AUTOMATED FOOD ATTENDANCE ROBOT

NUR IZZATI BINTI ABDULLAH

This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical Engineering (Electronics)

Faculty of Electrical & Electronics Engineering
Universiti Malaysia Pahang

NOVEMBER 2007
“All the trademark and copyrights use herein are property of their respective owner. References of information from other sources are quoted accordingly; otherwise the information presented in this report is solely work of the author.”

Signature : ____________________________

Author : NUR IZZATI BINTI ABDULLAH

Date : NOVEMBER 2007
DEDICATION

Specially dedicated to:
- My late father, who really support me doing this project until his last breath, my mom, family, beloved ones and all friends -
ACKNOWLEDGEMENT

In preparing the thesis, I was in contact with many people, researches, and academicians. They have contributed towards my understanding and thought. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Pn. Nor Maniha Bt Abd Ghani, for encouragement, guidance, advices and supervision. I am also thankful to my unofficial co-supervisor, En. Mohammad Fadhil Bin Abas, for his guidance and advice regarding PIC programming. Not forgetting, Encik Mohd Azlan Bin Sayuti, thank you for your motivation and guidance related to the mechanical part of the robot. Without their continued support and interest, this thesis would not have been the same as presented here.

I am also indebted to Faculty of Electrical and Electronic, Universiti Malaysia Pahang (UMP) for funding my final year project. Laboratory instructors, thank you for all your cooperation especially sacrifice your resting time during weekend to open the laboratory.

My sincere appreciation also extends to all my colleagues especially Khairul A’alam Bin Abdul Ghani and others who have provided technical assistance and support. Good luck in your future undertaking. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family members for their non stop support. Last but not least, thanks God for giving me a healthy body to finish this project. Hopefully this project can contribute something useful to the committee.
ABSTRACT

This project presents the design and development of a robot from disposal raw material, name automated food attendance robot. The function of the robot is to deliver a food to unable people especially patient in hospital and old folk’s home from pantry to their bed with just pressing a start button. This robot will follow the line tracking which is black in colour. To sense the line, three sensors are used to detect right, center and left line. This project consists of two parts which are software and hardware development. The software development involved the programming for PIC 16f877 microcontroller. Melab programmer and Microcode studio are used for this purpose. Since the raw material that used is mostly aluminum, riveting process is used to build up the body of the robot. After few experiment done, the project is not fully succeeded because of the mistakes in choosing the material as will be discussed in this thesis.
ABSTRAK

TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITLE</td>
<td></td>
<td>i</td>
</tr>
<tr>
<td>DECLARATION</td>
<td></td>
<td>ii</td>
</tr>
<tr>
<td>DEDICATION</td>
<td></td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td></td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td></td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td></td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td></td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td></td>
<td>xiii</td>
</tr>
</tbody>
</table>

1 INTRODUCTION

1.1 Background 1
1.2 Problem Statement 2
1.3 Objectives 2
  1.3.1 To design a robot that can carry the patient/disable/old folk’s meal at their place 2
  1.3.2 To control the robot by using PIC microcontroller due to path tracking 3
1.4 Scopes of project 3
2  LITERATURE REVIEW

2.1  Carrier robot “CARREY”  
   2.1.1  Robot Operation  
   2.1.2  Robot Structure  
   2.1.3  Review  

2.2  Automated Food Attendance Robot  
   2.1.1  Robot Operation  
   2.1.2  Robot Structure  
   2.1.3  Review

3  METHODOLOGY

3.1  Overview  
   3.1.1  Literature review and researches  
   3.1.2  Robot body development  
   3.1.3  Circuitry design and development  
   3.1.4  Software development  
   3.1.5  Combining hardware and software  
   3.1.6  Documentation

4  HARDWARE DESIGN

4.1  Components  
   4.1.1  Motor  
   4.1.2  Batteries  
   4.1.3  PIC Microcontroller  
   4.1.4  Driver  
   4.1.5  Sensor  
   4.1.6  Tray
4.2 Robot Body
   4.2.1 Tray handle
   4.2.2 Height adjustment
   4.2.3 Sensor placement
   4.2.4 Steering and wheel
   4.2.5 Full version of robot body

5 SOFTWARE
   5.1 Overview
   5.2 Analog to Digital converter (ADC) program
   5.3 Left sensor input
   5.4 Right sensor input
   5.5 Center sensor input

6 SYSTEM OPERATION
   6.1 Delivering operation
   6.2 Going back operation

7 RESULT AND DISCUSSION
   7.1 Result
   7.2 Discussion

8 CONCLUSION AND RECOMMENDATION
   8.1 Conclusion
   8.2 Recommendation
      8.2.1 Auto Avoiding Obstacles
      8.2.2 Voice Recording Function
8.2.3 Bigger robot
8.2.1 Costing and Commercialization

REFERENCE
APPENDICES
APPENDIX A
APPENDIX B
APPENDIX C
APPENDIX D
APPENDIX E
APPENDIX F
APPENDIX G
APPENDIX H
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Carrier Robot “CARREY”</td>
<td>4</td>
</tr>
<tr>
<td>2.2</td>
<td>Automated Food Attendance robot</td>
<td>6</td>
</tr>
<tr>
<td>2.3</td>
<td>PU Timing Belt</td>
<td>8</td>
</tr>
<tr>
<td>3.1</td>
<td>Methodology Flowchart</td>
<td>11</td>
</tr>
<tr>
<td>4.1</td>
<td>Power Window Motor</td>
<td>16</td>
</tr>
<tr>
<td>4.2</td>
<td>Lead Acid Batteries</td>
<td>17</td>
</tr>
<tr>
<td>4.3</td>
<td>PIC 16F877 Microcontroller</td>
<td>18</td>
</tr>
<tr>
<td>4.4</td>
<td>MD30A Motor Driver</td>
<td>19</td>
</tr>
<tr>
<td>4.5</td>
<td>Structure of Detection of White and Black</td>
<td>21</td>
</tr>
<tr>
<td>4.6</td>
<td>Single Line detection Circuits</td>
<td>21</td>
</tr>
<tr>
<td>4.7</td>
<td>Commonly Used Tray</td>
<td>22</td>
</tr>
<tr>
<td>4.8</td>
<td>Tray Holder</td>
<td>23</td>
</tr>
<tr>
<td>4.9</td>
<td>(a)Height Adjuster (b) Hole to Adjust Height of Robot</td>
<td>24</td>
</tr>
<tr>
<td>4.10</td>
<td>Sensor placement from front view</td>
<td>25</td>
</tr>
<tr>
<td>4.11</td>
<td>Sensors Arrangement</td>
<td>25</td>
</tr>
<tr>
<td>4.12</td>
<td>(a) Differential drive (b) Synchro drive (c) Car Type Drive</td>
<td>26</td>
</tr>
<tr>
<td>4.14</td>
<td>Side View of Full version of robot</td>
<td>27</td>
</tr>
<tr>
<td>6.1</td>
<td>Delivering Operation Flowchart</td>
<td>34</td>
</tr>
<tr>
<td>6.2</td>
<td>Going Back operation Flowchart</td>
<td>35</td>
</tr>
<tr>
<td>TABLE NO</td>
<td>TITLE</td>
<td>PAGE</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>2.1</td>
<td>Control Table of the Carrier Robot</td>
<td>5</td>
</tr>
<tr>
<td>4.1</td>
<td>Comparison of Three Types of Wheel Driving System</td>
<td>26</td>
</tr>
<tr>
<td>7.1</td>
<td>Truth Table of Motor</td>
<td>36</td>
</tr>
<tr>
<td>8.1</td>
<td>Costing</td>
<td>40</td>
</tr>
</tbody>
</table>
# LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Appendix A PIC 16F877 Datasheet</td>
<td>42</td>
</tr>
<tr>
<td>B</td>
<td>Appendix B Motor Driver Datasheet</td>
<td>46</td>
</tr>
<tr>
<td>C</td>
<td>Appendix C Phototransistor Datasheet</td>
<td>52</td>
</tr>
<tr>
<td>D</td>
<td>Appendix D LM324 Datasheet</td>
<td>55</td>
</tr>
<tr>
<td>E</td>
<td>Appendix E Full Circuit Diagram</td>
<td>59</td>
</tr>
<tr>
<td>F</td>
<td>Appendix F Robot Drawing</td>
<td>60</td>
</tr>
<tr>
<td>G</td>
<td>Appendix G ADC on PIC</td>
<td>64</td>
</tr>
<tr>
<td>H</td>
<td>Appendix H Full Program using PIC</td>
<td>70</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Background

There are various methods of determining the exact position of a robot within a place. Line follower robot is one of the methods. It is the self operating robot that follows a line that drawn on the floor. Automated food attendance robot is a line follower based robot. But in this project it is designed so that the robot can function as a food attendance robot. Below is the definition of each words used for this project:

(i) Automated means, use or introduction of automatic method or equipment in place of manual labor.

(ii) Food is referred to substance taken in to maintain life growth. The meals in this project including breakfast, lunch, tea hour, dinner and supper.

(iii) Attendance will be the persons used to deliver the meals to patients.

(iv) Robot means mechanical or virtual, artificial agent. It is usually an Electromechanical system which, by its appearance or movements, conveys a sense that it has intent or of its own. The word robot can refer to both physical and virtual software agents, but the latter are usually referred to as bots to differentiate.

Basically, the function of the robot is to carry a tray contains of patient’s food from kitchen to patient bed and come back to kitchen. The robot will deliver the food to
unable person at hospital and residents of the old folk’s home 5 times a day. It is including breakfast, lunch, tea hour, dinner and supper. The robot will follow the path as programmed in PIC microcontroller.

1.2 Problems Statement

Patient/old folk’s/disable people can’t move freely as healthier person and they need someone to serve their meal. For the time being, attendance or volunteer (helpers) in those places have doing this job. The problems occur when sometimes the helpers is not enough to do this job while attendance is doing their others job. To overcome this problem, I suggest to built the robot that can help both helpers and the patient/old folk’s/disable people doing this job since robot has took place a lot of man’s work for the past years.

1.3 Objectives

1.3.1 To design a robot that can carry the patient/disable/old folk’s meal at their place

One of the purposes of this project is to design a robot that can carry the patient/disable/old folk’s meal at their place. As stated before, this group of people can be label as disable where they need some external helps in doing their daily life works including serving their meals.
1.3.2 To control the robot by using PIC microcontroller due to path tracking

In order to make sure the robot is functioning, a controller to control the motor (tire) movement automatically is needed. As PIC is one of the latest technology that used to control the movement (by controlling the pulse width modulation (PWM) according to input of sensor), the decision to choose PIC microcontroller as a controller of the robot has been made. Due to a lot of pass by in both locations, path tracking is used where there is a line that connects from the place the kitchen to the patient/old folk’s. The line is also used to acknowledge people that it is the path for robot. So that people can aware their step when pass thru the line.

1.4 Scopes of project

The scopes of this project are:

(i) The attendance robot is using the line follower based concept that is redesign to be function as carrier robot.
(ii) The robot took place in hospital/old folk’s house
(iii) The robot can carry a tray at one time
(iv) The height of the robot is in range of 80cm-100cm
2.1 Carrier Robot “CARREY”

Carrey (Figure 2.1) is a carrier robot done by Keisuke Tomio, Hiroya Igarashi and Akira Harada. The carrier robot designed was based on three functions which are
detection of user’s contact, detect black line colour and carrying the object. The robot system has been design moves by detection of user’s contact with using primitive mechanism. The robot was installed with vibration sensor so that it knows user is putting something on the top if it. When the vibration sensor is activated, the robot will move to the desire place that has been guided by the black line. In the same time, the robot is carrying the things that have been put by the user. At the end of the line, the second user, which is the receiver will touch the robot again to stop it and take the things that robot has carried [1].

2.1.2 Robot Structure

Carrey robot has a dimension of 170mm height x 190mm width. It is using microcomputer H8S/2144 to control the movement and using C language as the development language. In order to perform the function of the robot, CARREY has been installed by two sensors to give input to the robot. The sensors are vibration sensor and colour detection sensor. The vibration sensor is used to detect user contact. When vibration sensor detects the user contact, it will give input to the microcomputer to start the robot. For colour detection sensor CARREY used three infrared LED as transmitter and three photo IC. Each LED and photo IC is installed to sense right, centre and left. To move the robot, two DC motor is used. Table 2.1 shows the control table of carrier robot:


2.1.3 Review

According to carrier robot, the robot is looking like similar to food attendance robot that I want to build in terms of the aim of the robot. Both robot is build to carrying the something. In my case, the thing is patient’s food tray. In Carrey robot, the things would be office equipment. The idea is there, but the design implementation is not suitable for food attendance robot. Firstly, Carrey robot is too small to be implemented as food attendance. The height is not too height so that it needs patients needs to come down from their bed to takes the meal. Despite, because of the height is not too tall, people will not notice the appearance of the robot that might cause incident, and the food fall down. Second thing is, the robot is using the vibration to start move and stop. In cases if there is something blocking their way, automatically it will stop and the food will not be transfer to the patients.
2.2 Automated Food Attendance Robot

Figure 2.2 Automated food attendance robot

2.2.1 Robot Operation

Figure 2.2 shows the automated food attendance robot, done by Norsinnira Zainul Azlan, Fadzilah Zainudin, Siti Farhanah Mohamad and Nazrah Abdul Aziz. This robot has been design to be as one of the service robot to deliver food to people who are unable to move. Once the button is pushed, the robot started to carry the manually loaded tray from the kitchen to patient bed. The robot traveled by following the guiding path. As the robot travel, the ultrasonic sensor that will detects if any obstacles that obstruct its navigation and the alarm will sound when it meets obstacle. After reaching at patient bed, the lifting mechanism will lift up the tray at patient bed height and the tray is pushed to the table. Then, it will continue to travel until it arrives at another bed and repeat the tray lifting and pushing process. For this prototype, the robot can carry two trays for a trip [2].
2.2.2 Robot Structure

The structure of the robot can be divided into three parts which are mobile platform, tray lifting mechanism and tray pushing mechanism. To ensure the mobile platform can support the entire load, the aluminum profile and plate is chosen for the construction of the robot. For robot motion, two DC motor with gearboxes is used to possess high torque in order to carry heavy load. As for brain of the robot, The Motorola MC68HC11 processor is used to control the robot to follow the line tracking. Two types of sensors are installed to the robot. One to sense the line, which is line following sensors (five sensors) while the other one is ultrasonic sensor that used to detect obstacle.

Tray lifting Mechanism is used to lift up the tray from the initial condition of the tray to the height of the patient bed. The tray holder is lift up by using PU timing belt as shown in Figure 2.3. In the other hand, tray pushing mechanism is install to make the robot can push the tray from tray holder to the patient bed or table. A rack and pinion driven by power window motor is used to accomplish this task. In this mechanism, the rotational motion of the motor is converted to the linear forward and backward motion of the tray.

![Figure 2.3 PU timing belt](image-url)
2.2.3 Review

According to explanation of the robot, it shows a complexity of the robot that makes the cost of the robot becomes high. In my opinion, some of the mechanism is not really necessary to include at the robot in order to reduce the cost. The terms that I referred to is the tray pushing and lifting mechanism. It is good to have those parts, but it is not the main important things to be included since it takes more than half of the total expenses for the lifting and pushing mechanism only. The another reason that it is not really necessary is, if we realized in hospital, the height of the bed or the table is varies. It depends on the situation of the patient. When the height is changed, it will effect the food in the tray is spilled, because it is not pushed at the same level. Thus, the height of the table or bed as the reference height can not been made, unless a sensor to sense the exact height of the table or bed at the current time is install. Third is, our mission to deliver the food might be accomplish. The problem is, the robot might deliver the food the bed where no patient is there because no measurement has been made to indicate there is a people or not.

As for automated food attendance robot, it just simple and more cost effective. Only a tray holder at the end of the robot to hold the tray and a limit switch is needed. The limit switch is connected at the tray holder. When the tray is still there, the load from tray will push the button and make the limit switch normally closed. Once patient takes the tray, the limit switch will be normally open. Until then only the robot will move to the next station.
CHAPTER 3

METHODOLOGY

3.1 Overview

In order to gain information for literature review to done this project, a lot of relevant and important information can be obtained via surfing the internet, browsing books and journals and also with the assistance from supervisor in charge and also person that have done similar project before.

Several methods need to be implemented in order to make sure this project success. Research is one of a good method as it can give some knowledge while doing this project. Through these researches, a lot of information gained.

During the first semester, the project is more on gaining information towards the project. This process is called as literature review and researches. It is continues with the robot, circuit, and program development in second semester. The methodology flowchart is shown as in Figure 3.1
3.1.1 Literature review and research

The project begins with the literature review. In this part, all the information related to the project is gained. Before beginning to search the material, first it is need to
understanding in details about the project so that the design of the robot can be drafted. Things that should be considered in this project are the place where the robot will took placed, who is the target for this project, the height of the patient bed and also weight of the meals. Rather than that, information regarding to PIC microcontroller is also needed. My referenced is based on the project that is similar to my project that has been fully succeeded. In general, this robot is line follower type robot that is redesign to be functioning as automated food attendance robot. As mention before, most of the information obtained is from internet and books source. Despite, some observation has been done to gain information related to the height of the patient bed and also weight of the meals of patient.

3.1.2 Robot body development

After obtaining the information in literature review section, the decision to start the project with the body development has been made. Before start the development, the design of the robot was sketched and the material that will be used to build the robot was estimated. The body development of this robot takes about three weeks. Most of the part of the body comes from used and damaged trolley bag. Than, it is redesign to becomes food attendance robot that follows the specification that I need.

3.1.3 Circuitry design and development

Next, after the development of the body design is finished, the project continues with the circuit design and development. The circuit design includes the circuit design for the sensor, the PIC microcontroller connection an also the motor driver connection. Circuit design starts from a single sensor to three sensors, than followed by PIC microcontroller connection and the motor driver connection. A step by step progress should be done for troubleshooting purpose. While designing those circuits, a lot of
research has been done. Basically those circuits are provided in the internet and books. Some adjustment must be done with the circuitry in order to make sure the objectives and scopes of this project are followed. After the circuit is functioning, the circuit is soldered on the strip board. When I face the problems regarding the circuit, I need to review back to know what is the caused of the problem.

3.1.4 Software development

The robot can not be functioning without the appearance of the program. PIC microcontroller is the brain of the system of the robot. Micro Code Studio program is used to write the program and to check error of the program while Melab Programmer is used to program the PIC 16F877. A step by step process should be done in order to make easier to troubleshoot the error. The first step is to make sure that the line detecting sensor is functioning. For this purpose, three LED is connected between the output of the sensor and input PIC that indicates which sensor is functioning, right, center, or left. Second step is to check the analog to digital (ADC) program is functioning. This can be done by making simple program for ADC. For my project, I used program to ON and OFF LED depends on which sensor is detecting the black line. The third step is to change the ON and OFF LED program into ON and OFF motor. This has been done part by part according to truth table. For example, when the right sensor sense the track, the left motor will rotate while right motor stop. This shows that the robot is turning to the right. After that, proceed to the other side of sensor. Once again, the literature review is review back when problem occur.

3.1.5 Combining hardware and software

The next stage is to combine the hardware and software. This process is the measurement to indicate the project is succeeded or not. Sometimes, when combining
the software and hardware, the robot can’t function as desired. The failure may come from hardware problems or the hardware itself. To overcome the problem, the cause of the problem possibility is guess and the problem is fixed by using ‘try and error’ method.

3.1.6 Documentation

All the work through out this project needs to be documented in the last step.
CHAPTER 4

HARDWARE DESIGN

In order to complete building the robot, there are a lot of robot parts that should be considered in designing the robot. The parts can be divided into some components which are:

4.1 Components

In this section, the details about the component decision will be discussed. The components that used in projects are motor, batteries, PIC microcontroller, motor driver, sensor and tray.

4.1.1 Motor

In general, there are three types of motors commonly used in robotic and related application. They are DC motor, stepper motor and servo motor.

DC motors are inexpensive, small and powerful motors that used widely. It needs gear train reduction to reduce the speed and increase the torque output of the motor. DC
motor also excellent in powering the drive wheels of a mobile robot as well as powering other mechanical assemblies.

Stepper motor in other hands is a motor that commonly used in linear performing mechanism. Usually it is used by the robotics. One of the applications is floppy and hard disk drive head motors.

The other type of commonly used motor is servo motor. A servo motors includes a built-in gear train and is capable of delivering high torques directly. Unlike DC motors and stepper motors, the servo motor has output shaft that does not rotate freely [3].

This robot needs a high torque motor. According types of commonly used motor in the market, the best motor to be used is servo motor. The common used of servo motor is the power window motor as in Figure 4.1. Despite that, the speed of the motor is not necessary for this motor since it is not used to participate in competition. If it is too fast, sometimes people can not avoid it and can make an accident between human and the robot.

![Figure 4.1 Power window motor](image_url)
4.1.2 Batteries (Power supply)

The most widely used of battery is rechargeable Lead Acid batteries as in Figure 4.2. It is because of easiness and inexpensive to manufacture. Even though it has been available since 1950s, it is still being used because of it is cheaper and available on the shelf. The serious problem of this kind of batteries it is large and heavy and need to always be kept charged.

![Lead acid batteries](image)

**Figure 4.2** Lead acid batteries

There are three main types of lead acid batteries in market. Namely wet cell (flooded) Gel Cell and Absorbed Glass Mat (AGM). The Gel Cell and the AGM battery is cost twice than wet cell. However, they store very well and do not tend to sulfate or degrade as easily or as easily as wet cell. The possibility of a hydrogen explosion or corrosion when using the batteries is very little. In most cases, it is believed that the AGM batteries will give greater life span and greater life cycle than a wet cell battery [4].

Despite the battery can deliver power to motor, most likely 12V to move power windows motor, the other important characteristic of the battery that I want to choose to suit my robot are:

(i) The battery must be cost wisely
(ii) The battery is rechargeable and less recharging time
(iii) The battery has greater life span
(iv) The battery can be used frequently in a day.

Based on characteristic above, I have chosen to select AGM battery is chosen to be the main supply to my robot. The Lead Acid Batteries problem, which is large and heavy, will give me an advantage. This is because the battery heaviness will give balance to the whole robot. By putting the battery at the back will balance the robot with the load of meals.

4.1.3 Controller (PIC microcontroller)

PIC is one of the micro controllers. PIC is used because it has its own language (high level language), name Pic Basic Pro Compiler that is simpler for the user to program it. The PIC microcontroller for this robot is PIC16F877, as shown in Figure 4.3.

![Figure 4.3 PIC 16f877 microcontroller](image)

The decision of this microcontroller is made because it has a feature to generate PWM. It is also have two ports for this feature. According to this feature, it suits my need where I want to control the PWM of two motors so that the robot can follow the path tracking. The datasheet of this PIC is attached in appendix A. Despite of PIC is more easy to used, it also quite cheap and easy to obtain than other micro controller like
Motorola 16HC 11 A that learnt in embedded micro controller subject that have a lot like a same features to PIC 16F877. The cost of one PIC 16F877 around RM 20 in other hand Motorola 16HC 11A is about RM 40. The data sheet of the PIC 16F877 as in appendix A

4.1.4 Driver

At first, IC motor driver which is L298 was selected to be the motor driver. It has 4 inputs to control the motion of the motors and two enable inputs which are used for switching the motors on and off. In application of PWM to the IC, the PWM with variable duty cycle can be connected to the enable pins. In designing this driver to the motor, the diodes is connected to prevent back EMF of the motors from disturbing the remaining circuit.

After a long research, L298 is founded not suitable for a power window motor since power window motor required higher amp than L298 can go. As shown in Figure 4.4, the driver used is specially designed for power window motor, MD30A driver. MD30A is designed to drive high ampere DC brush motor. It is a full bridge type motor driver intended for wide range of robotics and automotive applications.
With minimum interface, the board is ready to be plugged and play. The board also includes two push buttons for fast test run. The driver is ready to drive high current motor by just connecting the driver with supply. The specification of the motor driver is as below:

(i) Able to provide high current up to 30Amp.
(ii) Able to control heavy duty motor such as Power Window Motor, Power Wiper Motor or even Starter Motor.
(iii) Capable to control a motor in bi-directional.
(iv) Speed control can be accomplished by Pulse Width Modulator (PWM).
(v) Input voltage for motor is determined by users (12VDC, 24VDC, etc).
(vi) Easy to control by connect 5 lead wires (Gnd, PWM, CCW, CW, Vcc) to PIC controller.

The details according to MD30A can be referred as in appendix B.
### 4.1.5 Sensor

The most important part for my robot is the sensor. Without appearance of a robot, robot will not have any input. It will be just like a machine. Robot needs sensor to let them know what is happening in their world and be able to react with the changing situations [3].

In this part, the sensor used in for detecting line was considered. The cheapest choice of diode is to use standard red LED's as for light source. The LED used is white LED since it can give more light to the detector comparing to the other colour of LED. As for the receiver, phototransistor is used. Phototransistor that used is L14G1. Instead of using standard red LED's some said that, the use infra red light is better. Infra red gives some advantages is based on there isn't so much infra red light in sunlight as there is red light and that's why it's possible to make detectors with build in daylight filter. As its pair, the infrared detector is used. But, since the robot is used in door, the consideration of the sunlight can be ignored. So, it is not important to used infrared light to replace the LED.

How the sensor does works? At first, emit the white LED towards the floor. It will reflect almost all light if the floor is white in colour. As the result, the phototransistor will detect a strong signal comes from the reflection of the LED light mean while if the floor is black, it absorbs almost all the LED. In other words, the robot can distinguish between white and black line by detecting the strength of the reflected light signal which will given different value of voltage. Below is the structure of detection of white and black.
Figure 4.5 Structure of detection of white and black

Figure 4.6 Single line detection circuits

Figure 4.6 shows the single circuit of line detection sensor. At first, when I develop the circuit as in Figure 4.6, the difference voltage that should be when it detects line is not obtained. Since the white LED is emitting the light, prediction has been made that something wrong with phototransistor connection. So, I change the phototransistor is replaced with the LDR which only has two pins. As a result, reading of 0.73V when it detects black line while 0.24V to 0.4 V when it is white line was obtained. Since I got
the result, so I predict that the connection of the phototransistor is wrong. After the pin location of the phototransistor, the voltage reading is as expected. The circuit gives a 2-3.5 V when it detects black line depends on the distance between the light sensor and the line. As for white line, it gives a measurement of 0 - 0.14V. The details regarding to phototransistor and LM324 can be referred as in appendix C and D. For the full circuit drawing, see appendix E.

### 4.1.6 Tray

Figure 4.7 shows the tray that will be used to put the patient’s food. The tray that I selected is the design of the tray that always used in hospitals. Despite of it’s design is frequently used, the tray is also have enough space to hold the tray which is 2cm. This tray will be the reference in designing the width of the robot. The size of the tray is 12”x 16.5”.

![Commonly used tray](image)

**Figure 4.7** Commonly used tray
4.2 Robot body

In this part the tray handle, adjustment height, sensor placement and the full version of robot body will be describe.

4.2.1 Tray handle

Figure 4.8 shows the design for the tray handle. The handle of the handle is sprayed with red colour so that people will notice the appearance of the robot. It has a dimension of 24 cm x 42 cm. Basically, the size is measured according to the tray as in Figure 4.7. As we can see in Figure 4.8, the labeled 1 placed at the figure shows that it will support the side labeled as 1 in figure 4.7. The same things happen for labeled 2. By doing this design, the tray will be support by the tray handle and will not slip. A limit switch is installed at the tray handle to indicate the existence of tray.