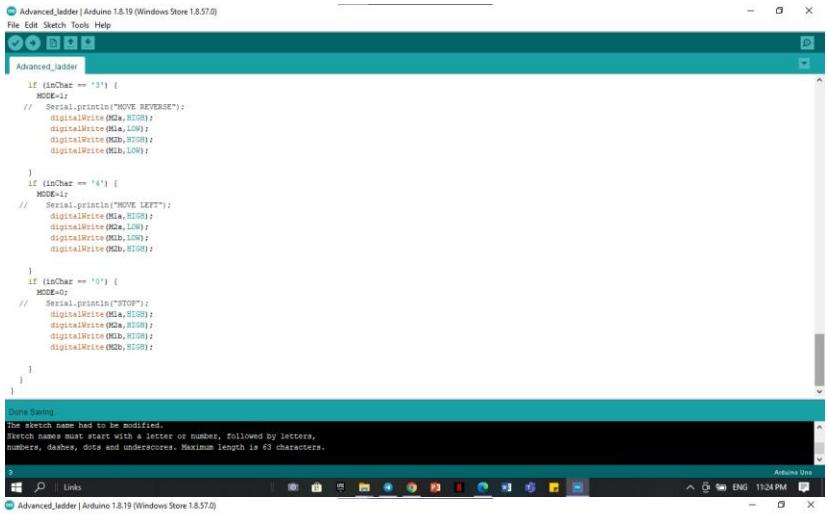
APPENDIX C – SURVEY FORM

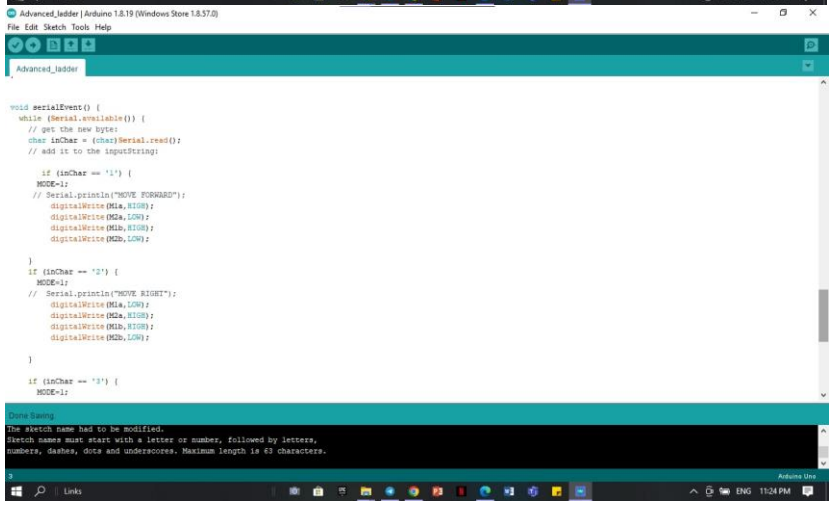


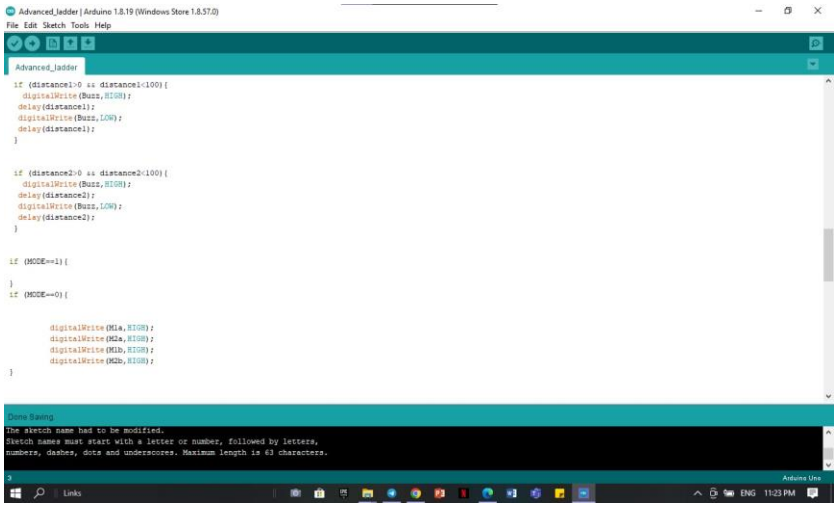


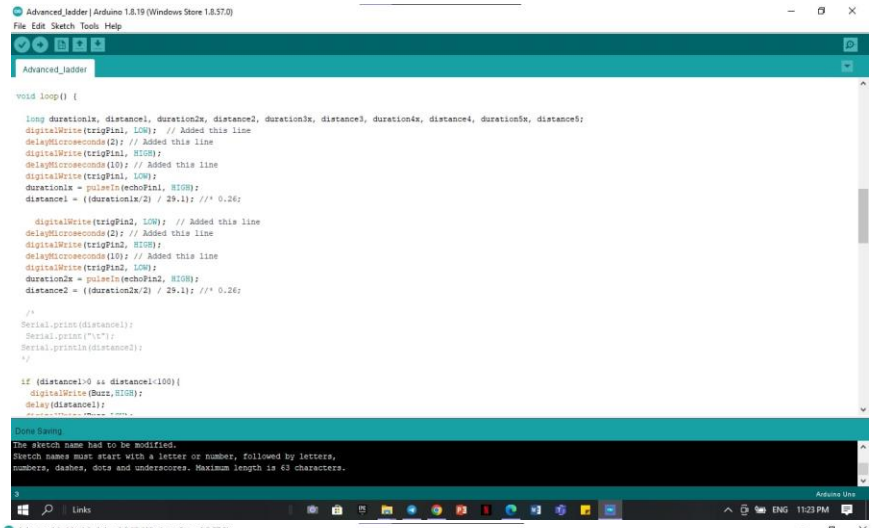


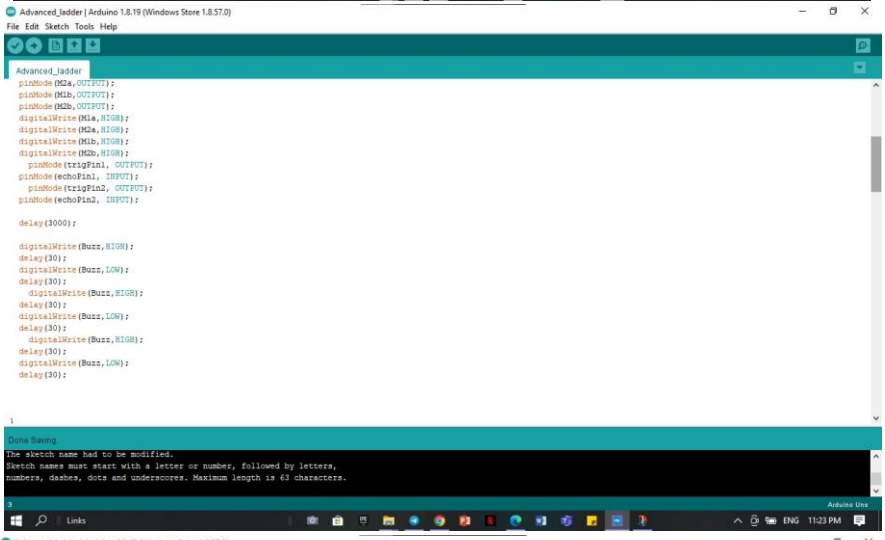
APPENDIX D – CODING AND PROGRAMMING OF ARDUINO SOFTWARE

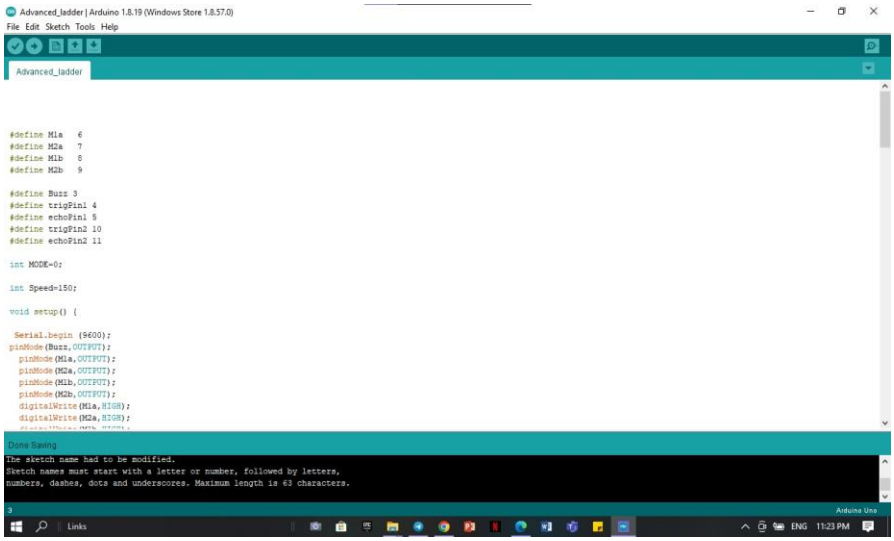




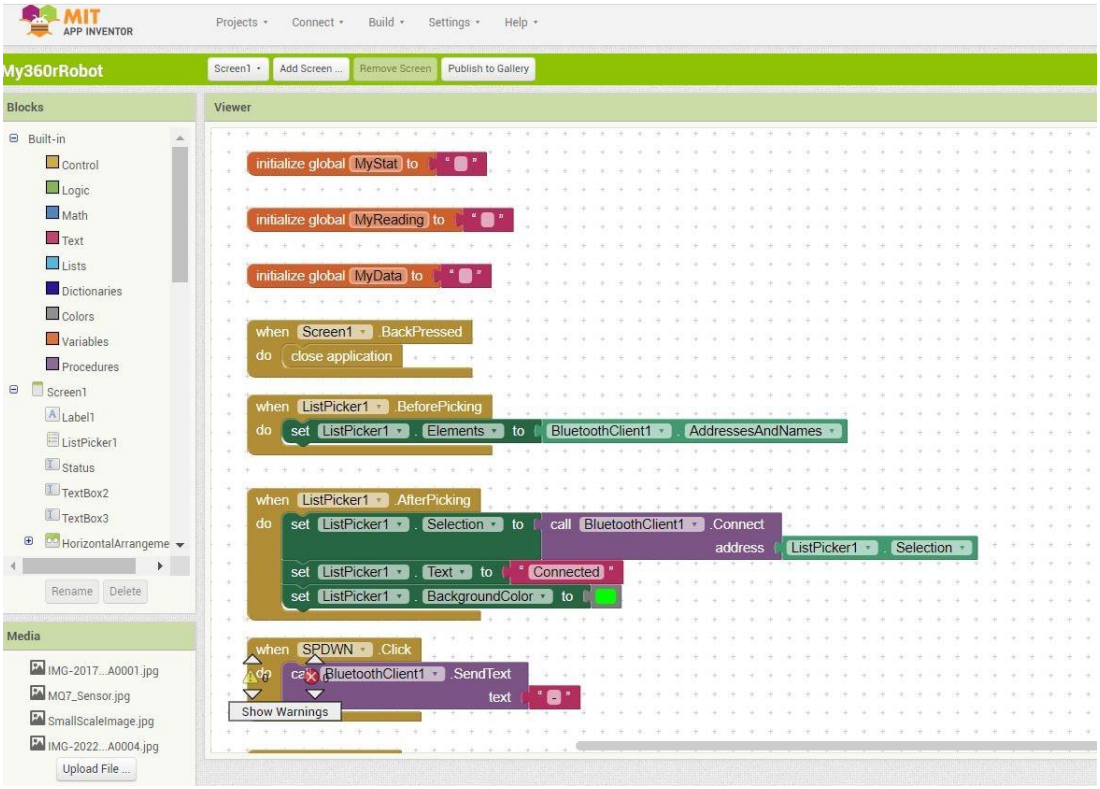


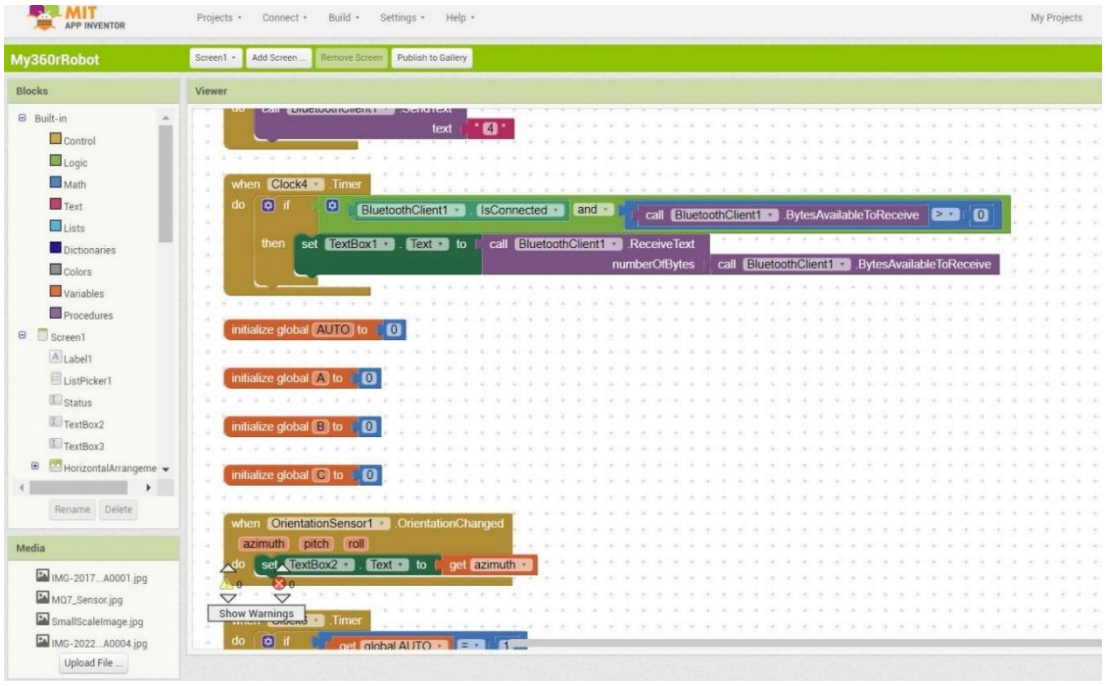

Advanced_ladder | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
Advanced_ladder
void loop() {
long duration1x, distance1, duration2x, distance2, duration3x, distance3, duration4x, distance4, duration5x, distance5;
digitalWrite(trigPin1, LOW); // Added this line
delayMicroseconds(2); // Added this line
digitalWrite(trigPin1, HIGH);
delayMicroseconds(10); // Added this line
digitalWrite(trigPin1, LOW);
duration1x = pulseIn(echoPin1, HIGH);
distance1 = ((duration1x/2) / 29.1); //* 0.26;
digitalWrite(trigPin2, LOW); // Added this line
delayMicroseconds(2); // Added this line
digitalWrite(trigPin2, HIGH);
delayMicroseconds(10); // Added this line
digitalWrite(trigPin2, LOW);
duration2x = pulseIn(echoPin2, HIGH);
distance2 = ((duration2x/2) / 29.1); //* 0.26;
/*
Serial.print(distance1);
Serial.print("\t");
Serial.println(distance2);
*/
if (distance1>0 && distance1<100){
digitalWrite(Buzz,HIGH);
delay(distance1);
Done Saving.
The sketch name had to be modified.
Sketch names must start with a letter or number, followed by letters,
numbers, dashes, dots and underscores. Maximum length is 63 characters.
Arduino Uno
Links
ENG 11:23 PM


Advanced_ladder | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
Advanced_ladder
pinMode(M2a,OUTPUT);
pinMode(M1b,OUTPUT);
pinMode(M2b,OUTPUT);
digitalWrite(M1a,HIGH);
digitalWrite(M2a,HIGH);
digitalWrite(M1b,HIGH);
digitalWrite(M2b,HIGH);
pinMode(trigPin1, OUTPUT);
pinMode(echoPin1, INPUT);
pinMode(trigPin2, OUTPUT);
pinMode(echoPin2, INPUT);
delay(3000);
digitalWrite(Buzz,HIGH);
delay(30);
digitalWrite(Buzz,LOW);
delay(30);
digitalWrite(Buzz,HIGH);
delay(30);
digitalWrite(Buzz,LOW);
delay(30);
digitalWrite(Buzz,HIGH);
delay(30);
digitalWrite(Buzz,LOW);
delay(30);
Done Saving.
The sketch name had to be modified.
Sketch names must start with a letter or number, followed by letters,
numbers, dashes, dots and underscores. Maximum length is 63 characters.
Arduino Uno
Links
ENG 11:23 PM


Advanced_ladder | Arduino 1.8.19 (Windows Store 1.8.57.0)
File Edit Sketch Tools Help
Advanced_ladder
#define M1a 6
#define M2a 7
#define M1b 8
#define M2b 9
#define Buzz 3
#define trigPin1 4
#define echoPin1 5
#define trigPin2 10
#define echoPin2 11
int MODE=0;
int Speed=150;
void setup() {
Serial.begin (9600);
pinMode(Buzz,OUTPUT);
pinMode(M1a,OUTPUT);
pinMode(M2a,OUTPUT);
pinMode(M1b,OUTPUT);
pinMode(M2b,OUTPUT);
digitalWrite(M1a,HIGH);
digitalWrite(M2a,HIGH);
Done Saving.
The sketch name had to be modified.
Sketch names must start with a letter or number, followed by letters,
numbers, dashes, dots and underscores. Maximum length is 63 characters.
Arduino Uno
Links
ENG 11:23 PM

APPENDIX E – APPLICATION SOFTWARE PROGRAMMING





APPENDIX F – PITEC 3 POSTER

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ABSTRACT

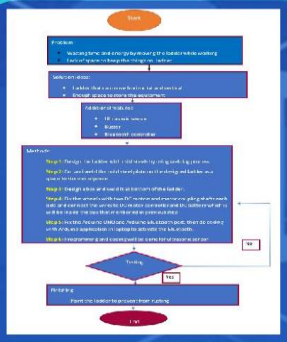
Most economists believe that technological innovation is a fundamental determinant of economic development and human welfare. In order to be a part of the technological innovation, a development in ladder has been introduced in this project which is called Advanced Ladder. Survey and research are done in favor to design the ladder in an ergonomic and comfortable way to overcome common problems faced by users while using ladders such as being tired of getting up and down to move ladders while working and insufficient space to place equipment. Therefore, the project is designed as an ergonomic structure of a ladder that would make people work at ease. The main features of Advanced Ladder are the ability to move from one place to another horizontally and vertically by a mechanical mechanism, enough storage space at different levels of height on the ladder to avoid users overreach to grab tools and finally has ultrasonic sensors at two sides of the ladder to alert the users if there is any obstacles or uneven surfaces. Every component that is used and designed has its own advantages and safety measures in Advanced Ladder to ensure this revolution of ladder be beneficial and admissible.

OBJECTIVE

i. To develop a mechanical mechanism for horizontal and vertical movement of ladder.
ii. To design enough storage space to store equipment while using the ladder.
iii. To fabricate and analyze the prototype of the project.

METHODOLOGY

Based on research, ladders in market did not help the users well to reach their daily target. Therefore, a project is worked to find a solution to the problems which gave the idea to innovate Advanced Ladder to ease the users. The drawing of the project has done in Fusion 360 software. After that, the process of making the ladder began with making the structure using welding process. Fixing the electronic components for the moving mechanism of the ladder which is held after spraying paint to the structure. Recorded the programming process and result in the report.



PRODUCT DESCRIPTION

RESULT

ELEMENTS	NORMAL LADDER	ADVANCED LADDER
Picture		
Material	Aluminum	Metal
Weight	10KG	20KG
Price	RM 100	RM 480
Battery	-	12V
Motor	-	2 DC 12V
Ultrasonic sensor	-	2
Phone holder	-	1
Storage space	×	✓
Movability	×	✓
Time taken to move	45 seconds	30 seconds

ORIGINALITY

- MYIPO number – LY2022W04937

CONCLUSION

In conclusion, Advanced Ladder is a product to boost user's productivity by helping them to stay comfortable while working on the ladder. Advanced Ladder can overcome the common problems faced by people when using ladders by saving user's time and energy to position the ladder to the working platform needed and also by providing enough storage space to store equipment on the ladder. In addition, by providing ultrasonic sensors the users will be alert of their surroundings when using the ladder. In order to achieve the objectives of the project, the survey and research on previous ladder designs helped to gain ideas to improvise and innovate from existing features on ladder. Hence, this project is believed to bring an evolution of ladders in the country.

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