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## Faculty of Electrical and Electronic Engineering Technology



# Development of The Automated Medical Trolley under COVID-19 Pandemic

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**Bachelor of Electronics Engineering Technology with Honours**

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# Development of The Automated Medical Trolley under COVID-19 Pandemic

**NUR AQILAH BINTI KAMARUDIN**

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

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2021**

## DECLARATION

I declare that this project report entitled “Development of the Automated Medical Trolley under Covid-19 ” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Student Name : NUR AQILAH BINTI KAMARUDIN

Date : 11/01/2022

**APPROVAL**

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

Signature : .....

Supervisor Name : Ts. Dr. Norhashimah Binti Mohd Saad

Date : 11/01/2022

Signature : .....

Co-Supervisor Name (if any) : .....

Date : .....

## DEDICATION

This project report is dedicated to my devoted mother Zuran binti Sulaiman, my father Kamarudin bin Hassan, and my siblings, who have provided as a continuous source of inspiration. I'd like to convey my gratitude to my supervisor, Ts. Dr. Norhashimah Binti Mohd Saad, as well as to all of my lecturers, for their aid and assistance throughout this project. They've given me the motivation and discipline to attack each project with zeal and dedication. Finally, but certainly not least, I want to express my gratitude to all of my friends. Without their assistance, this project would not have been possible.

## ABSTRACT

COVID-19 cases continue to rise daily, leaving frontline personnel, particularly medical personnel, exhausted and at risk of infection. As is well known, this virus is transferred via air, physical touch between humans, and even direct contact between humans and objects. According to a current study, the COVID-19 virus can survive for up to 72 hours on the surface of plastic and stainless steel, so it is best to avoid any direct contact with medical personnel. The medical trolley alleviates the workload on medical professionals and reduces the risk of infectious disease spread. The purpose of this project is to create a prototype of a medical trolley for an infectious disease patient in order to limit the danger of infection to medical personnel. This concept introduces a new way of utilising the medical trolley in order to improve the working environment for medical personnel. Additionally, the system makes use of a human follower that is equipped with ultrasonic sensors. By automatically following the human location at a predetermined distance, the human follower controls the direction of the medical trolley prototype. Additionally, medical trolley innovation can assist medical workers in performing their duties more efficiently and in a safer work environment.

## *ABSTRAK*

Kes COVID-19 terus meningkat setiap hari, menyebabkan kakitangan barisan hadapan, terutama kakitangan perubatan, kelelahan dan berisiko dijangkiti. Seperti diketahui, virus ini ditularkan melalui udara, sentuhan fizikal antara manusia, dan bahkan hubungan langsung antara manusia dan objek. Menurut kajian semasa, virus COVID-19 dapat bertahan hingga 72 jam di permukaan plastik dan keluli tahan karat, oleh itu lebih baik untuk mengelakkan sebarang kontak langsung dengan pegawai perubatan. Troli perubatan mengurangkan beban kerja profesional perubatan dan mengurangkan risiko penyebaran penyakit berjangkit. Tujuan projek ini adalah untuk membuat prototaip troli perubatan untuk pesakit penyakit berjangkit untuk membatasi bahaya jangkitan kepada pegawai perubatan. Konsep ini memperkenalkan cara baru untuk menggunakan troli perubatan untuk meningkatkan persekitaran kerja bagi kakitangan perubatan. Selain itu, sistem ini menggunakan pengikut manusia yang dilengkapi dengan sensor ultrasonik. Dengan mengikuti lokasi manusia secara automatik pada jarak yang telah ditentukan, pengikut manusia mengawal arah prototaip troli perubatan. Inovasi troli perubatan dapat membantu pekerja perubatan menjalankan tugas dengan lebih cekap dan dalam persekitaran kerja yang lebih selamat

## ACKNOWLEDGEMENTS

In the Name of Allah, the Most Merciful, the Most Gracious

I like to convey my gratitude to the Technical University of Malacca (UTeM) for facilitating this research. Additionally, I appreciate the financial help provided by the Ministry of Higher Education Malaysia (MOH). Additionally, I appreciate the financial help provided by the Ministry of Higher Education Malaysia (MOH).

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Finally, I want to express my heartfelt gratitude to my friends for their encouragement and for serving as a pillar of support during my undertakings. I'd also like to express my gratitude to my adoring parents for their unending support, love, and prayers. Finally, I want to express my gratitude to everyone who has assisted, supported, and inspired me to begin my research.

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## LIST OF SYMBOLS

| | | |
|---|---|---|
| $\delta$ | - | Voltage angle |
| v | - | Volt |
| kg | - | kilogram |
| cm | - | centimeter |
| N.m | - | Newton Meter |

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| $V$ | - | Voltage |
| m | - | Mile |
| K | - | Kilogram |
| B | - | Byte |
| M | - | Mega |
| Hz | - | Frequency |
| W | - | Power |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

The first chapter covers the project overview, including the project overview, project aim, project scope, project methodology, and the structure of this project report. This section also briefly explains the breadth of work that has been completed from the beginning to the completion of the project. This chapter will lay the groundwork for the rest of the project, which will involve COVID-19's construction of an automated medical trolley. The ultrasonic sensor is used in this project to create a touchless medical trolley.

## 1.2 Background



A hospital is an institution that can provide medical and surgical treatment, as well as provide nursing care for sick or injured people. Hospitals are known for providing health services to people in order to maintain their health and get treatment. Therefore, the employees at the hospital are always busy to ensure that they can provide the best service to the public. Moreover, in the current challenging situation, where the spread of the Covid-19 virus that has hit the world, including Malaysia, has resulted in an increase in the workload for frontline workers, especially health workers. As a result of the spread of the Covid-19 virus, millions of people have died. Covid-19 cases are increasing in Malaysia on a daily basis, leaving frontline personnel, particularly medical personnel, exhausted and highly exposed to the

virus. This virus spreads through the air, through human-to-human physical contact, and through direct human-to-object contact.

To reduce the workload of medical staff, automatic trolleys have been innovated with a few smart features to control the movement of the trolley, by develop automated human followers. The stainless-steel trolley is a main tool that helps the medical staff to place their medical equipment or any medical items for treatment within the hospital. The medical staff needs to bring a trolley from one place to another in order to perform medical treatment or for other purposes, such as delivering food to the patient. Because of that, an automated trolley has developed in order to help medical staff during this critical period in the hospital. This new version of the trolley can minimize manpower because this trolley can move without the need for manpower. With this method, it can help to reduce the workload of health workers while reducing the risk of spreading the virus to frontline workers dealing with Covid-19 patients. The smart feature method is the use of human followers to control the movement of the trolley.



## 1.3 Problem Statement

The old version of the trolley was not user-friendly and required manual control. It required a lot of manpower to move from one place to another, which led to the heavy workload. Health workers face difficulties moving trolleys around to provide health services such as delivering medicines, food, clothing, and other medical necessities to patients.

The second problem is that medical staff are exposed to the risk of infection from viruses when dealing with the COVID-19 patients. Furthermore, in the case of the Covid 19 pandemic, dumping in hospitals is increasing. This encourages a large workforce of health staff, and direct contact with patients can cause a high percentage of infections to them.

Therefore, the development of a touchless trolley is essential to reduce the occurrence of direct contact rates.

## 1.4 Project Objective

The aim of this project is to build an automated trolley to ease the burden of the medical staff and ensure their safety during an infectious disease outbreak.

a) To develop a prototype of an automated medical trolley system integrated with the microcontroller based on the Arduino Uno R3 under the COVID-19 pandemic.
b) To analyze the trolley system using proteus and Arduino software.
c) To evaluate the performance of the mechanism and functions of the medical trolley system

## 1.5 Scope of Project

This project is divided into two main parts. The first part is about the programming coding for the obstacle detection and automated following functions using the Arduino IDE software and proteus. Using this platform, the circuit of the system is designed and the coding for the system is written

This automated medical trolley has feature that using an ultrasonic sensor that acts as a human follower. This method can move any direction. The trolley will move by the direction input given by user.

The second part of this project consists of the hardware of the wire connection from the Arduino to the sensors and output device. These main two parts are important in order to achieve the objective. This project scope is stated below:

a) To design and construct the circuit using proteus and Arduino software as coding for the system.

b) To control the trolley's movement by using the wireless switch using buttons and the human follower using ultrasonics

c) To detect obstacles within a certain range by using ultrasonics

The main purpose of this project is to help the medical staff in the ward by reducing the staff workload by bringing the trolley from one place to another. This medical trolley can ease the medical staff's lifting of heavy loads. This trolley can use any place or any direction as it does not require any specific track.

## 1.6 Outline of the project

Introduction (Chapter 1)

This chapter summarises the project, which will be discussed in greater depth later in the report. That is the project's background. The project's introduction will be described in this section, which will include an overview, an issue report, the study's objectives, and the scope of work.



Review of the Literature (Chapter 2)

This chapter summarises concepts, experimental investigations, and major discoveries from previous research that are relevant to the current project. The research will also be highlighted.

Methodology is the third chapter.

Chapter 3 delves deeper into the planning process for achieving the objectives. This chapter will go over control theory and how to use it. Each stage, as well as the overall project's flow chart, has its own technique.

Result and Analysis (Chapter 4)

The graphics and graphs that accompany the tests depicted in the photographs, as well as the study's findings, are discussed in this chapter.

Conclusion and Recommendation (Chapter 5)

The findings of the study, as well as the project's important milestones, are summarised in this chapter. This chapter also includes some predictions for improvement growth and improvement. For potential innovators, recommendations for further research are also being prepared.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter discusses the project's literature review. Based on the past articles, papers, theses, or any similar sources that relate to the "Development of the Automated Medical Trolley Under the Covid-19 Pandemic" project. The similar ideas of the past referenced in this project, such as the hardware of the project used, the software used, the advantages and disadvantages of the project, and the prices of the components used, have been analyze and summarize in this chapter. By studying those elements of the past reference, we can help this project develop by adding the features and finding other solutions based on the limitations of the past reference project. Furthermore, based on the results of the past research that has been analyzed, this project is very important in order to understand its function and flow.



## 2.2 Previous Research Paper

From the previous study, [1] proposed paper follows me multifunctional automated trolley. A "follow me" automated trolley is capable of carrying products while autonomously following the user without the need for human assistance. A tablet with an Android platform is attached to the trolley to perform the functions mentioned above. After that, the trolley returns to its spot automatically whenever the customer has completed their purchases. According to this research paper, a follow me robot is being developed to automatically follow the client when the client is completing shopping activities at the supermarket. The Sharp IR sensor is used to control the trolley, which is linked to an Arduino mega board. The distance between the customer and the trolley will be determined using a Sharp IR. The

Arduino microcontroller was used to build the following line, and all of the sensors were attached to the Arduino board. An Android app created with the Android Studio IDE. Through this application, the programme will present the consumer a list of suggestions for the goods that the customer has already purchased, and the customer will simply need to use a bar code scanner to purchase the items. All of the data is stored in a hosted database, and the data was transferred to the Android application using Json. The desktop application was created with the Microsoft Visual Studio IDE. Based on this application, all purchasing details were saved in a desktop application using web services while the customer was shopping.



Figure 2.1: Robot Automatic Following

This paper provided a new framework of multi motion layer analysis to detect and track moving objects in an aerial platform based on a paper [2]. To begin, the moving object will

be detected using registration and temporal difference. Establish a motion layer system that consists of object detection and tracking, which is tested by using real data obtained from the router network to analyse the performance of a surveillance system for Detecting and Tracking Moving Objects. This paper discusses the notion of cameras mounted on trolleys, as well as the technology for detecting moving items and tracking. The wheels serve as the foundation for a real-time object recognition and tracking system that is controlled by a computer system. The primary goal of this study is to implement this object by mounting it on a trolley. Recognize that each real-world form of the robot uses a different level of power input based on the load. This paper's modules are trolley movement, product with barcode, object tracking, and facial detection. The robot acquires images using a web camera, which is then delivered to image processing software for further processing. The visual sensor system is used in the field to identify and track objects. Blob detection methods are designed to recognise items in a digital image that have distinct features, such as coloured objects' brightness or colour, from the surrounding regions. The Raspberry Pi will consider using various image processing algorithms to recognise the object. This paper was created with the low cost, low power consumption client in mind so that they may enjoy their shopping without having to push a shopping trolley. Using a pi camera and infrared sensors on the trolley, it can detect and track the customer/human and follow the human for a limited distance, stopping when the customer stops, and there is an add-on feature barcode scanner fixed on the trolley to scan the product to automatically generate the total bill amount of the purchased product.



This research [3] proposes to construct an automated purchasing cart that provides the user with incredible convenience and efficiency. This automated trolley eliminates the need for humans to push a heavy-loaded cart. The goal is to avoid collisions with barriers, detect

reachable pathways, and notify consumers when the cart is obstructed. The Arduino microcontroller was used to design the system. The trolley can move automatically thanks to the power of two 12 V DC motors, the voltage of which is regulated by Arduino to modify the speed of movement. Three PIR sensors are embedded in the cart's front, left, and right sides, identifying which path is available and alerting customers when impediments are detected within its range. Arduino, our main microcontroller, serves as the information transport and processing centre. The system operates using an infrared sensor that maintains the distance between the trolley and the customer and is connected to port zero of the microcontroller. The microprocessor decides whether to press the motor or not based on the distance between the trolley and the customer. The motor force circuit is connected to the microcontroller's port 2. There may be no desire to convey a heavy trolley in a computerised trolley. It automatically follows the buyer. It also keeps a safe distance between the clients, the obstacles, and itself.

[4] proposed paper Human following robot using Arduino. The project's aim is to produce a robot that can help humans with various tasks. In this paper, a prototype of a human following robot that uses Arduino Uno and other sensors related to detection and following an object, such as ultrasonic and IR sensors, is presented. This robot needs to follow a specific objective, such as being capable of accurately following a person, being capable of taking various degrees of turns, and being insensitive to environmental factors like noise, and it must be capable of avoiding collisions. There are several components that were used in this project. The main components are the Arduino Uno, DC motors, motor shield, ultrasonic sensors, and IR sensors. This system uses a four-wheel robotic vehicle mounted with a separate microprocessor and control unit with different sensors and modules. The ultrasonic and infrared sensors are placed on the robot. The ultrasonic sensor is to detect an

obstacle and to maintain a specific distance. The infrared sensor works by detecting the object's distance via infrared radiation. These two sensors work in unison to navigate its path by avoiding obstacles and maintaining a specific distance from objects. The robot perfectly follows the person wherever they go within a 4 metre range.

Figure 2.2: Human Following Robot

[5] proposed paper design and development of human following trolley. The goal of this study is to design and fabricate a robot that can tracking the target while avoiding an obstacle. This trolley needs to avoid any obstacle and must be intelligent to follow a person in a crowded area, indoor and outdoor place.to match this function, a unique tag is placed to person. There are some advantages of this project such as it maintain accurancing by provide a best posibble result, it reduce the human efforts, and last but not least, it is easy to handle. The hardware component that used in this paper are raspberry pi, ultrasonic sensor, camera and motor driver. DC motor used for robotic wheel movement. The trolley which is a robotic vehicle have two wheels and one freewheel that mounted along with ultasonic sensor and camera module. The user can control the trolley as it follow a particular person by a unique identification tag. This pi camera will capture continuous image and then compare it with original, and trolley will follow if the result is matched. While following a person it also identified if any obstacle and avoid them by using ultrasonic sensor. Pi camera works

by capture continuous image to identify the unique tag. This paper used computer vision camera to recognize the tag at the back person.

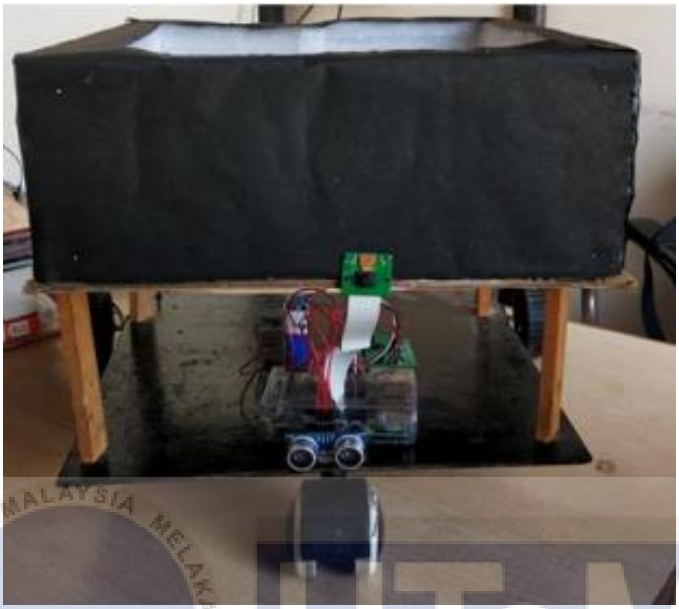


Figure 2.3: Physical Implementation Of The Trolley

[1] proposed a paper design of automatic mobile trolley using ultrasonic sensor. The trolley in this paper is controlled by a microcontroller module. This trolley is designed to automatically follow human movement in a defined range, such as moving right, left, backward, or forward. This project's major components are an ultrasonic sensor, a DC motor, and an Arduino module. The ultrasonic sensor used to detect obstacles in robots employs sound waves for ringing, and the speed of sound is affected by a variety of environmental parameters. Based on the distance data, the system creates a trolley that can move. Desbin logic is used by the programme logic to go forward, backward, right, and left. To stop the trolley from moving, use if logic. The distance must be greater than 40 cm in order to move forward. While trolley stops when the distance is greater than 30 cm but less than 39 cm, and reverses when the distance is less than 20 cm. The distance is shown on the computer monitor serial programme via the arduino module unit.

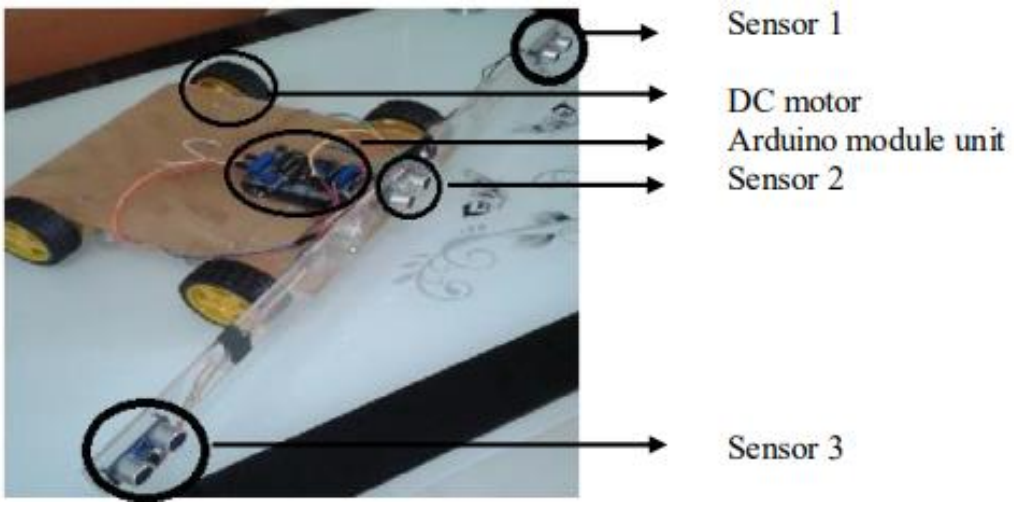



Figure 2.4: Design of the Trolley

[7] proposed in their paper a person-following robotic cart operated by a smartphone app: design and evaluation. The purpose of this article is to develop and test a robotic cart using a smart phone application. This project also can set into a follower mode where use ultrasonic sensor as the sensor that can located the person when the person walk infront it and keep the contant distance. this development can give benefit for industry such as warehouses, airpot, or shopping malls. The user can controll the cart via a smartphone application which means allow the user to make the cart stand still when loading or unloading the object on cart. it also can automatic  follow the walking user when the user use tele-operating the cart via bluetooth link. In order to making this cart, this paper state that it uses six ultrasonic by put three at the top and three at the bottom, Arduino Mega, bluetooth module, smartphone application and motor. Using Android Studio the smart phone application is coded. It communicate with microcontroller via blutooth module.

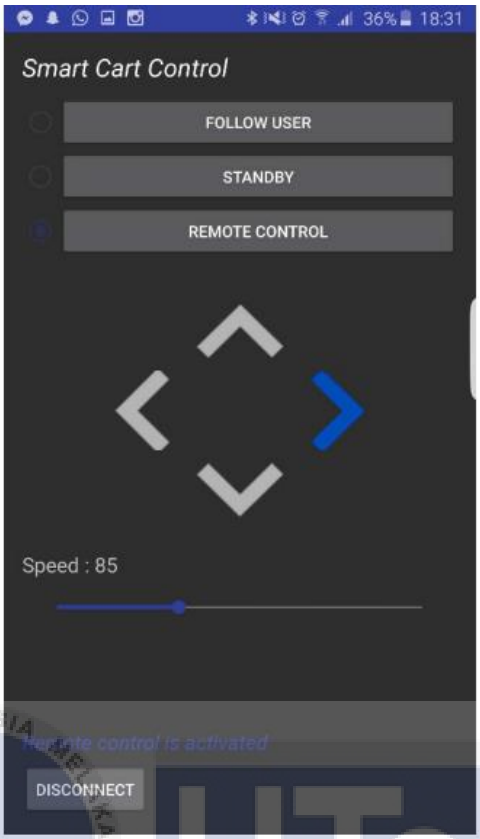



Figure 2.5: Smart Phone Application In Remote Control Mode

Figure 2.6: A Robotic Cart Human Follower Mode

[8] proposed the paper development of sensor controlled convertible cart-trolley. This paper is focused on the development of a controlled cart- trolley that can support physical distributian of goods. The system design consit with three mechanisms design where the system turn to a cart when it stretched, when it titled it turn to incline cart with flat plate and it turn into trolley when folded. The material use in this project is square pipes, gear motor, wireless module, relay, ultrasonic sensor, and wiper motor. There are a few feature of this project such as the convertible cart is an electric based cart, using two batteries as the source power, wheels attached to a wiper motor, the cart use sensor to avoid obstacle, and sent the command using wireless hotspot to wireless module to change the direction of the cart. The wireless module serves as a microcontroller, containing the command to be executed by the cart, while the relay controls the amount of current released by the batteries to the motor and circuit. Depending on the command sent by wireless module from the phone's WiFi hotspot, the cart will begin moving and following the user. When an application is developed using wireless module software, the user is able to control the cart automatically. When the Wireless Module (ESP8266EX) on the panel receives the signal and sends the order, the cart can move forward, left, and right. The signal is transmitted from the phone using the phone's Wireless hotspot.

Figure 2.7: prototype of the convertible cart

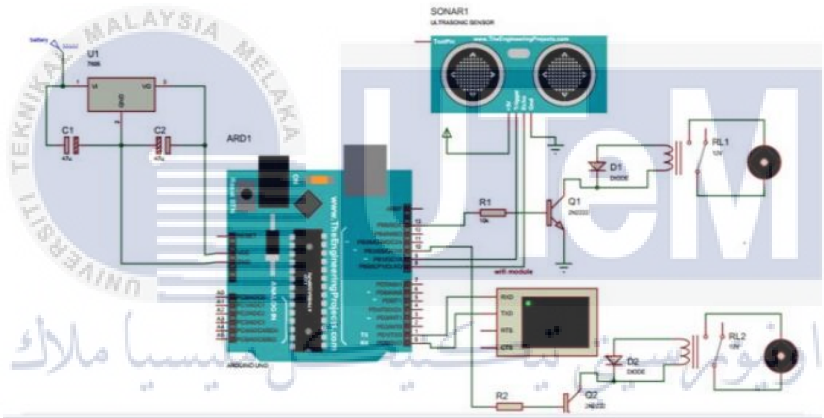





Figure 2.8 : Circuit of The Convertible Cart

[9] suggested a study report on the survey of trolley or wheelchair-based smart systems for specialised medical applications. The primary goal of this study is to assist rebidded people who are dependent on their caregiver. It is possible to lessen the caretaker's workload by developing a smart trolley. The goal of this project is to provide services to patients, children, and the elderly who are dependent on their caregivers. The trolley is used to provide and receive supplies to those in need, such as medications, food, and other necessities. This project's electronic hardware includes a L298 driver, a HC-05 bluetooth module, a buzzer,

an ultrasonic sensor, a DC motor, and an Arduino Uno. The trolley is controlled by an Android application that is linked to a Wi-Fi module.

[10] proposed the autamatic shopping trolley using sensors. The objective of this project is to make shopping more easy and comfartable as the customer can move freely becouse the trolley will move after the customer at specific range distance. the trolley also attach with RFID reader which make the total amount diplayed on the lcd and can be traked by the cashier. The component use in this project are power supply, RFID-EM18, barcode scanner, LCD, IR sensor, DC motor and PIC 16. Infrared sensor is use to detect object and detecting motion. the sensor will attach at one port of PIC and its will sesnse the coming infrared, the the trolley will move in that direction. DC motor that connected to another port use to drive the trolley movement.

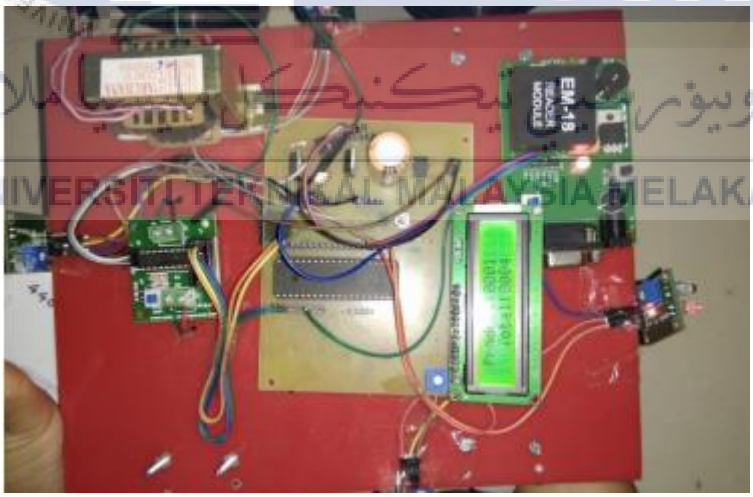



Figure 2.9 : The Circuit Design of The Project

[11] proposed the paper development of smart trolley system based on android smartphone sensors. The project goals is to develop an automatic moving trolley with smart shopping devices. The main component of this project are ACCU Motobatt as main power source of

the trolley, DC dual motor driver module board that can control the speed an direction of the dc motor that used to rotate the wheel on the trolley, the IOIO Board VI that act as main controller to receive instruction from android smartphone. The android smartphone will control the robot by sending a signal to ioio microcontroller. The IOIO microcontroller is pairing with the robot's actuator. By sending the input signal, the user can monitor the situation using the smartphone camera.

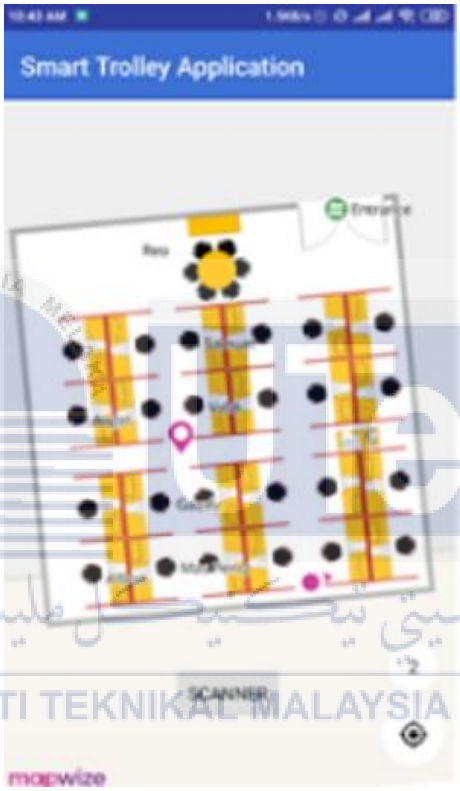



Figure 2.10: User Interface Of Smart Trolley Application


Figure 2.11: Trolley Interface Of The Smart Trolley Application

Figure 2.12: Trolley Movement Test

Another research paper is [12], it proposed the automated trolley system for airport. This system ensure that the user can access their trolley for transportation trolley to respective terminals of the airport. The user also does not to carry the luggage becouse the trolley will reach its pre-defined terminal. This trolley operated via the RFID card reader to identify the

location and the load cell is used to identify the weight of the luggage. The advantage of this system is it can redue the cost of man power and the maintenance. The component uses in this research are IR sensor, load sensor, and RFID reader. The IR sensor act as optical sensor in this system. It uses to detect the obstacle and trigger the buzzer. It does not give any reflected if the sensor far away from obstacle. But if the obstacle is in the range of sensor, the signal will get reflected then the obstacle is detected. The load sensor is used to measure and display the weight of the luggage. The RFID reader is use to read identification card using radio waves. The sensor are interfaced to the microcontroller. RFID card reader use to read card and the memory chip on the RFID card contains a unique code. The code is sent to the RFID reader antenna. The code that receive via antenna will sent to the arduino for processing the data. Motor driver control the motor uses and the relay function is to controlling the direction of the motor. The sensor will observed the enviroment to find any obstacle and if the obstacle found at specific range, it will alert by alarming the buzzer. The trolley sent feedback by stop moving until the no obstacle detect. The trolley start to move again if the obsctacle ia out in the range and it will stop untill it reach at the destination.



The paper of [13] proposed the automated trolley system. This paper objective is to design and implement algorithms effeciently generate the shortest path in a static and dynamic obstacle enviroment. This automatic trolley system will autonomously maneuvered from on place to another place. The operator will sent the initial intructuions wirelessly. The algorthms can be directly embedded into robot which can be used in the real world application. This project features consist with the trolley system will navigate over white line over black line surface that the floor will be grid of white over black surface by using the white line sensor module. The system detect the obstacle present through the obstacle detection module. The system use the shortest path algorithm to fine a path between any

two points which it can be preprogrammed into the system. the system also give a real time output and capable demostrating the actual scenario. The system use the tracing flooded path to find the path from the maze which is flooded via flood fill algorithm. The part tracing algorithm to initial coordinate of the robot. Depending with the value it will desides the movement of the trolley. The white line tracing for the robot to trace the entire path by follow the white path and follow the coordinates. If the obsctacle is detected, the robot will waits for a some time until the obstacles move away from its way and the robot trolley will continous to move forward until its reach at destination.

Figure 2.13: Automated Trolley System

The paper [14] proposed the smart dustbin with auto follower path trolley. This paper explain about the design of the microcontroller based dustbin trolley with auto follower path. The main objective of this paper is to develop the smart dustbin with auto follower path. The arduino uno will detect the level of the trolley-bin when it filled by any type of waste. If the parameter  equal or exceed the limit, the trolley will automatically start to move using the line follower technique to reach the dump aread and wait for manual dumping at disposal

area. After the bin is empty, the trolley will come back to the its initial position for next dumping cycle. The smart bin consist with the ultrasonic sensor for measurement of the garage level in the bin while the force sensitive resistor is used to detect the weight of the garage bin. The ultrasonic sensor placed in the top of the bin for measurement level. Force sensitive resistor placed in the bottom of the bin to sense the weight of the trolley bin. Arduino uno used to controlling the system. the other component that use also motor driver L293D and DC stepper motor, these component use to moving the trolley to desired location. This system divide into two module, the first one is detection of grafe level an the other module is motion of the dustbin to the container in the predefined path. All the signal from the ultrasonic sensor and the force sensitive resistor are sent to the arduino uno then from the sensor arduino give the intruction to the trolley for moving toward the defined path.

[15] propose the paper automatic human guided shopping trolley with smart shopping system. in this paper, the project system design both in hardware and software is described. The aim of this project development is to avoid the inconvenience and time wasting for customer to search the product in a supermarket. Due these problems, a line following portable robot is install under the trolley . this installation is to lead the user to item location. A portable robot is develop to assist the customer to carry heavy load while shopping with the human and line following function. Its also develop to identified the location each item in the supermarket. Arduino mega is used in this system as microcontroller for portable robot. The component such as RFID reader, ultrasonic sensor, bluetooth module, auto-calibrating line sensor and motor drive are attach to the arduino mega. The RFID reader function is to read the tag cards and sent the tag card data to android smartphone via bluetooth module. The ultrasonic sensor is use to detect the obstacle while the line sensor is use for robot line following purpose. The communication between the smartphone and robot is via

bluetooth connection an the movement of the shopping trolley is controlled by using a smartphone.

Figure 2.14: The Automated Trolley Prototype

## 2.3 COMPARISON OF PREVIOUS RESEARCH PAPER

Table 2.1 Summary of The Research Paper

| No | Title and author | Component | Method | Advantages | Disadvantages |
|---|---|---|---|---|---|
| 1 | Human following robot using Arduino. [9] | Arduino uno, dc motor, motor shield, ultrasonic sensor, IR sensor. | Ultrasonic sensor placed on the top of the robot to detect the obstacle and to maintain the distance for robot either to move or stop while IR sensor is used to control the movement of motor. | - This robot can assist and serve human. | - The robot only can detect the object on the specific range. |
| 2 | Automatic Human Guided Shopping Trolley with Smart Shopping System | Ultrasonic sensor, HC-SR04, RFID reader, RDM 6300, Wi-Fi hotspot and Bluetooth. | RFID to determine the location of items. Ultrasonic sensor to detect obstacle. Use Wi-fi and Bluetooth for communication. Line following | - Easy the user to shopping without pushing the | - This shopping trolley has limitation because |

| | | | | | |
|---|---|---|---|---|---|
| | [8] | | using PID control by Infrared sensor. | shopping trolley themselves. | it follows the line to move. |
| 3 | Automated trolley system for airport [5] | IR sensor, load sensor, Arduino atmega328, RFID sensor, switch, LCD, buzzer, DC motor and RF receiver. | The RFID helps in identifying the destination and the movement of the motor in all directions is controlled by the microcontroller. The sensors such as IR and load cell provide safety and security. The RF module helps in monitoring whether the trolley has reached its correct destination. | - Easy the customer to transport their luggage.<br>- The customer does not need to carry their trolley.<br>- User friendly and cost effective.<br>- Reduce the man power | - Time taken for trolley to load and unloaded the luggage expend.<br>- The system become more sensitive because the load senses the reduction in weight of the luggage. |

## 2.4 Summary

This chapter discusses the review of the literature. On the basis of prior research papers and thesis, the advantages, limitations, method, and component are analyzed. By examining those parts of the previous reference, we can aid in the development of this project by adding functionality and identifying alternative solutions to the previous reference's limitations. Additionally, the results of previous research that have been analyzed are critical for this project in order to comprehend the project's function and flow.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

This chapter will discuss furthermore about the detail applied to carry out for this medical trolley project process. This chapter also discussed about the project planning, the hardware development, software development and the estimate costing in order to build a prototype of this medical trolley.

## 3.2 Methodology

This thesis presents the strategic and flow of the project that is required in order to implement this project. In this methodology, the progress of the proposal is shown in the project planning flowchart. The main purpose is to reduce direct contact between medical staff and patients, besides helping to reduce the medical staff's workload. The project starts with the title and then proceeds to the research, project operations and initial results of the project.

### 3.2.1 Process Flow of The Project

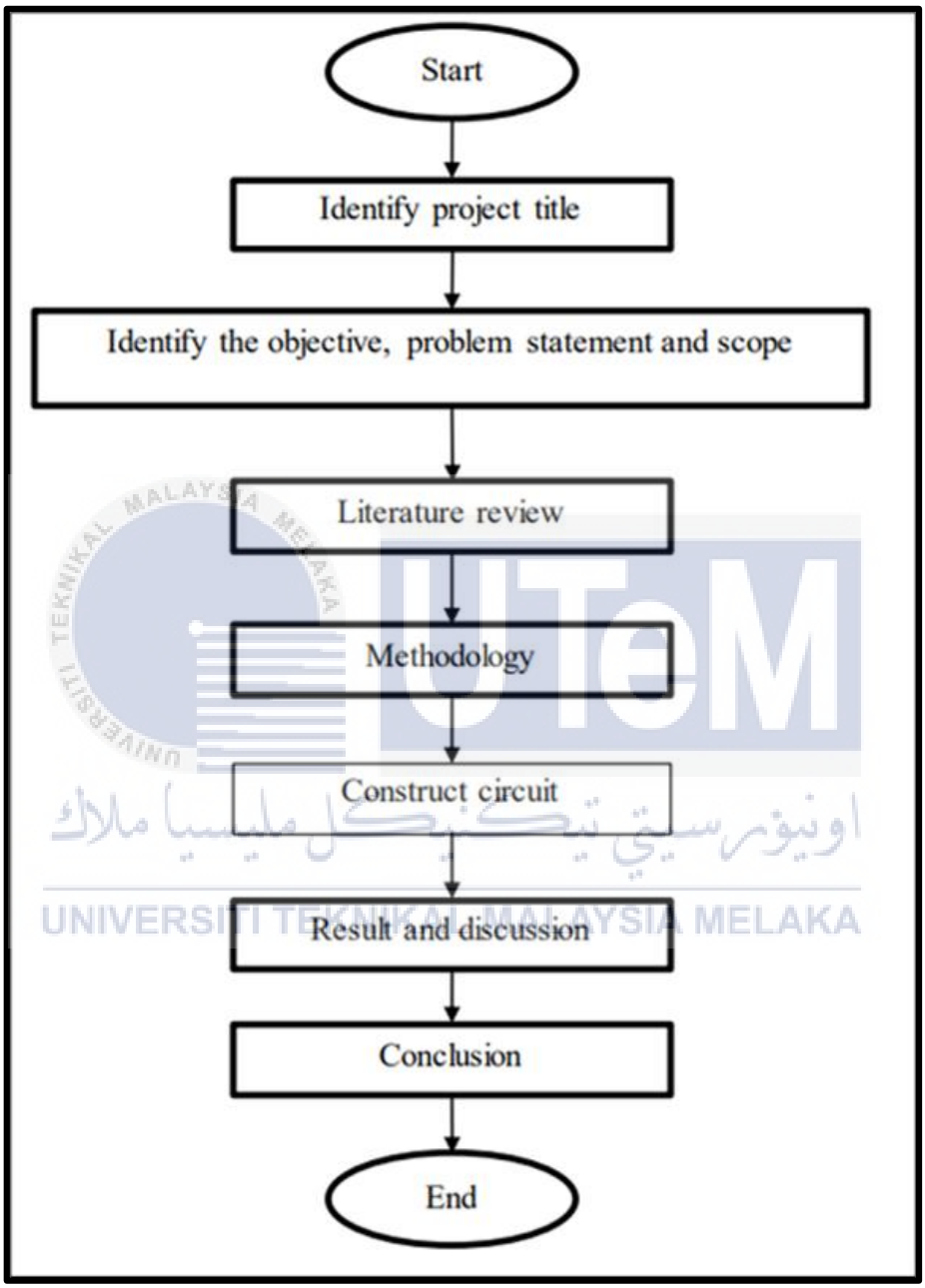



Figure 3.1: Flowchart of The Project Flow

According to the graphic above, the process of completing the project prototype is represented in detail. Beginning with bachelor's degree project 1 and progressing through to bachelor's degree project 2, all project flows are in strict accordance with the flowchart.

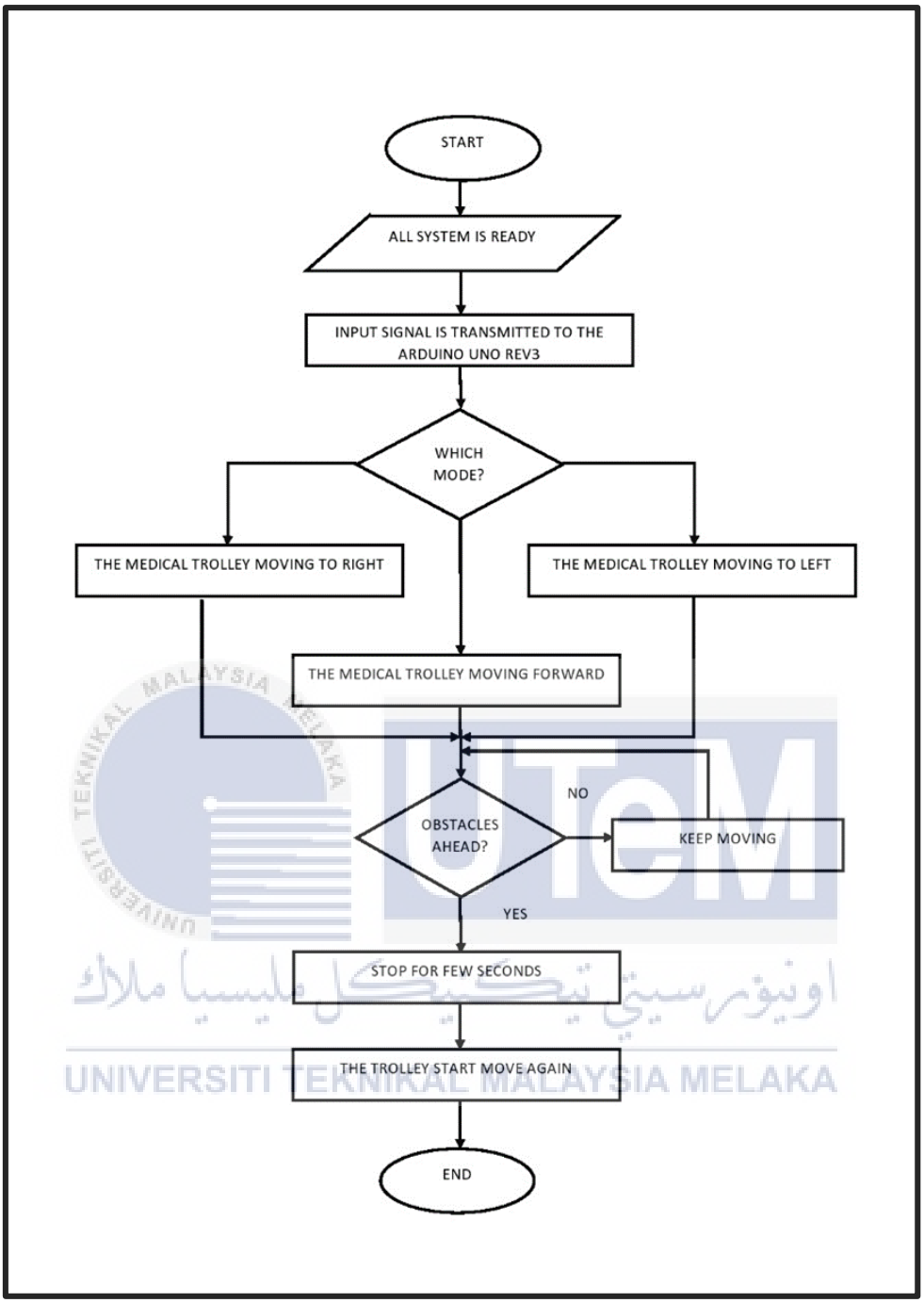



Figure 3.2: Flowchart for Input from Human Follower Using Ultrasonic Sensor

The flowchart depicts the input utilising an ultrasonic sensor to identify and perceive an object at a given distance, as shown in figure 3.5. The ultrasonic sensor is located at the trolley's front, left, and right sides. The ultrasonic sensor detects an object at a distance of 10

cm to 100 cm. If the ultrasonic sensor detects the closest range of the thing being observed, the trolley will begin to move. The trolley will not move if the ultrasonic detector senses input from less than 10 cm. However, if the input is between 10 and 100 cm, the trolley will begin to travel in the direction of the input. However, if the input is larger than 100 cm, the trolley will come to a halt.

## 3.3 Hardware requirement

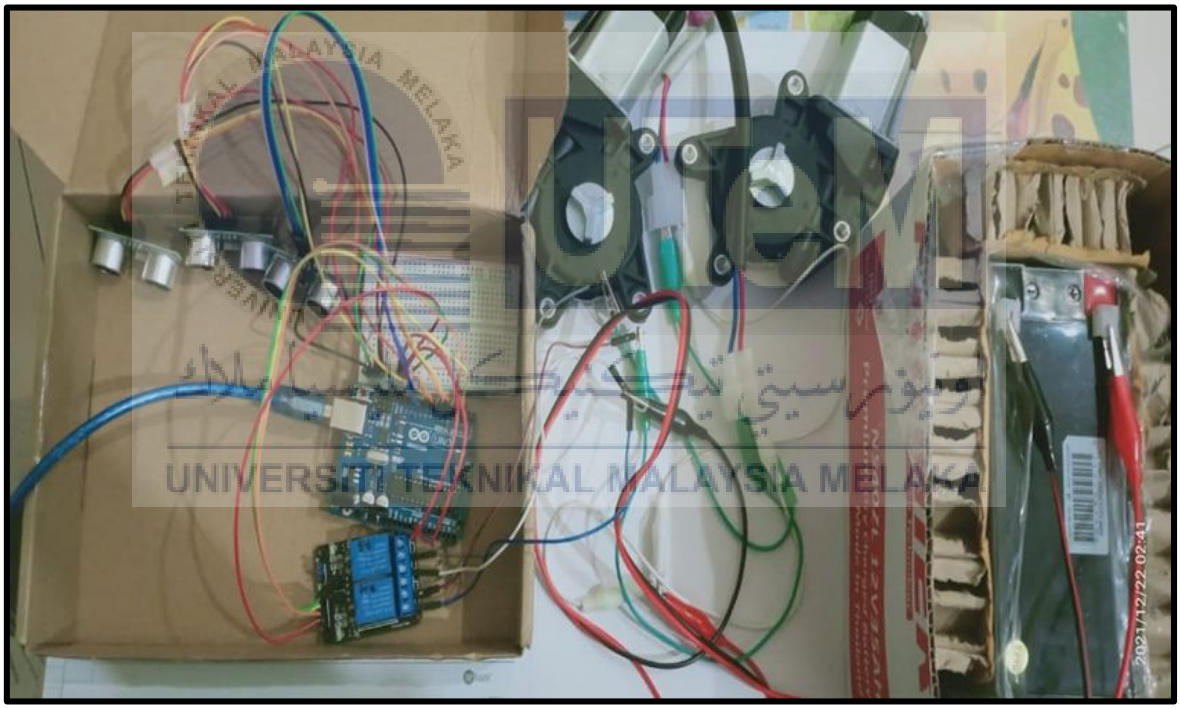


Figure 3.3: Hardware Circuit Board for Human Follower System

A hardware implementation includes electronic devices, Arduino Uno, Relay, Ultrasonic sensor and battery are the hardware use in development of this project. The device

used ultrasonic sensor to detect the obstacle and the input and the battery power to power up the system.

### 3.3.1 Arduino Uno Rev3

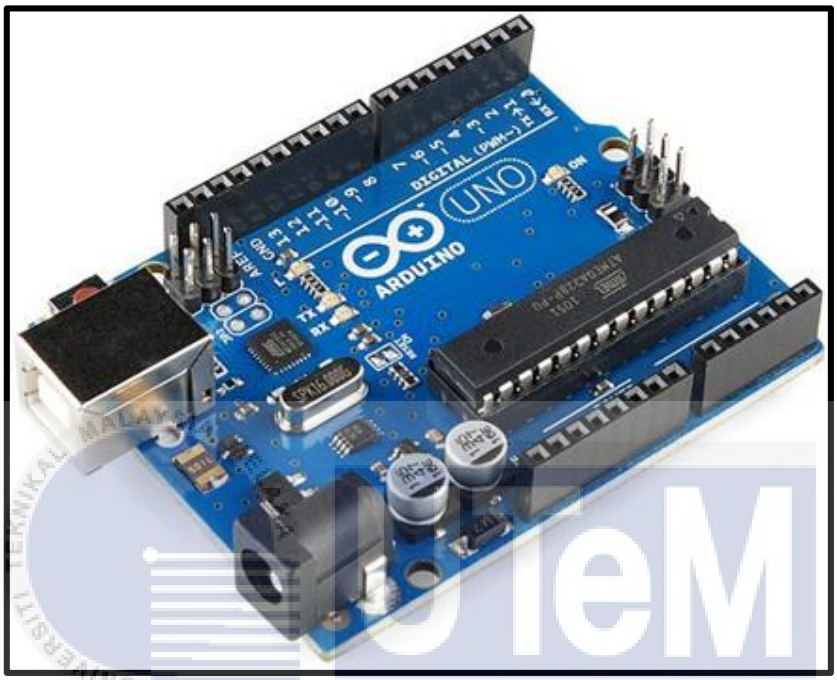



Figure 3.4: The Arduino Uno Rev3 Used In This Project



Arduino Uno is a microcontroller board based on the Atmega328. Arduino is one of the open-source single board microcontroller electronic component that commanly used for development platform, easy-to-use hardware and software modules. In this study, Arduino Uno R3 with an onboard USB to serial chip is used to load code into on-board Atmega328 Microcontroller. This Arduino contains everything needed to support the microcontroller. In order to get start, user simply needs to connect Arduino Uno R3 to a computer with a USB cable. The Arduino consist 14 digital input/output pins which is used as a PWM outputs, 6

analog inputs, 6MHz crystal oscillator, a USB connection,power jack an in-circuit system programming (ICSP) header and a reset button.

| | | |
|---|---|---|
| Pin12 (14xDigital IN/OUT) | Connect | Ultrasonic sensor 1 |
| Pin10 (14xDigital IN/OUT) | to | Ultrasonic sensor 1 |
| Pin9 (14xDigital IN/OUT) | ⇨ | Ultrasonic sensor 2 |
| Pin8 (14xDigital IN/OUT) | | Ultrasonic sensor 2 |
| Pin7 (14xDigital IN/OUT) | | Ultrasonic sensor 3 |
| Pin6 (14xDigital IN/OUT) | | Ultrasonic sensor 3 |
| Pin4 (14xDigital IN/OUT) | | Relay |
| Pin3(14xDigital IN/OUT) | | Relay |
| Pin2 (14xDigital IN/OUT) | | Relay |
| Pin1(14xDigital IN/OUT) | | Relay |

Table 3.1: The Connection Of Arduino UNO R3 For Human Follower Using Ultrasonic Sensor.



### 3.3.2 Ultrasonic Sensor


Figure 3.5: The Ultrasonic Sensor

The ultrasonic sensor is one of the sensor that used to measure the distance between an object. The ultrasonic sensor widely used to measure distance due to the compact scale, low cost, and small size. To detect the distance, the ultrasonic will produce a sound wave at certain frequency and sound wave will travel until reach at surface of an object then the sound wave rebound. The ultrasonic sensor has stability and a high precision of between 2cm and 450cm.

| Pin | Feature of the pin |
|---|---|
| VCC | the power supply for HC-SR04 Ultrasonic distance sensor.<br>Connected with the 5V pin on the Arduino uno. |
| Trigger | used to trigger the ultrasonic sound pulses. |
| Echo | When a reflected signal is received, pin sends out a pulse. The time it took to detect the transmitted signal is proportional to the length of the pulse. |
| Gnd | Ground pin.<br>Connected with ground arduino uno. |

Table 3.2: Ultrasonic Pin Configuration

### 3.3.3 Power Window Motor

Figure 3.6: The Power Window To Control The Wheel

The power window is used to open and shut the windows. The power window is lightweight, has a voltage rating of 12vdc, is suitable for 5 people, and can use up to 10 A shield to drive the motor.The rated speed is 60±15RPM, while no load speed is 85±15RPM. The current with no load is less than 5A, the rated current with load is a maximum of 15A and stall current when the trolley is locked is a maximum of 28A at 12V. The power window rated torque is 30kg.cm (2.9N.m) while the stall torque is 100±15Kg.cm (~10N.m).

### 3.3.4 Relay Module

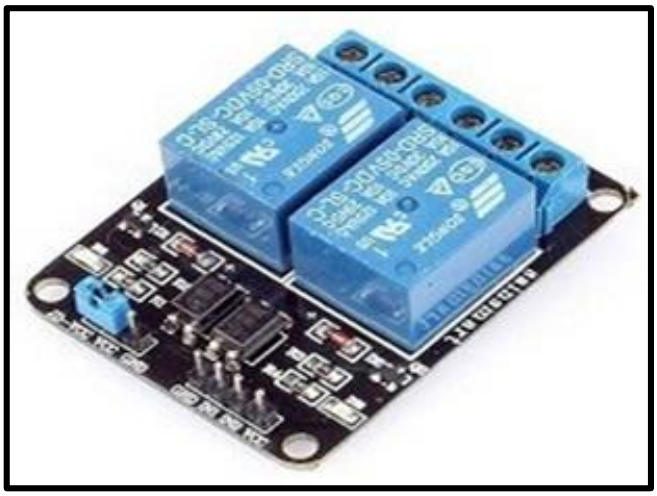


Figure 3.7: The Relay Module For Two Channels

By opening and closing the disconnections on the transmission and distribution lines, the relay module detects and isolates problems. The relay function is to use a signal to control a lower-powered circuit or track circuit. The relay switch is an electrically driven switch that uses the current flowing through the coil to generate a magnetic field. The contacts of the switch are pushed and adjusted by this magnetic field. Relays have two switch positions and generally include double throw (changeover) switch contacts because the coil current of the relay can be off or on. The relay's supply voltage is 5 volts. The dual-channel relay module includes switching relays and related drive circuitry, making it simple to include relays into a microcontroller-based project. Two terminal blocks are on the left that are used to connect mains wires to the module without soldering. Then there are the two relays. The relay coil is rated for 5VDC, and the contacts are rated for 10A at 250VAC or 30VDC, or 125VAC or 28VDC, as shown on the body of the relay. The signal from the inputs is amplified enough by the switching transistors to drive the relay. Voltage spikes across the switching transistors are avoided by using freewheeling diodes. When the relay is active, the status LEDs

illuminate and signal switching. Additional isolation between the input and the relays is provided by optocouplers. The VCC/JDVCC jumper can be used to select the isolation. The input jumper includes two input and two power pins, making it simple to connect jumper cables, microcontrollers, and sensors.

| Type of pin | Pin name | Description |
|---|---|---|
| 1 | JD-VCC | Input for isolated power supply for relay coils |
| 2 | VCC | Input for directly powering the relay coils |
| 3 | GND | Input ground reference |
| 4 | GND | Input ground reference |
| 5 | IN1 | Input to activate the first relay |
| 6 | IN2 | Input to activate the second relay |

Table 3.3: Relay Pin Description

### 3.3.5 Battery 12V


Figure 3.8: The Battery Power Used In This Project.

The power of the battery is used to supply the medical trolley with power. The battery power is divided into two terminal parts: positive (anode) and negative (cathode). Battery power uses include smartphones, hybrid vehicles, and flashlights.

### 3.3.6 Breadboard

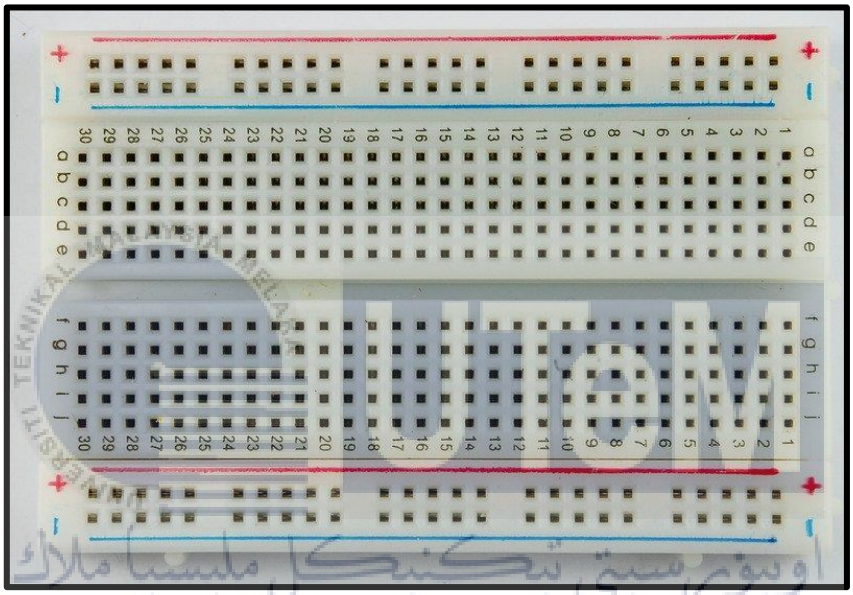


Figure 3.9: Breadboard



An inexpensive solderless circuit board that can be used to quickly prototype gadgets and test circuit concepts is known as a breadboard. When connecting electrical components in electronic circuits, the bulk of them can be connected simply by inserting their leads or terminals into the holes and connecting them together using wire

### 3.3.7 Jumper Wire

Figure 3.10: Jumper Wire

A jumper is used to link the components of a breadboard or other prototype or test circuit together, either internally or in combination with additional equipment or components. without the need for soldering. This project makes use of a variety of jumpers, including female-to-female jumpers, female-to-male jumpers, and male-to-male jumpers.

## 3.4 Software Requirement

### 3.4.1 Proteus 8.11 Professional

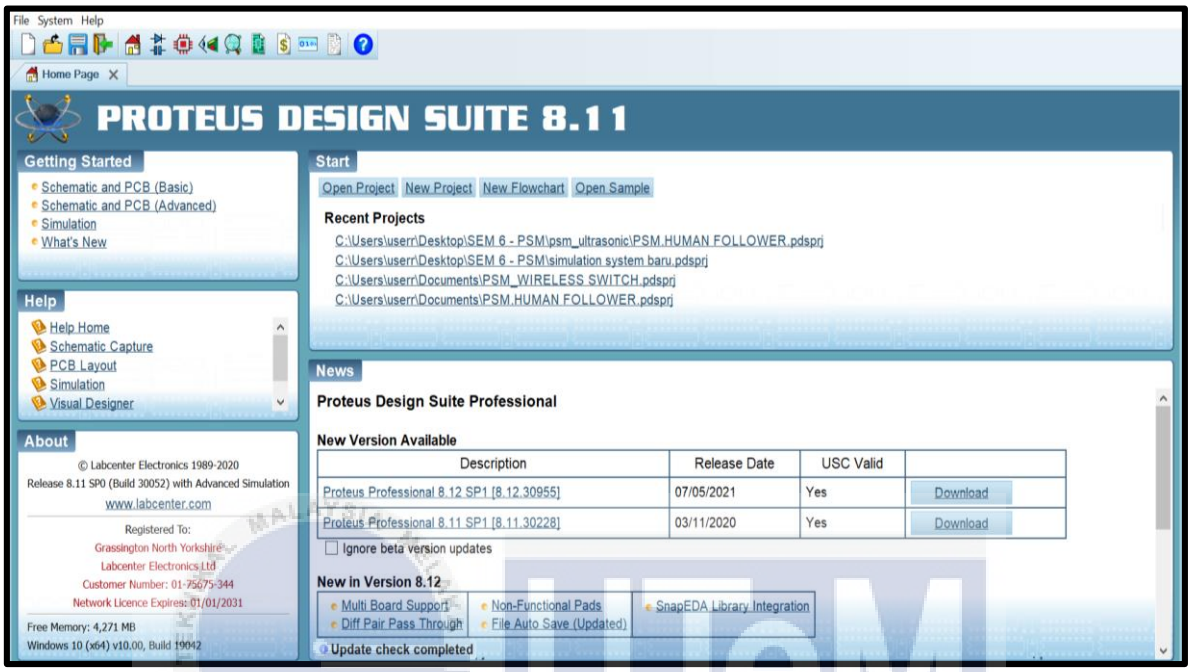



Figure 3.11: Proteus 8 Professional Software

Proteus 8 professional is software that can be used to draw schematics, PCB layout, simulate the schematic and code. Labcenter Electronics Ltd created this software.This software is used to design and run the entire system circuit of the medical trolley project.The simulation of the human follower using an ultrasonic sensor via schematics.

### 3.4.2 Arduino Ide

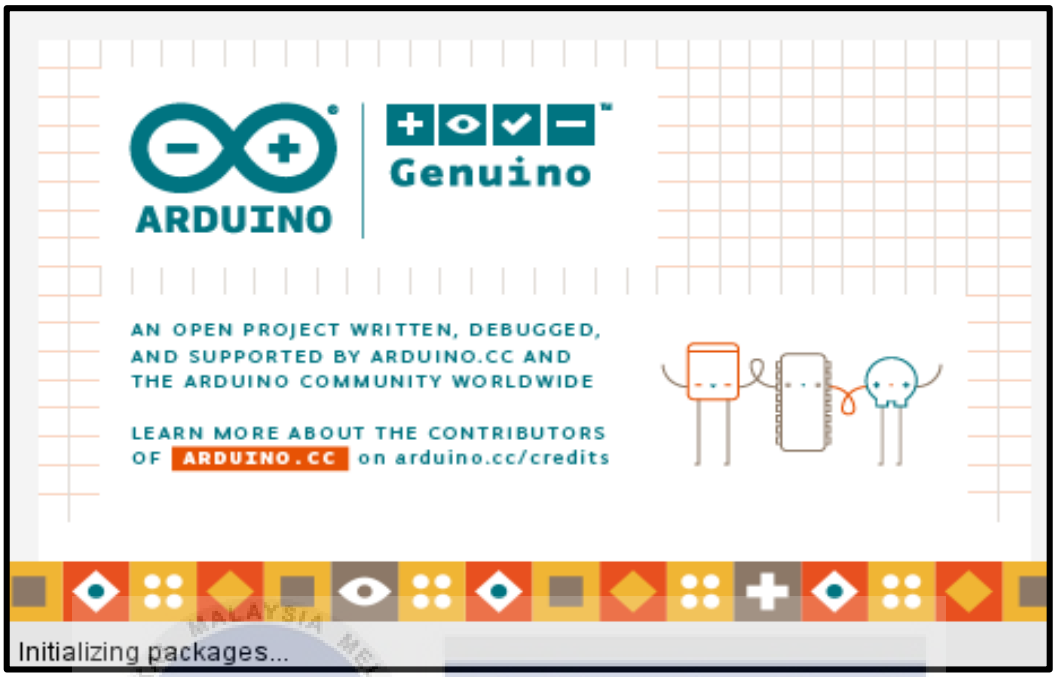



Figure 3.12: Shows Arduino IDE Software


Figure 3.13: show arduino IDE software

IDE stands for "World of Interconnected Development". It is an official Arduino.Cc program. This is used primarily to modify, compile and upload Arduino code. Most of the Arduino modules are compliant with open source applications and can be installed and started on the go.

| No | Part of the IDE | Explanation |
|---|---|---|
| 1 | Compile | It must be translated to instructions that the board knows before the application "code" can be delivered to the board. This compilation method is named. |
| 2 | Stop | This avoids the process of compilation. |
| 3 | Create new Sketch | It opens a new window for a new drawing. |
| 4 | Open Existing Sketch | This will load your computer with a diagram from a file. |
| 5 | Save Sketch | This saves the improvements to the drawing on which you are working. |
| 6 | Upload to Board | This constructs and transmits to your board through the USB cable. |
| 7 | Serial Monitor | When your programs (sketches) didn't work, you just pulled out the hair and tried harder. |
| 8 | Tab Button | You can create a variety of files in your drawing. |
| 9 | Sketch Editor | That's where you are composing or editing drawings. |
| 10 | Text Console | This tells you what the IDE is doing and also shows error messages as you typing the program. (Syntax error is also called) |
| 11 | Line Number | This tells you on which line your cursor is. It is useful because the compiler includes a line number for error messages. |

Table 3.4: Arduino IDE Software Explanation

## 3.5 Summary

Within this chapter, users will learn about the approaches that should be used to build a new, comprehensive plan for medical trolleys with the objective of lowering COVID-19 viral transmission. It is the execution and implementation of this project that are the primary emphasis of the technique shown. The study was carried out and finished in accordance with the objectives that had been set. This device application must be built and executed in order for this project to be considered a complete success.

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Introduction

This chapter describes the results and conclusions that were reached as a result of the study and development of an automated medical trolley system. In order to achieve the project's goal, a schematic design was created by combining the Proteus and Arduino programming environments with the Arduino hardware. In order to complete this system project, both hardware and software components were necessary. The movement of the automated trolley will be sensed by the use of an ultrasonic sensor. It will take some investigation to determine the operation of this system.

## 4.2 Results and Analysis

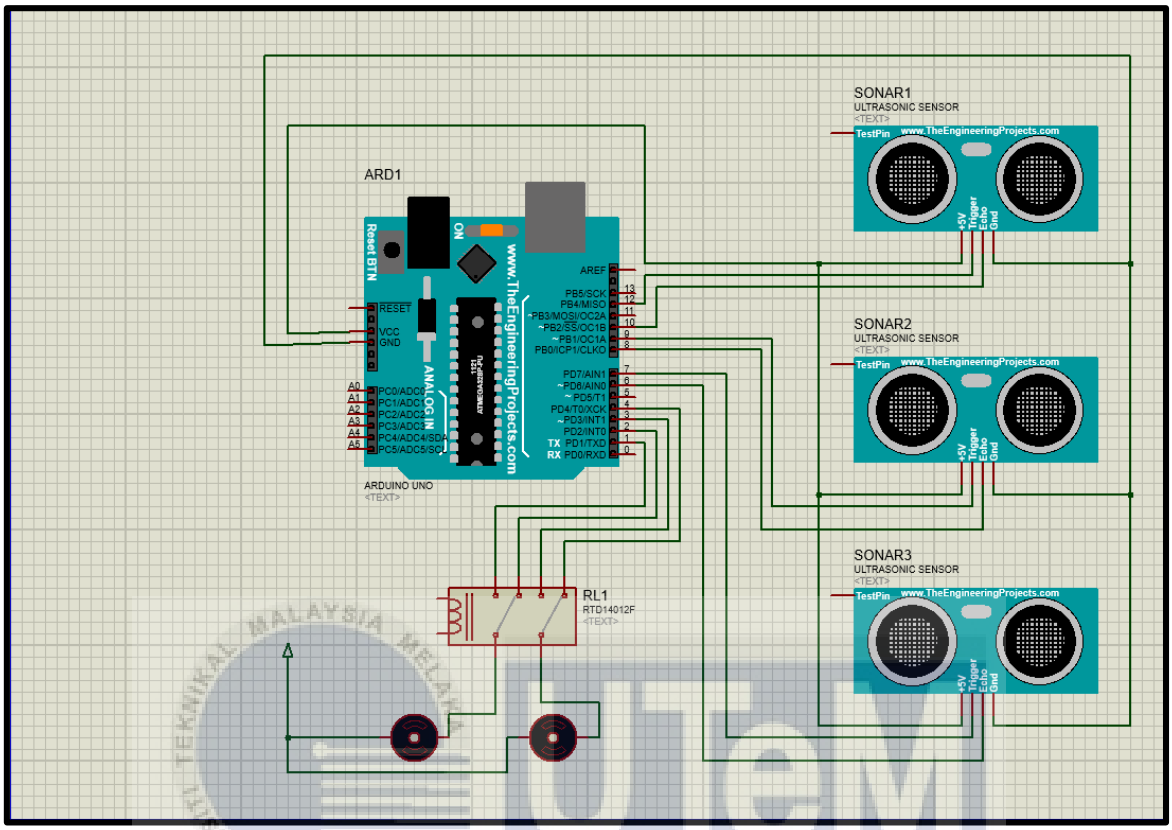



Figure 4.1: Schematic Diagram of The Human Follower System

As illustrated in Figure 3.14 above, the Arduino Uno R3, three ultrasonic sensors, relays, two motors, and a few wiring connections are among the components that make up the human follower system. Because it regulates the system's input and output, the Arduino Uno R3 is referred to as the "brain" of the circuit. It is used to process the input from the instructor and transmit data to the power window. The Arduino Uno R3 is a sensitive microcontroller where several precautions must be considered. The maximum voltage applied to the Arduino Uno R3 is 5.5 volt where it does not exceed 12 volts to avoid overload voltage and it is applied on direct current only. The input and output pins were not shortened to avoid overcurrent condition on both input and output pins.

Throughout the system, the ultrasonic sensor serves as an input device, while the motor serves as an output device. Pins 6, 7, 8, 9, 9, 10, and 12 of the ultrasonic sensors are linked to the Arduino's pins 6, 7, 8, 9, 9, 10, and 12. Pins 2 and 4 of the Arduino are linked to a relay. It is necessary to connect a relay between the Arduino uno and the motor because it allows the Arduino to supply a small amount of current while still supplying a larger amount of current to run the motor. This is necessary because the motor requires 5 V and the Arduino uno can only supply 5V of power.


Figure 4.2: shows the prototypes of the automated medical trolley system

The Arduino Uno R3 serves as the system's controller, with an ultrasonic sensor serving as an input and a gear motor serving as the system's output. Each of the ultrasonic sensors is mounted on the trolley's left, front, and right sides. There are three of them. Additionally, an ultrasonic sensor is comprised of a transmitter and a receiver that are mounted on top of it. The transmitter is responsible for transmitting ultrasonic waves, while the receiver is responsible for detecting ultrasonic waves that are reflected back by the barrier in front of the transmitter. The distance between an item and the sensor that has been mounted on the trolley may be estimated by comparing the time gap between the transmission and received times of the object and sensor. The distance between the trolley and the obstruction was determined by comparing three different distances, then choosing one that was closest in terms of distance. As soon as the front sensor identifies the closest obstacle, it will activate the relays of both gear motors, with the relay supplying electricity to the gear motor. When the left sensor detects a nearby impediment, it will activate the relay for the right motor, causing the trolley to move to the left. The same principle applies to the right sensor, but in the opposite direction. In the interest of safety, the system has further enhanced the human follower system by including a feature that causes the trolley to stop when it is 20 cm away from an obstruction. This feature is primarily intended to prevent people from being struck by the trolley if they stop moving.



The Arduino Uno Rev 3 was used to successfully implement a medical trolley system that uses human followers. microcontroller is the primary controller in this project. All the input from the sensor will be sent to the Arduino uno microcontroller. By using ultrasonic sensor, the Arduino Uno can control the functionality of the medical trolley. The power window motor used in this project will control the movement of the medical trolley wheel

based on instructions from the human follower. Using an ultrasonic sensor, the trolley will detect humans at a specific range. The ultrasonics will be installed on the trolley's front, left, and right sides. The human follower system has a feature to avoid a collision between the trolley and the user at a specific range.

The automated medical trolley's power window was used as a way to show where it was going. Torque is cut down on the motor to make sure that it moves the tyre in a way that is right for the floor surface. There is less inertia impact when the torque of the power window motor is less. When the trolley moves and stops, this safety measure is thought to keep medical supplies from falling down when the trolley moves and stops. Another thing to think about is the surface of the tyres. The surface of the tyre was made to have more grip, so the trolley can move to where it needs to go and not slide around and end up in another place.

The automated medical trolley is made of aluminum sterilize to keep germs and infections from getting on it, and it moves on its own. It is very important to keep clean in a health care environment, because this product will be used in a hospitality environment. Aluminum is a metal that is used in a lot of hospitals because it doesn't rust. Thus, it is simple to clean.

## 4.3 Analysis of the product

| | Power Window Motor | DC motor 12V |
|---|---|---|
| Motor specification | Voltage : 12V<br><br>Power : 138 W<br><br>Speed : 100 rpm<br><br>Torque : 30 KG-cm<br><br>Motor Weight : 0.55 Kg | Voltage : 12-24V<br><br>Power : 80 W<br><br>Speed :3500 rpm (at 24V)<br><br>Torque : 2 KG-cm (at 24V)<br><br>Motor Weight : 0.355 Kg |
| Function | - Manual open or close function.<br>- One touch auto open or close function.<br>- Window lock function When the window lock.<br>- switch is turned on.<br>- Jam protection function.<br>- Key-off power window function | - Move forward and reverse |
| Price | RM 26.80 | RM 60 |

Table 4.1: Analysis the Power Motor Window with DC Motor.

| | Our system | System 1 | System 2 |
|---|---|---|---|
| Purpose | Automated Trolley Instrument System | Smart Trolley using Arduino and smart phone | Automatic Human Guided Shopping Trolley with Smart Shopping System |
| Function | - Used ultrasonic sensor to sense the object and it will activate the power window to move the trolley in any direction.<br>- ultrasonic sensor has function to avoid the collision between trolley and users. | - Used smartphone as a barcode scanner.<br>- Used RFID to follow the object, has RFID reader and RFID tag to make sure the trolley follows the object anywhere it goes.<br>- Used Bluetooth module to transfer the information from barcode scanned to Arduino. | - Line following using PID control by Infrared sensor<br>- RFID to determine the location of items<br>- Ultrasonic sensor to detect obstacle<br>- Use Wi-fi and Bluetooth for communication |
| Cost | Cost effective | Cost effective | Cost effective |

Table 4.2: Analysis Automated Medical Trolley Features with The Smart Trolley in Market

## 4.4 Summary

This chapter describes the inputs and outputs of a medical trolley system. The schematic diagram of the medical trolley includes human followers and the whole schematic diagram of the automatic trolley system is described in this chapter.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

A medical trolley system is constructed and combined using an Arduino Uno based on the ATmega328 microcontroller. The Arduino uno can operate the medical trolley through an ultrasonic sensor using human followers' method. To reduce the risk of a collision, a medical trolley is equipped with an ultrasonic sensor that will immediately stop if any obstacle is detected at specific range to avoid collision between trolley and user. The medical trolley can automatically follow humans wherever they go thanks to the human follower system.

A medical trolley is designed to reduce the workload of the hospital's medical staff because this trolley does not work. The medical staff can control the trolley by using a wireless switch or using the human follower system. This medical trolley is also essential equipment in this pandemic, particularly in hospital wards. The medical trolley's function is to deliver items such as medicines, food, clothing and other medical necessities to patients, especially infected COVID-19 patients.

## 5.2 Future Works

For future improvements, the automated medical trolley results could be enhanced as follows:

- Adding the feature that can control the trolley movement in more far distance

- improve the system by change the ultrasonic sensor to RFID sensor around the trolley to improve its sensitivity to the environment.
- Instead of only following the nearest person, a tag could be held by the person and the trolley will move in the direction where the tag is detected. Find the braking system can be improved.
- The system should be redesign so that after detecting obstacle, the trolley will reduce its speed before completely stop.

## REFERENCES


[1] E. D. Suryanto, H. Siagian, and D. Perangin-angin, “Design of automatic mobile trolley using ultrasonic sensors,” 2018.

[2] M. O, A. Etienne, and A. Siadat, “ScienceDirect ScienceDirect ScienceDirect Development of Controlled Development of Sensor Sensor Controlled Convertible May Convertible Olayode architecture of A new methodology to analyze functional and physical for an assembly oriented product identific,” *Procedia CIRP*, vol. 91, pp. 71–79, 2020, doi: 10.1016/j.procir.2020.03.097.

[3] D. Pandita, A. Chauthe, and N. Jadhav, “Automatic Shopping Trolley using Sensors,” *Int. Res. J. Eng. Technol.*, vol. 4, no. 4, 2017, [Online]. Available: https://www.irjet.net/archives/V4/i4/IRJET-V4I4656.pdf.

[4] A. A. S. Gunawan *et al.*, “Development of smart trolley system based on android smartphone sensors,” *Procedia Comput. Sci.*, vol. 157, pp. 629–637, 2019, doi: 10.1016/j.procs.2019.08.225.

[5] R. J. Ravindaranaath, K. Karthik, R. Vishnupriyan, S. Suryakumar, and G. Thamaraiselvi, “"Automated Trolley System for Airport ",” *Int. J. Commun. Comput. Technol.*, vol. 5, no. 1, pp. 32–35, 2019, doi: 10.31838/ijccts/05.01.07.

[6] I. Journal and O. F. Engineering, “International journal of engineering sciences & research technology,” vol. 4, no. 1, pp. 2–5, 2015.

[7] A. Waghmare, A. Degaonkar, B. Mohini, and P. M. Patil, “Smart Dustbin with Auto Follower Path Trolley,” *SSRN Electron. J.*, pp. 1–6, 2019, doi: 10.2139/ssrn.3418558.

[8] Y. L. Ng, C. S. Lim, K. A. Danapalasingam, M. L. P. Tan, and C. W. Tan,

"Automatic human guided shopping trolley with smart shopping system," *J. Teknol.*, vol. 73, no. 3, pp. 49–56, 2015, doi: 10.11113/jt.v73.4246.

[9] D. Sati, S. Avkirkar, R. Pandey, and A. Somnathe, "Human Following Robot Using Arduino," *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 4, no. 2, pp. 347–350, 2021, doi: 10.48175/ijarsct-1025.

[1] L. S. Y. Dehigaspege, M. K. C. Liyanage, N. A. M. Liyanage, M. I. Marzook, and D. Dhammearatchi, "Follow Me Multifunctional Automated Trolley," vol. 6, no. 07, pp. 84–90, 2017.

[2] H. R. Poorvitha, T. N. Pavithra, T. M. Sowbhagya, K. B. Savithramma, and O. Yadav, "A survey on Automated Shopping Trolley Follower for Super Market Billing System," vol. 6, no. 2, pp. 67–70, 2018.

[3] S. Rastogi and V. Agarwal, "An Intelligent Sensing Follower Cart (AUTOMATIC SHOPPING TROLLEY)," Ripublication.Com, vol. 2, no. 2, pp. 21–25, 2017, [Online]. Available: http://www.ripublication.com/ijaer18/ijaerv13n23_50.pdf.

[4] D. Sati, S. Avkirkar, R. Pandey, and A. Somnathe, "Human Following Robot Using Arduino," Int. J. Adv. Res. Sci. Commun. Technol., vol. 4, no. 2, pp. 347–350, 2021, doi: 10.48175/ijarsct-1025.

[5] M. S. Hassan, M. W. Khan, and A. F. Khan, "Design and Development of Human Following Robot," Student Res. Pap. Conf., vol. 2, no. 15, pp. 79–86, 2015.

[6] E. D. Suryanto, H. Siagian, and D. Perangin-angin, "Design of automatic mobile trolley using ultrasonic sensors," 2018.

[7] N. A. Rawashdeh, R. M. Haddad, O. A. Jadallah, and A. E. To, "Smartphone Application : Design and Evaluation," 2017.

[8] M. O, A. Etienne, and A. Siadat, "ScienceDirect ScienceDirect ScienceDirect

Development of Controlled Development of Sensor Sensor Controlled Convertible May Convertible Olayode architecture of A new methodology to analyze functional and physical for an assembly oriented product identific," Procedia CIRP, vol. 91, pp. 71–79, 2020, doi: 10.1016/j.procir.2020.03.097.

[9] C. Engineering and C. Engineering, "A SURVEY OF TROLLEY / WHEELCHAIR BASED SMART SYSTEM FOR EXCLUSIVE MEDICAL APPLICATIONS," pp. 2595–2601, 2018.

[10] D. Pandita, A. Chauthe, and N. Jadhav, "Automatic Shopping Trolley using Sensors," Int. Res. J. Eng. Technol., vol. 4, no. 4, 2017, [Online]. Available: https://www.irjet.net/archives/V4/i4/IRJET-V4I4656.pdf.

[11] A. A. S. Gunawan et al., "Development of smart trolley system based on android smartphone sensors," Procedia Comput. Sci., vol. 157, pp. 629–637, 2019, doi: 10.1016/j.procs.2019.08.225.

[12] R. J. Ravindaranaath, K. Karthik, R. Vishnupriyan, S. Suryakumar, and G. Thamaraiselvi, ""Automated Trolley System for Airport "," Int. J. Commun. Comput. Technol., vol. 5, no. 1, pp. 32–35, 2019, doi: 10.31838/ijccts/05.01.07.

[13] I. Journal and O. F. Engineering, "International journal of engineering sciences & research technology," vol. 4, no. 1, pp. 2–5, 2015.

[14] A. Waghmare, A. Degaonkar, B. Mohini, and P. M. Patil, "Smart Dustbin with Auto Follower Path Trolley," SSRN Electron. J., pp. 1–6, 2019, doi: 10.2139/ssrn.3418558.

[15] Y. L. Ng, C. S. Lim, K. A. Danapalasingam, M. L. P. Tan, and C. W. Tan, "Automatic human guided shopping trolley with smart shopping system," J. Teknol., vol. 73, no. 3, pp. 49–56, 2015, doi: 10.11113/jt.v73.4246.

# APPENDICES

## Appendix A Data sheet for Arduino Uno

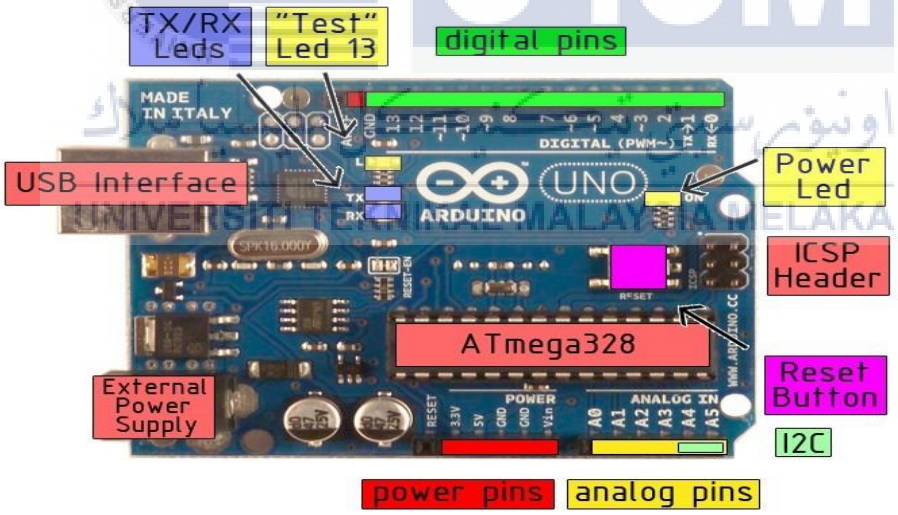
# Technical Specification

EAGLE files: arduino-duemilanove-uno-design.zip Schematic: arduino-uno-schematic.pdf

## Summary

| | |
|---|---|
| Microcontroller | ATmega328 |
| Operating Voltage | 5V |
| Input Voltage (recommended) | 7-12V |
| Input Voltage (limits) | 6-20V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| Analog Input Pins | 6 |
| DC Current per I/O Pin | 40 mA |
| DC Current for 3.3V Pin | 50 mA |
| Flash Memory | 32 KB of which 0.5 KB used by bootloader |
| SRAM | 2 KB |
| EEPROM | 1 KB |
| Clock Speed | 16 MHz |

## the board




The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

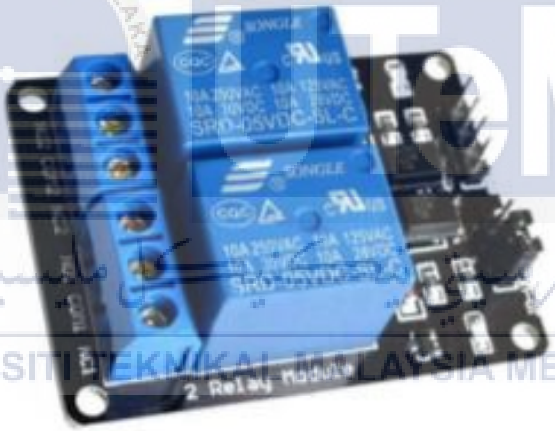
**Appendix B Data sheet for 2 channel 5v module**

HT **Handson Technology**

**User Guide**

# 2 Channel 5V Optical Isolated Relay Module

This is a LOW Level 5V 2-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equipped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller. This module is optically isolated from high voltage side for safety requirement and also prevent ground loop when interface to microcontroller.






**Brief Data:**

- Relay Maximum output: DC 30V/10A, AC 250V/10A.
- 2 Channel Relay Module with Opto-coupler. LOW Level Trigger expansion board, which is compatible with Arduino control board.
- Standard interface that can be controlled directly by microcontroller ( 8051, AVR, *PIC, DSP, ARM, ARM, MSP430, TTL logic).
- Relay of high quality low noise relays SPDT. A common terminal, a normally open, one normally closed terminal.
- Opto-Coupler isolation, for high voltage safety and prevent ground loop with microcontroller.

Tech Support: services@elecfreaks.com

# Ultrasonic Ranging Module HC - SR04

## □ Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

(1) Using IO trigger for at least 10us high level signal,

(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time×velocity of sound (340M/S) / 2,

## □ Wire connecting direct as following:

5V Supply
Trigger Pulse Input
Echo Pulse Output
0V Ground



## Electric Parameter

| | |
|---|---|
| **Working Voltage** | **DC 5 V** |
| **Working Current** | **15mA** |
| **Working Frequency** | **40Hz** |
| **Max Range** | **4m** |
| **Min Range** | **2cm** |
| **MeasuringAngle** | **15 degree** |
| **Trigger Input Signal** | **10uS TTL pulse** |
| **Echo Output Signal** | **Input TTL lever signal and the range in proportion** |

## Appendix D Project Coding for Human Follower System

human_follower_coding

```
#include <NewPing.h>
int TRIGGER_Front = 13;
int ECHO_Front = 12;
int TRIGGER_Left = 9;
int ECHO_Left = 10;
int TRIGGER_Right = 8;
int ECHO_Right = 7;

NewPing sonar_Front(TRIGGER_Front, ECHO_Front);
NewPing sonar_Left(TRIGGER_Left, ECHO_Left);
NewPing sonar_Right(TRIGGER_Right, ECHO_Right);

int Relay1 = 4;//motor depan kanan
int Relay2 = 3;//motor belakang kanan
```

human_follower_coding

```
void MotorFoward()
{
  digitalWrite (Relay1, LOW);
  digitalWrite (Relay2, LOW);

}
void MotorTurnLeft()
{
  digitalWrite (Relay1, HIGH);
  digitalWrite (Relay2, LOW);

}
void MotorTurnRight()
{
  digitalWrite (Relay1, LOW);
  digitalWrite (Relay2, HIGH);
}
void MotorStop()
{
  digitalWrite (Relay1, HIGH);
  digitalWrite (Relay2, HIGH);

}
```

human_follower_coding

```
}
void setup() {
  // put your setup code here, to run once:

  pinMode (Relay1, OUTPUT); // Set Relay 1 as output
  pinMode (Relay2, OUTPUT); // Set Relay 2 as output

  Serial.begin(115200);
  Serial.println("System Initialize  \n");
  Serial.println("********************************  \n");
}
void loop() {
  // put your main code here, to run repeatedly:
  int distance_Front = sonar_Front.ping_cm();
  int distance_Left = sonar_Left.ping_cm();
  int distance_Right = sonar_Right.ping_cm();

        if ((distance_Front  >=100)&&(distance_Left  >=100)&&(distance_Right  >=100))
        {
          MotorStop();
          Serial.println("\n TOOOOOOO FARRRRR \n");
        }
  else if ((distance_Front && distance_Left && distance_Right) != 0)
  {
    if((distance_Right <10)||(distance_Left <10)||(distance_Front <50))
    {
      MotorStop();}
      Serial.println("\n STOPPPPPPPPPPPPPPPPPPPPP \n");
    }
    if ((distance_Front < distance_Left) && (distance_Front < distance_Right)&&(distance_Front >=50))
    {
      MotorFoward();
      Serial.println("Front: ");
      Serial.print(distance_Front);
      Serial.println(" cm");
      Serial.println("\n FRONTTTTTTTTTTTTTTTTTTTT \n");
  }
  if ((distance_Left < distance_Front) && (distance_Left < distance_Right)&&(distance_Left >= 10))
  {
    MotorTurnLeft();
    Serial.println("Left: ");
    Serial.print(distance_Left);
    Serial.println(" cm");
    Serial.println("\n LEFTTTTTTTTTTTTTTTTTTTTT \n");
  }
  if ((distance_Right < distance_Front) && (distance_Right < distance_Left)&&(distance_Right >=10))
  {
    MotorTurnRight();
    Serial.println("Right: ");
    Serial.print(distance_Right);
    Serial.println(" cm");
    Serial.println("\n RIGHTTTTTTTTTTTTTTTTTTTT \n");
  }
  delay(1000);
}
```