# ROSTRUM SYSTEM FOR AUTOMATED HEIGHT ADJUSTMENT

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# ROSTRUM SYSTEM FOR AUTOMATED HEIGHT ADJUSTMENT

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A report submitted in partial fulfillment of the
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## SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

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Date : ____________________________________

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Position : ____________________________________

Date : ____________________________________

**STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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**To my beloved ammi and abbu**

**Hj Sabir Ahmad Bin Hj A. Badaruddin**
**Hjh Taiba Binti Hj Basir**

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# ABSTRACT

Rostrum is a very important part of any ceremony especially a formal ceremony. It is used to attract attention of the ceremony to the speaker. It is also used to instil confidence in first time speakers. The rostrum is an international item for ceremonies yet most of it has a fixed height. As it is known, the international citizens have a variable average height which means the rostrum cannot have a fixed height. This project concentrates on producing a rostrum system for automated height adjustment. The height adjustment allows the speaker to speak comfortably without having to hunch or tiptoe. The system is controlled by a single PIC microcontroller and the driver to rotate the motor in two directions is used to protect the PIC from current feedback. The mechanism used in the rostrum is the lead screw method where the lead screw is attached or welded onto the motor and connected to the rostrum. The rotation clockwise and counter clockwise makes the rostrum move upwards and downwards. The body of the rostrum is made of Poly Methyl Methacrylate Acrylic to make it look unique and attract attention of audience. This rostrum can be used in all situation and functions as it is unique and still fulfils the basic function of the rostrum.

**ABSTRAK**

*Rostrum* merupakan sebuah perabot atau alat yang sangat penting untuk menjayakan sebuah majlis, terutamanya majlis formal. Ianya digunakan untuk menarik perhatian orang ramai kepada speaker. Ia juga digunakan untuk memupuk sifat berani bercakap di khalayak ramai pada speaker-speaker muda. *Rostrum* merupakan sebuah alat yang digunakan secara global. Namun, ketinggian kebanyakan *rostrum* adalah tetap. Seperti yang diketahui umum, purata ketinggian manusia diserata dunia adalah jauh berbeza. Maka, *rostrum* yang hendak digunakan secara global tidak boleh mempunyai ketinggian yang tetap. Projek ini menekankan pada penghasilan sebuah sistem khas untuk *rostrum* yang ketinggiannya boleh diubah. *Rostrum* yang mempunyai kelebihan ketinggiannya boleh diubah dapat memudahkan speaker untuk menyampaikan syarahan atau ucapan dengan selesa tanpa perlu membongkok atau terjengket-jengket. Sistem ini dikawal oleh sebuah *PIC Microcontroller*. Sebuah cip *Driver* digunakan untuk membolehkan motor bergerak dua arah, dan untuk melindungi *PIC* dari tindakbalas arus. Mekanisma pergerakan yang digunakan untuk mengubah ketinggian *rostrum* ini adalah kaedah *lead skru* dimana sebatang besi yang berulir dikimpal pada sebuah motor dan ia disambung pada *rostrum*. Pusingan motor mengikut arah jam dan melawan arah jam membolehkan *rostrum* bergerak keatas dan kebawah. Keseluruhan *rostrum* dihasilkan menggunakan *acrylic* bagi tujuan kelihatan unik, dan untuk menarik perhatian orang ramai. *Rostrum* ini boleh digunakan untuk semua jenis majlis kerana walaupun ia kelihatan unik, namun ia masih memenuhi fungsi asas sebuah *rostrum*.

# TABLE OF CONTENTS

# LIST OF TABLES

## LIST OF FIGURES

## LIST OF SYMBOLS

| | |
|---|---|
| Ω | Ohm, Value of resistance |
| F | Farad, unit of capacitor |
| $\mu$ | Micro, 1 x $10^{-6}$ |
| $\pi$ | Pi, valued at 3.142 |
| $\omega$ | Omega, rotation per frequency |
| T | Torque |
| p | Pico, 1 x $10^{-12}$ |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| V | Voltage |
| cm | Centimeter |
| mm | Milimeter |
| PIC | Programmable Logic Circuit |
| A | Ampere |
| CAD | Computer Aided Design |
| CAM | Computer Aided Manufacturing |

# CHAPTER 1

# INTRODUCTION

## 1.1 Project Motivation

Rostrum according to the Merriam Webster online dictionary means an ancient Roman platform for public orators, a stage for public speaking, or a raised platform on a stage. It has been used by leaders, speakers to convey messages and to speak formally to a crowd. Up to today it is still used and continuously upgraded to keep up with the need of the market. Today, ministers, leaders of nations, political icons, celebrities, and even regular speakers uses rostrums for formal ceremonies such as meetings, award giving ceremonies, political campaigns, and others. In short, even though rostrum is always overlooked as something less than important, it is truly what the world need in the arena of public speaking.

Rostrum has mainly been used to instill confidence in the young children. This is by making them speak at the rostrum which gives them the confidence they need as the rostrum is a good support for new speakers. New speakers usually would have stage fright and would stumble while giving their speech. This can be overcome by using the rostrum to his or her advantage (Joanne Mikola, 2008).

Rostrum is also an effective way to give out information. People would listen to the speaker once the speaker is on the podium. It is a good way to attract attention to convey the message or information. Clearly, the study of rostrum, podium is needed to cope with the ever-growing demand of the market.

## 1.2 Project Background

The rostrum in the market today has many flaws that can be considered when doing research. The major problems or disadvantages in the current rostrum design are heavy and hard to transport, majority rostrum has a fixed height, manually adjustable height of microphone, no pointer on rostrum for presentation, majority rostrum does not have screen display for text/speech, microphone doesn't follow personal movement, there is no wheels on the lower part of rostrum for easy transportation, and the list goes on.

The first problem is the rostrum is heavy and hard to transport due to the rostrum having no wheels. Ordinary rostrums are normally made from oak, pine and wood of good quality. But the negative backlash here is that the rostrum becomes too heavy. So by being heavy and not having any wheels, it creates a problem for moving the rostrum. More man power will be needed to transport the rostrum.

Majority rostrum in the market doesn't have screen display that makes it easier for the speaker to speak without having to see his or her notes. Normally, speakers use cue cards to deliver speeches in a more organize manner. Sometimes the speaker can get lost in the cue card searching for his or her notes. This could create panic and increase stage fright in the speaker. This would ruin the speech. Rostrum with an screen display could solve the problem.

In the market currently majority rostrum does not have a pointer for presentation purposes. This creates a problem when an extra person is needed to navigate the slides. This is an important feature as it can be used for multiple presentations even for paper presentation at a technical conference.

The microphone normally is adjusted manually and it is an extra task for the master of ceremony to manually adjust the rostrum after each speaker. There is also the problem when the speaker moves from side to side but the microphone stays constant. No feedback happens causes the microphone to be constant. This causes the voice projection of the speaker to be disturbed which limits the movement of the speaker.

The last problem highlighted in this part is concerning the height factor of speakers. Current designs of rostrum are fixed for one height and this creates a problem for speakers who are either too small or too big for the rostrum.

### 1.3 Project Problem Statement

This project is to solve the height problem as explained earlier. Current design of rostrum in the market shows that the rostrum has a fixed size (based on regular human height) and if it can be adjustable, it will still need manual adjustments or trained personal for the automated adjustment. This is a problem for the master of ceremony as he or she has to adjust it for the speaker if the speaker is not familiar with it. It creates the need of an extra man power.

The rostrum in the market currently has one major problem. The master of ceremony needs to adjust the size of the rostrum every time the speaker changes. This is due to the design in the market is very new and majority of the people doesn’t know how to operate the rostrum (if it is the adjustable type). Even if the rostrum uses pneumatics, the master of ceremony still has to adjust the height every time the speaker changes. Even if this design solves the problem for the permanent height of the rostrum, it creates a new kind of problem, additional man power.

The current designs in the market, either the fixed sized rostrum or the adjustable rostrum have not yet completely solve the problem of variable height of speakers successfully.

## 1.4 Project Objectives

The project objectives are:

a) Design the rostrum with an automatic system using sensors.
b) Assemble the electronic part of the rostrum.
c) Build the mechanical part of the rostrum. (including the rostrum outer surface)
d) Link between the electronic device and mechanical system using software and coding.
e) Assembly the project.

## 1.5 Project Scopes

The project scopes of this project are:

a) The development of the rostrum is still at a prototype level and is still a new type of product in the automated rostrum field.
b) The rostrum is to be controlled via sensor.
c) This design is only suitable for average sized human from around the world. It is not suitable for abnormality in height.
d) This is the first step in the evolution, many other features can be added on in later research such as remote controlled for the automated system.
e) These problems are not considered in this project:
    - The rostrum is heavy and hard to transport due to having no wheels.
    - The rostrum has no pointer for presentation.
    - The rostrum has no chiller or heater.
    - There is no screen display on the rostrum.
    - The microphone doesn’t follow personal movement.
    - The rostrum has no automatic adjustable microphone.
    - The optimization of the motor speed of the automated system.

## 1.6 Project Report Organization

The rest of the report is organized as follows:

a) Chapter 2: Literature Review and Background Knowledge

- Understanding the design of former rostrum in the market. This includes the adjustable and non adjustable rostrum, the system used, the mechanism, and others.
- Compare design and understand the weakness and strength of current design of rostrum in the market.

b) Chapter 3: Design and Methodology

- Design the rostrum using SolidWorks and find the best design to suit the need to be automated.
- Understand and manipulate the electronic circuit for the system.
- The design is shown with explanation on why this design is the optimum design.
- All data are collected and development process of the design is started followed by the assembly.

c) Chapter 4: Result

- The rostrum is tested under different set of height.
- The result of the test is presented.

d) Chapter 5: Project Conclusion

- Project conclusion and the recommendation for future works are presented.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

In this chapter, there will be explanation on the definition of rostrum, the types of rostrums currently in the market, functions of current design of rostrum, and problem of rostrums.

## 2.2 Definition of Rostrum

Rostrum is an essential part of formal meeting, public speeches, talks, and ceremonies (The Flower Expert, 2008). It is know with few names such as podium, lectern, or special religious rostrum such as minbar, bimah, and bema (Merriam-Webster, 2008). According to the Merriam Webster Online Dictionary, rostrum is defined as a platform for speakers in the Roman Forum decorated with the beaks of captured ships, an ancient Roman platform for public orators, a stage for public speaking, and a raised platform on a stage.

## 2.3 Function of Rostrum

Rostrum is a platform on which people stand to deliver speeches. It is not a must to use podiums but most formal ceremonies would opt to use rostrum. It is used as a place for the speaker to stand and give his or her speech. Some speaker uses the podium to place notes or cue cards for the speech. This helps them to organize what they plan to say better. The rostrum can also be used to ease stage fright.

## 2.4 Types of Rostrums

There are 2 major types of rostrum in the market. The first one is fixed height rostrum and the second one is adjustable rostrum.

### 2.4.1 Fixed Rostrums

The fixed type of rostrum is the one regularly found today. It is made with one fixed size. It is regularly made with wood and some are also made from metal and see through acrylic. The price ranges from RM 1000 to as high to RM 13000 for custom made rostrum (Drumshields, 2008).

- **Wood Based**

**Figure 2.1** Wood base rostrums
[Taken from ewlBiz, 2008 (the right picture),
RJ Fine WoodWorking, 2008 (the left picture)]

This is the most commonly found rostrum in the market. It has been made using all type off wood such as pine, oak, mahogany and maple. This is cheaper compared to the other type of rostrums. This kind of rostrums comes in many sizes as can be observed in public halls.

- **Metal Based**


**Figure 2.2** Metal based rostrum
[Taken from ewlBiz, 2008]

This is another type of fixed rostrum. It is made normally using light metal such as aluminum, alloys, and other light metals. The usage of this type of rostrum is starting to grow. The number of metal based rostrums is increasing. Some of the design has a surface finish that looks exactly like a wooden based podium.

- **Acrylic Based**


**Figure 2.3** Acrylic based rostrum
[Taken from Drumshields, 2008]

This is one of the newest types of material used in making rostrums. It is light weight and looks beautiful as it is see through. It comes in all shapes as can be observed from the picture. One of the designs which are not stated above is the v shaped stand for the podium.

### 2.4.2 Adjustable Rostrum

The other type of rostrum currently found in the market is the adjustable type. This kind of rostrum is fabricated with a wider range of targeted users. This type of rostrum, even though it is new, can be found in few types.

- **Manually Adjustable Rostrum**

**Figure 2.4** Manually adjustable rostrum

[Taken from Ratstands, 2008]

Manually adjustable rostrums are the pioneer design among the adjustable rostrums. It can be adjusted manually by rotating the knob or by changing the location of the pin. The maximum and minimum height of the rostrum is the measure of the capability of the rostrum. This particular rostrum is used by orchestra to place their notes.

- **Automatic Adjustable Rostrum**

Automatic rostrum means a rostrum which is adjusted either using switches, by hydraulic pumps, or other means of mechanism. This type of rostrum is the newest type in the market. It is a new genre in the design of rostrum and it is still at its infant step.

- **Adjustable Using Switch**


**Figure 2.5** Adjustable rostrum using switch
[Taken from Nomadonline, 2008]

This is the automated rostrum which has the capability to change height according to the user need as it is control by a switch on the rostrum. It is one of the leading automated rostrum designs in the market today. This is because it has an all in one system which is simply controlled by one touch screen. It can be adjusted according to height and even suit children and a handicapped person on wheel chair.

- **Adjustable Using Hydraulic Pump**

This is another automated rostrum. The height of the rostrum is controlled by a leg paddle connected to a hydraulic pump. It is currently used for concert where the rostrum moves upward carrying the artist.

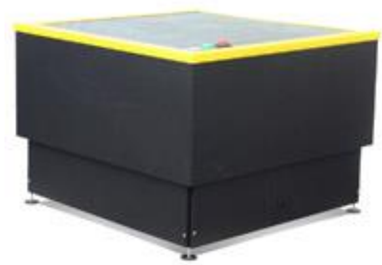

**Figure 2.6** Adjustable rostrum using hydraulic pump
[Taken from Ratstands, 2008]

## 2.5 Problem in Current Design of Rostrum

### 2.5.1 Fixed Height

There are few major flaws in the current design of automated rostrum designs and one of it is fixed height. From the first part of this chapter, it is rather clear that rostrum is used as platform to deliver a speech, give a comment, and commemorate the fallen soldier at war and many more. As the rostrum is being used for many purposes and it is used all around the world (Wikipedia, 2008), an adjustable rostrum should be made. This is because the height of men and women around the world differ a lot between one another especially for those from different origin, background, and even climate from the place they originated. This can be seen in the next sub chapter.

There are few adjustable rostrums currently in the market but it has other flaws. One of the designs is the manual adjustable rostrum. This is a great start to settle the fixed height problem. Then, the automated adjustable rostrum was manufactured. It is better as it can be adjusted using either a switch or paddle. Both of these designs have one thing in common, it solves the problem and creates one new problem. Both these rostrums need an additional person to come and help the speaker on stage to adjust the height of the rostrum. Even though the automated adjustable rostrum can be moved using a switch or paddle, not all people know how to operate the product.

- **Height Analysis of People from Around the World**

The people from all around the world have different average size (Wikipedia, 2008). This can be observed while comparing an Asian country to a European country. Having such a prominent difference, it is not suitable, not ergonomic for user from all races in the world to use the same fixed rostrum. This is because if the rostrum is too low, it creates back pain to the user while if it is too high it develops muscle pain in the neck. Both situations should be avoided as it disturbs the flow of the speech or agenda. It also creates muscle disorders to the speaker such as faced by typist due to non ergonomic working station. (Mirjana Aranđelović et. al, 2005)

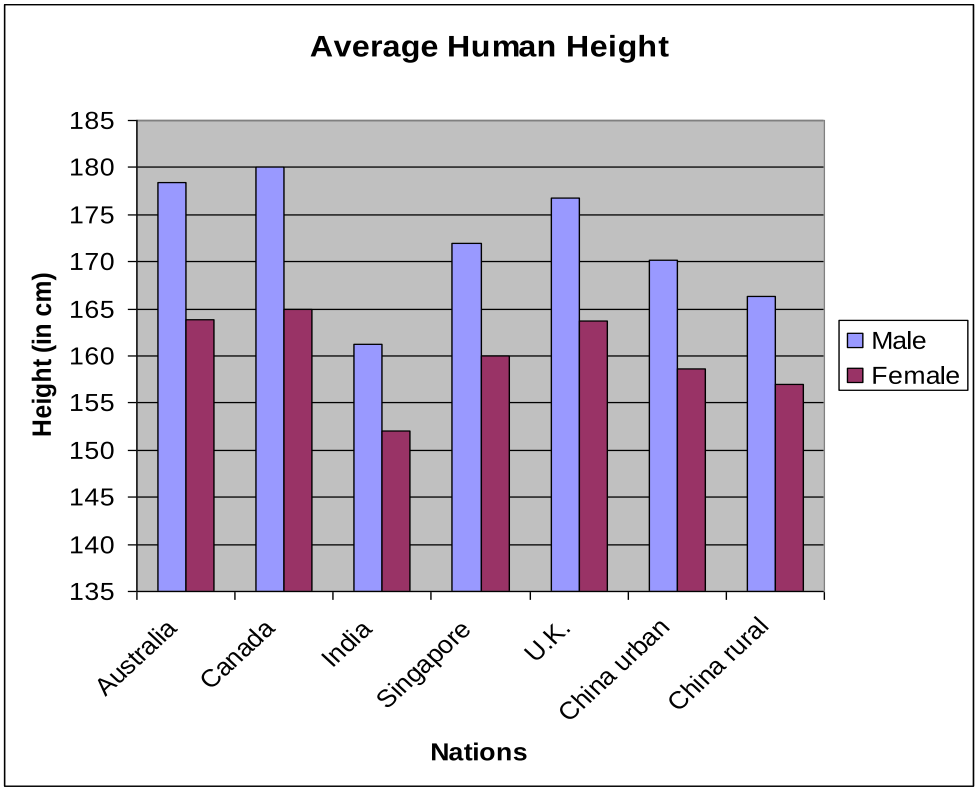


**Figure 2.7** Data for average height of citizens in major countries in the world

The data above is translated from the table that can be found in the appendices. The data compiled from various sources by Wikipedia shows the average height of men n women in a number of countries. As Malaysia is not stated in the research, Singapore is taken as reference (because of Malaysians and Singaporeans live in the same climate area and most of the races found in this two nations are from almost the same). The graph shows the average height of people in their 20's and 30's. The graph shows a clear gap between the height of averaged Asians and Europeans. Through the set of data in the appendices, it clearly show the difference between the smallest averaged sized women (Philippines) and the biggest averaged sized women (Croatia) is 18 centimeters and for men is 27 centimeters. This is the prove that fixed rostrum is not suitable for international market as the gap of height is far too big. Adjustable rostrum is needed. Automatic rostrum is needed to reduce the man power needed to adjust the rostrum.

### 2.5.2 Fixed Microphone with No Feed Back

Rostrum nowadays has static microphone. If the person sways to the right or to the left (normally, for presentation purposes), the speech or presentation is disturbed as the voice projection is cut off. The microphone can be adjusted manually to move either left or right, higher or lower. This creates another problem which is an extra person is needed to adjust the microphone every time the speaker changes his or her posture.

**Figure 2.8** Fixed microphones
[Taken form Apianotuner, 2008]

There are a few designs in the market that could ease this problem. It is the model like the one in the picture. The speaker can hold it and speak in it and can move around with it. The only problem viable is that the speaker needs to hold the microphone. This decreases the freedom of the speaker to move his hands and express his feeling into delivering a great speech.

### 2.5.3 Heavy and Hard To Move

Rostrums made from wood or metal are normally heavy. This is due to the density of each material. Rostrums need to be light or at least easily movable via either tires, chain or other rotary system. This is because the rostrum needs to be movable as many rostrums is moved to a place during ceremonies and kept in store on other days.


**Figure 2.9** Heavy rostrums and hard to move
[Taken from ewlBiz, 2008]

It is a great big hassle to move a rostrum as rostrum made from wood (mahogany, etc) is relatively heavy. It is a problem as many people are needed to transfer the rostrum from one place to another.

### 2.5.4 No Pointer on Rostrum for Presentation

Most rostrums in the market today does not have pointer on the rostrum to help smoothen the presentation. There are no arrows or pointers to move from slide to slide or to highlight any feature of importance in the slide. This reduces the efficiency of the presentation.

There are few presentation rostrums in the market. This type of rostrum is rarely found but it is a growing industry. One of it is the PD1100 Multimedia Podium. It has multiple other functions but the main attraction is the on screen pointer. This podium can be used to roll to the next slide or the one before during presentations and can also be used to highlight keywords or others on the slide. As modern as the design, one particular flaw which is the presentation slides and others is controlled using a touch screen. This is a flaw as the screen is sensitive and if not taken care well it will need maintenance every few short months (http://www.internettablettalk.com/forums). Public or speakers who are not familiar with the system have a high possibility of over pressing the screen. This could be disastrous as continuous maintenance has to be done. Thus, increasing the long term cost of this product.

**Figure 2.10** No Pointer on Rostrum for Presentation

[Taken from Nomadonline, 2008]

## 2.6 Conclusion

Throughout this literature review, clear definitions of rostrum, function of rostrums and types of rostrum have been clearly defined. The main reason of the need for an automated rostrum has been stated according to various sources even with the current automated rostrums in the market which still unable to completely fix the problem of various heights of the speakers.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

The methodology is the section which is a continuity from chapter 2, literature review. Methodology explains how, in detail, the project is made and tested. In order for the rostrum to be fully ready, many steps are taken which involves the fabrication process using the laser cutting machine (PC_NC), and the fabrication of the control system which controls the whole movement of the rostrum. This chapter also explains the designing stages and the finalized design and reason behind the decision. The mechanism used in this automated rostrum is selected from few types of mechanism and each are explained in this chapter. All design needs to take into consideration the cost of each material and the whole process.

## 3.2 Design Concept

This automated rostrum as it is a new type, new design is needed. As it is to be used as a stage to speak or perform in front of people, the design has to fulfill its function. This rostrum is to be able to attract attention yet still fulfill its function as an automated rostrum to cater for user from almost all height. This means the inner system which includes the mechanism to increase and decrease the height, and the system which controls the whole movement and sensor are to be compatible with the attractive design. The design is also needs to be unique to signify the difference from all other regular rostrums.

### 3.2.1 Selected Design Concept

The selected design concept for the automated rostrum is the system has three main control points which control the adjustable rostrum. These three points detect three important changes in the system. The first detects the absence or presence of a speaker which triggers the motor (DC motor) to move and this causes the rostrum to move upward. The second point detects the height to instruct the motor to stop at the right height. After the person leaves, the first point instructs the motor to move in the opposite direction which causes the rostrum to retract. The third point stops the motor when it reaches the minimum point for the rostrum to retract. The three points are connected to a microcontroller which acts as the brain of the whole system. Detail description of each part is explained later on in this chapter.

The Figure 3.1 shows the objective tree diagram for the development of an automated rostrum. As stated in the section before this, there are three main characteristics needed in this automated rostrum and they are

- Functionality
- Safety
- Efficiency

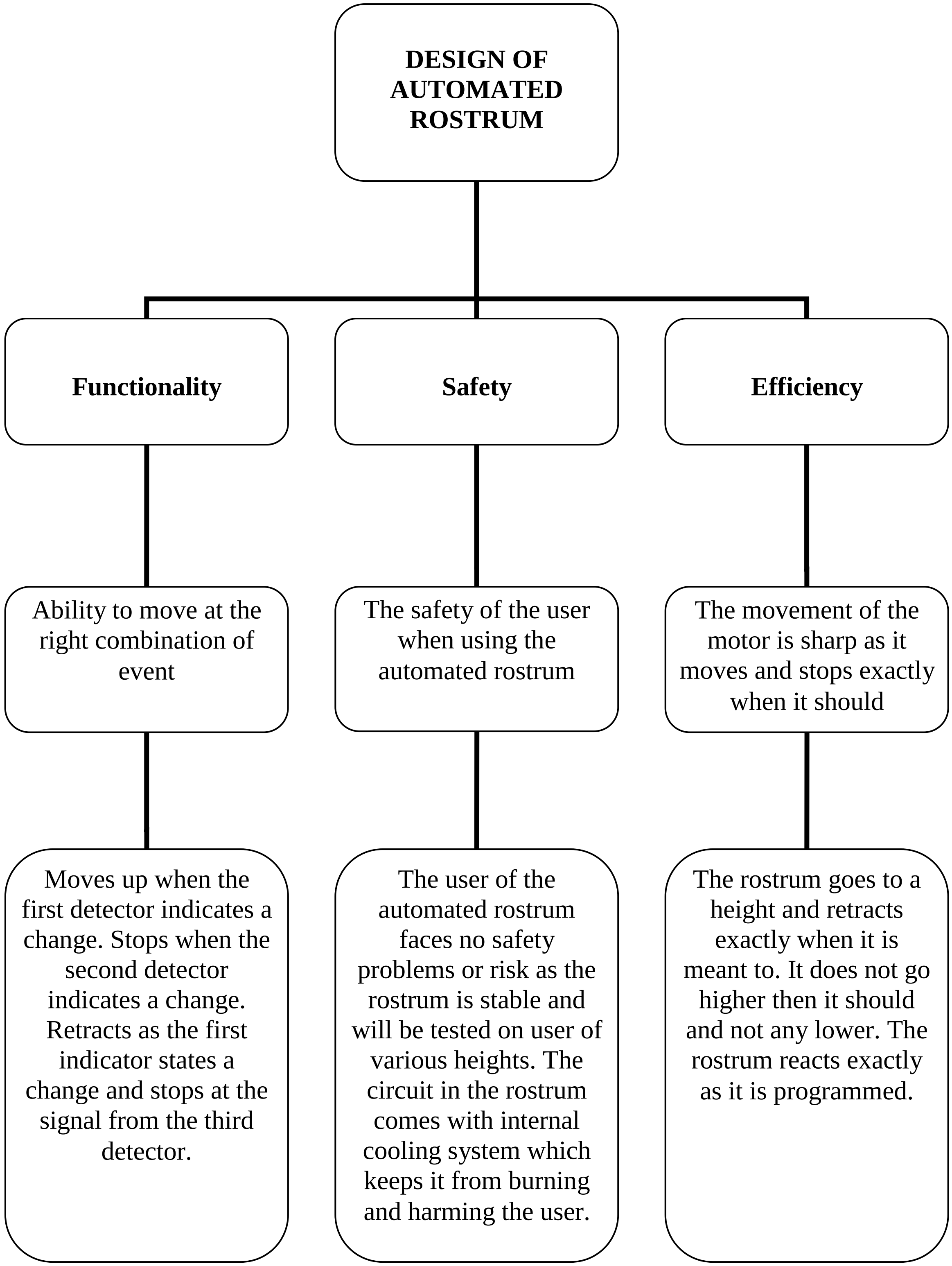


**Figure 3.1** Objective tree diagram for the development of an automated rostrum

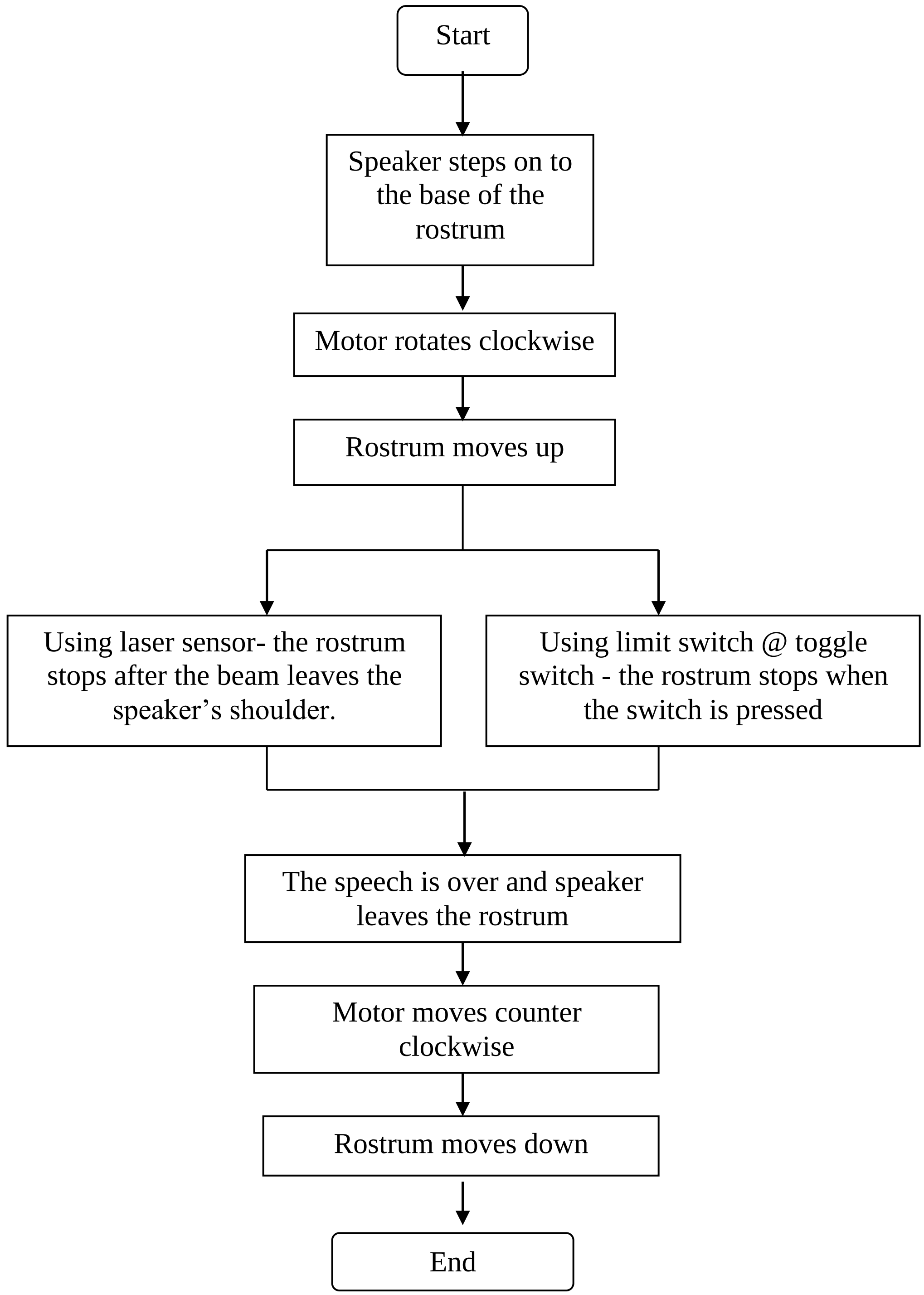


**Figure 3.2** Program flow diagram for the development of an automated rostrum

## 3.3 CAD Idea Modeling Stage

This part show the few designs made from the beginning until the last desired design was chosen. The following designs are created using the SolidWorks 2007. In this section, many considerations are made such as type of motor to be used, basic designs, and mechanism to be used, etc. In making a rostrum, the most important things are the design and functionality of the rostrum. The design depicts the creativity of the designer and prestige of the company owning it.

### 3.3.1 Design 1

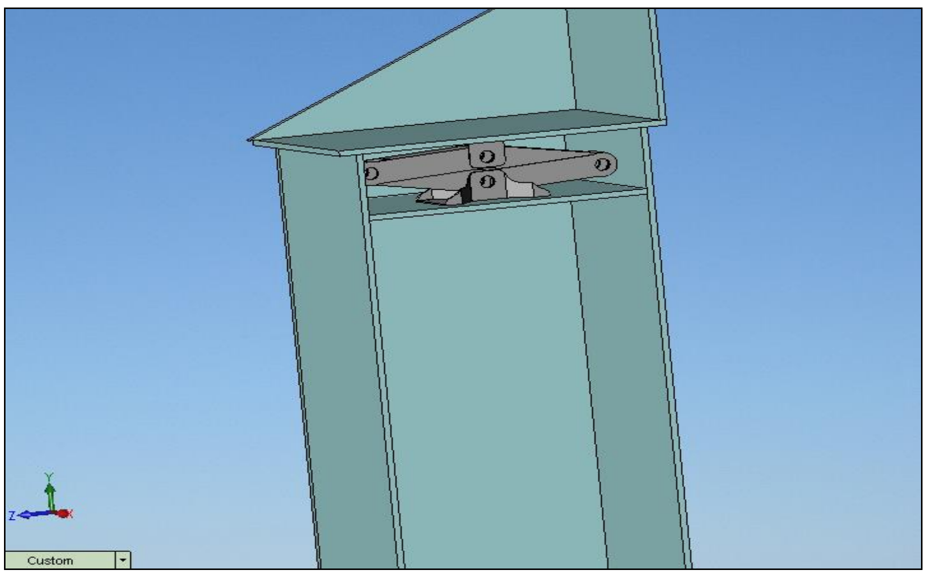


**Figure 3.3** Design 1

The picture shows a cut section view of the rostrum. The mechanism shown is a scissors mechanism using a manual car jack. Using this design would save material tremendously but the design is neither attractive nor unique and when it extends, the car jack can be seen and it is not a nice sight (car jack needs to be oiled to keep it working at its optimum condition).

### 3.3.2 Design 2

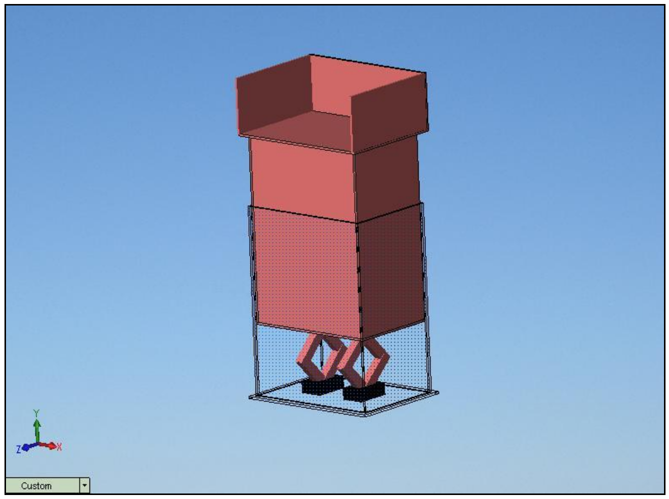

**Figure 3.4** Design 2

In the picture above the car jack is placed at the bottom of the adjustable part. The semi transparent part is fixed and remains the same in both designs. Using this design, the car jack can hardly been seen as it is at the bottom but the material used has doubled. Yet the design is very common.

### 3.3.3 Design 3

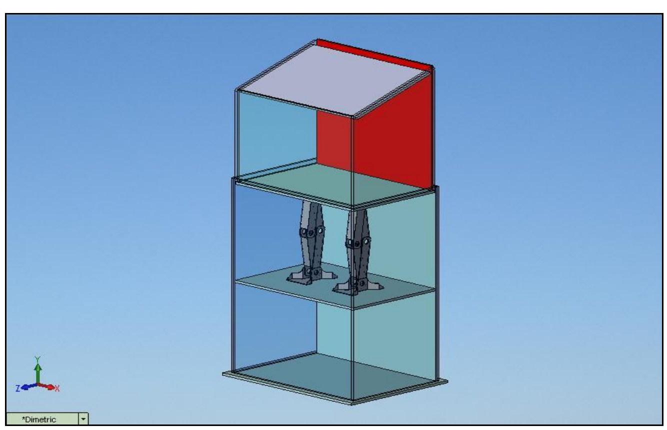

**Figure 3.5** Design 3

This picture is an upgrade from the first and second design. The car jack is placed at the middle of the rostrum. The semi transparent lower part is fixed and remains the same in this design. Using this design, the car jack can hardly been seen as it is in the middle and the material used is in an acceptable amount. The problem is it is not attractive and due to the fact the material used is polyethylene Meta acrylic, the car jack can still be seen. Beside that, the car jack needs to undergo maintenance regularly (oiled).

### 3.3.4 Design 4

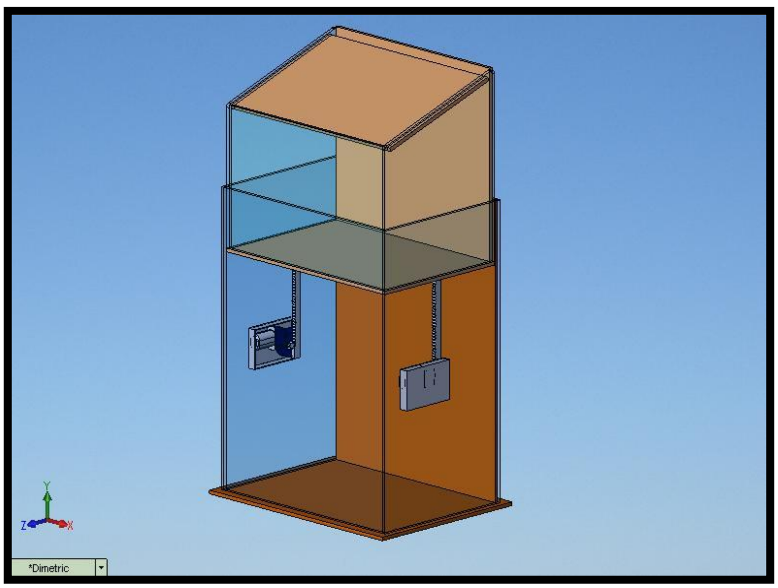


**Figure 3.6** Design 4

The picture above is an upgrade from the third design. The car jack is replaced by a mechanism called rack and pinion and the pinion is run by a dc motor placed at the middle of the rostrum. The semi transparent part is fixed and remains the same in this design. Using this design, the rack and pinion is a system that does the job and still can hardly be seen as it is located just at both corners. The only problem is it is still not so attractive.

### 3.3.5 Design 5

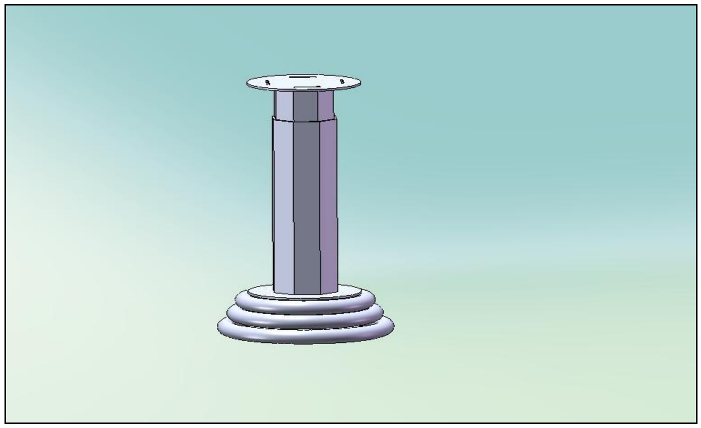

**Figure 3.7** Design 5

The picture shows a combination of two materials to for a futuristic automated rostrum. The curves at the bottom of the rostrum are made of galvanized pipes while the other parts are made from acrylic. This design is trendy and uses the same system and mechanism with design 4. The only flaw is that assembly between acrylic and galvanized still is not very viable.

### 3.3.6 Design 6

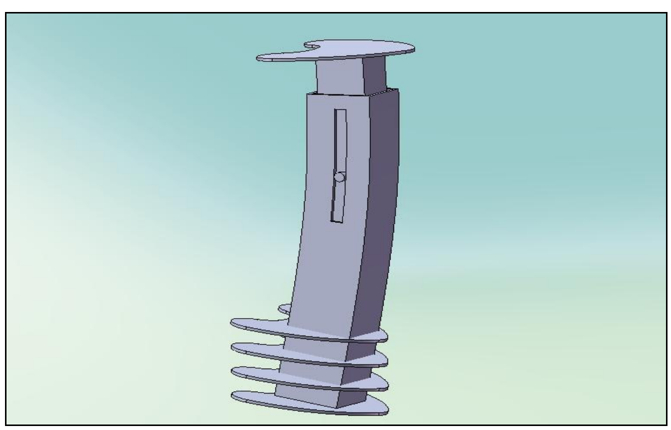

**Figure 3.8** Design 6

This is the last design and sums up to a total of six preliminary designs. This design is fully made from acrylic and uses the same mechanism with design no 4. Between this design and design no 5, this is more attractive due to the fact that it is fully see through. And the design is up to date.

## 3.4 Mechanism Design

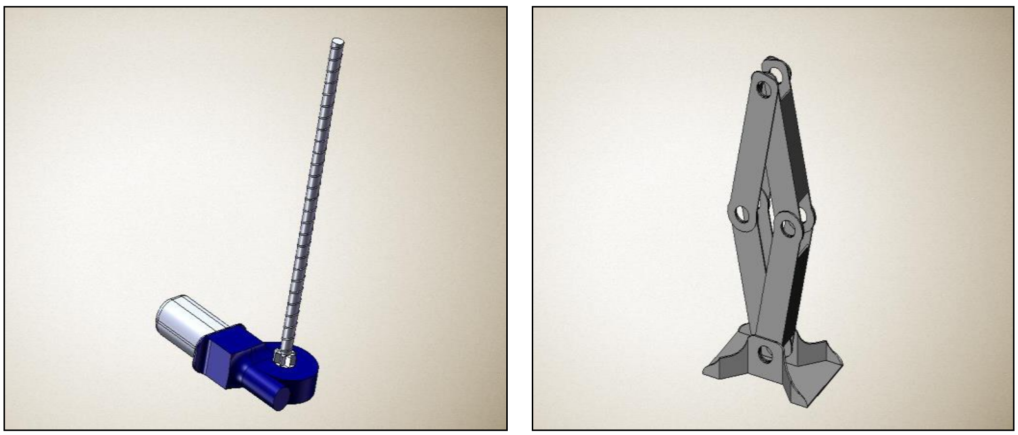

**Figure 3.9** Mechanism design

The mechanism used for this project is selected from a group of few types of mechanism. There are three major types of mechanism consider in this project. The first mechanism is the scissors mechanism. This mechanism is applied by using the car jack like the second picture above. This mechanism is safe but slow and a little dirty as it needs to be oiled at the joins. The second mechanism uses the rack and pinion in which the pinion is the power window and the rack is made using the Meta acrylic which is rather brittle and does not suit to be a critical component. Lastly the screw mechanism which is used in this project is a better mechanism even though it is a lot slower that the other two but it is smooth and the torque is higher as it is directly welded on to the power window motor.

### 3.5 Flowchart of Fabrication Process

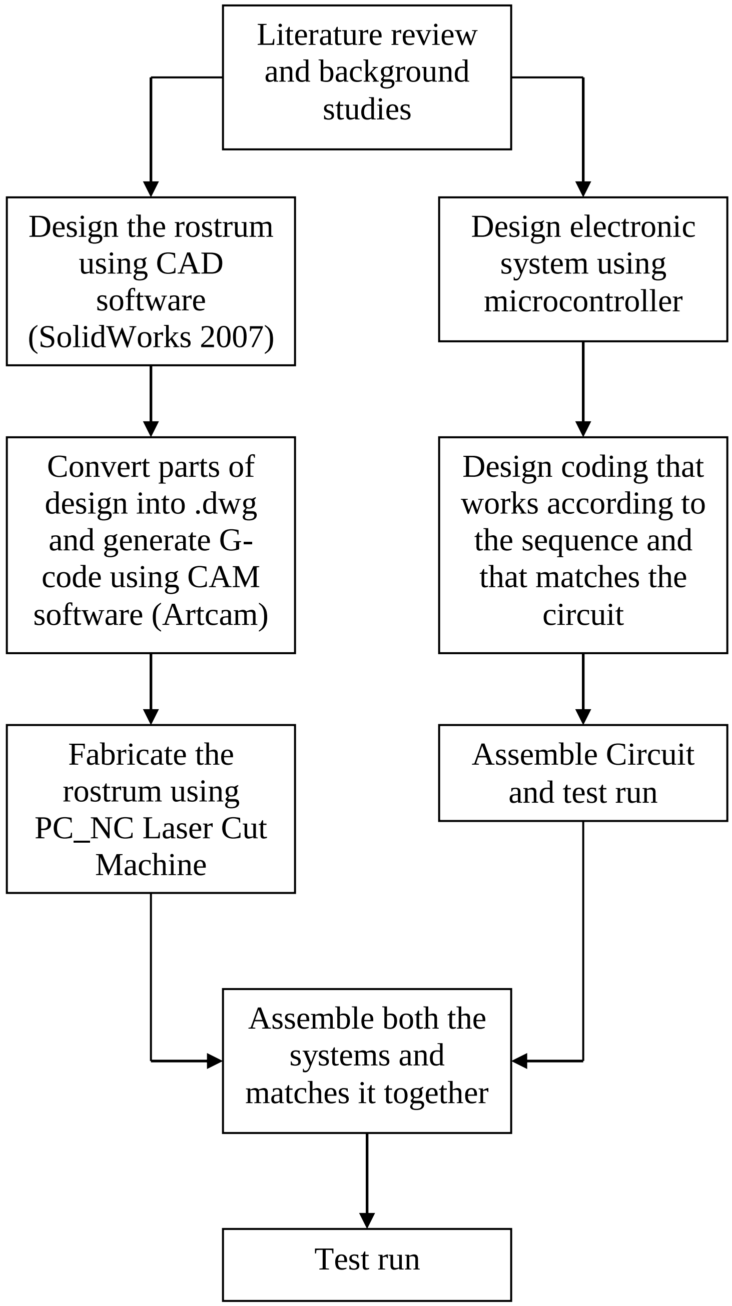


**Figure 3.10** Process of creating the automated rostrum

## 3.6 CAD CAM

In this project the software SolidWorks 2007 is used as a designing tool, CAM software is used to that generate the G-code for the machining. SolidWorks is a common tool that has been started to be widely used in the Malaysian industry. It has a very user friendly interface. CAM software in the market is almost as easy to use as the SolidWorks.

The CAM is Computer Aided Manufacturing which changes our engineering design into a set of coordinate which are called the g-code which is the instruction for any matching machine to process any work piece according to the setting in the software to produce the wanted design. The following is an example of a part of the G-code.

```
RAPID  X0.000 Y0.000 Z2.000 TOOL# 0
RAPID  X385.024 Y137.245 Z2.000
LINE   Z0.000 FEED 120.0
LINE  Y342.245  FEED 384.0
LINE  X173.024
LINE   Y137.245
LINE  X385.024
RAPID    Z2.000
RAPID  X30.131 Y20.294
LINE   Z0.000 FEED 120.0
LINE X30.256 Y20.032  FEED 384.0
LINE  X30.383 Y19.771
LINE  X30.514 Y19.509
LINE  X30.648 Y19.248
LINE  X30.785 Y18.986
LINE  X30.926 Y18.724
LINE  X31.070 Y18.462
LINE  X31.217 Y18.201
LINE  X31.368 Y17.939
LINE  X31.522 Y17.678
LINE  X31.680 Y17.417
LINE  X31.841 Y17.156
LINE  X32.005 Y16.896
LINE  X32.173 Y16.636
```

**Figure 3.11** G-code

The code above is the direction for the manufacturing process. Rapid here means the coordinate that follows the word Rapid is the coordinate at which the machining will not be done and it will move faster that the cutting speed. The rapid function is to cut time in movement of tool from one step to the next. Line means the coordinate at which the process is done.

## 3.7 Electronic Components Assembly Diagram

The components used in this automated rostrum are PIC16F877A, capacitor 2pF and 1µF, oscillator 20 MHz, power regulator L7805, driver L298, and resistor 470Ω. The main part of the project is the PIC which acts as the brain of the whole system. The components are assembled as follows.

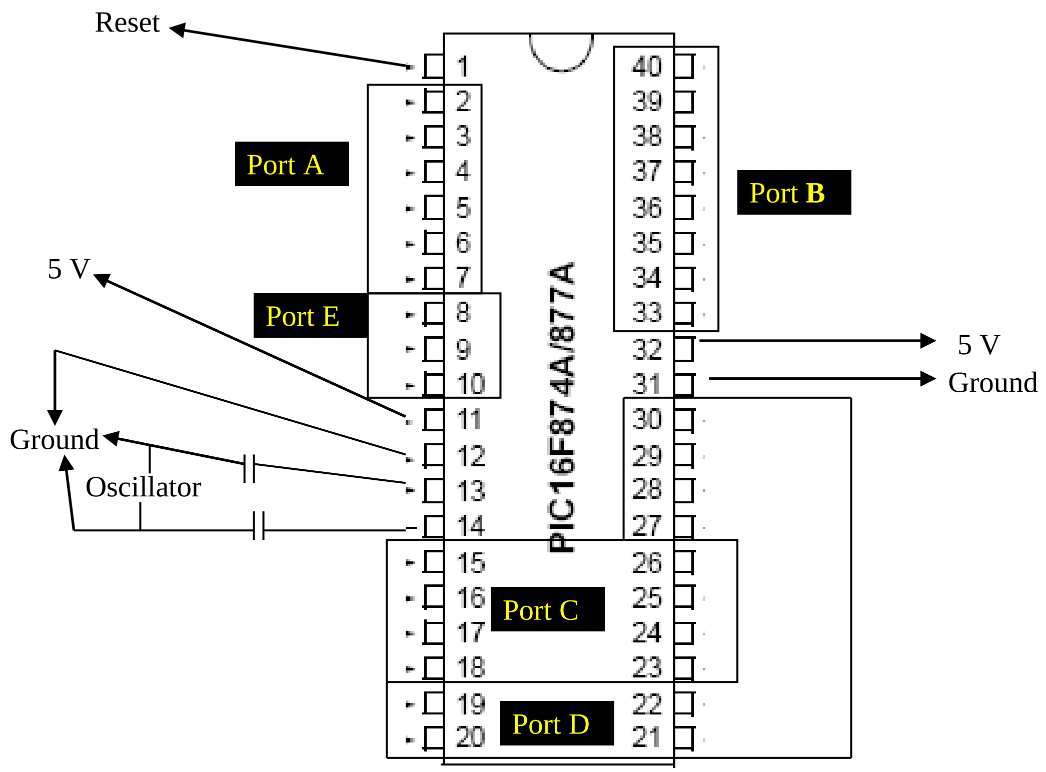


**Figure 3.12** Electronic component assemblies

The capacitors in this diagram are used as tanks to keep charges for the system to be stable in case of in stable power source. The oscillator or better known as crystal is used to make the electric wave to fluctuate in a constant pattern so that the power supply is more stable. The resistors are placed in the connection between the PIC and the L298 driver. This is to make sure if current feedback happens, the PIC is not going to be burned. Limit switches are attached at B5, B6, and B7 which will trigger the sequence.

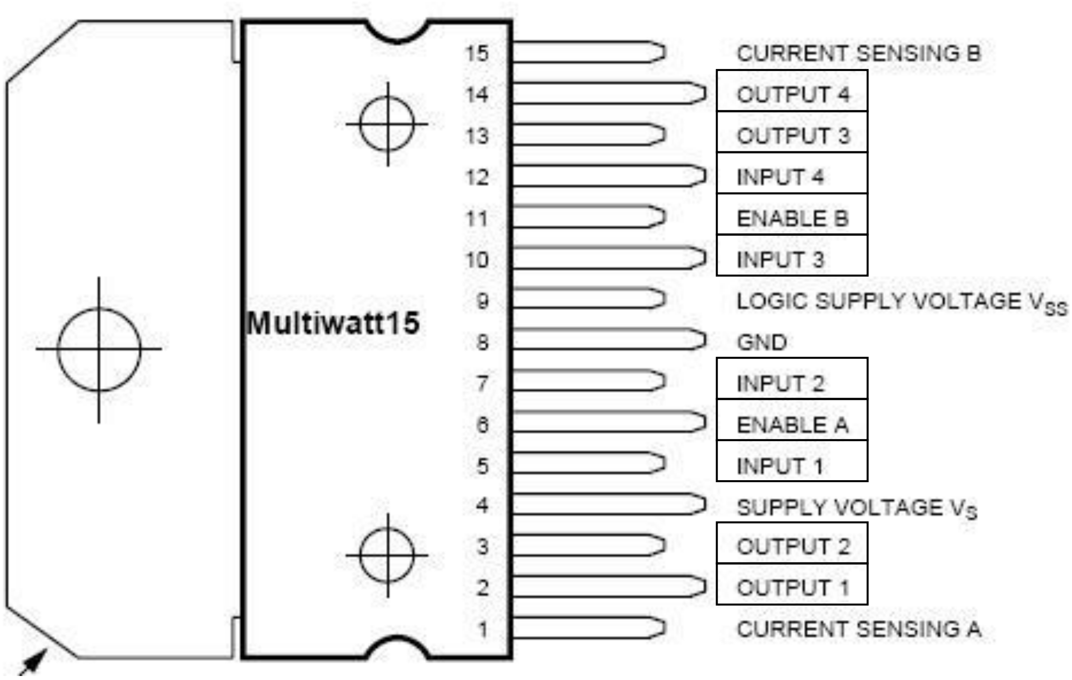


**Figure 3.13** Driver L298

The figure above is the driver L298 which acts as a control unit for the input from the PIC and drives the motor in two directions. This means this driver can rotate the motor clockwise and anti clockwise. This driver is attached to the PIC through the 4 inputs (Input 1, 2, 3, 4) and the 2 enable (which enables or acts as on/off switch for the driver). The large metal surface at the back is used to be attached to a fin or fan as it is used to supply out the heat released by the driver.

**Table 3.1** The connection between the PIC16F877A and the driver L298

| | |
|---|---|
| C1 | Input 1 |
| C2 | Input 2 |
| C3 | Enable B |
| C4 | Input 4 |
| C5 | Input 3 |
| C6 | Enable A |

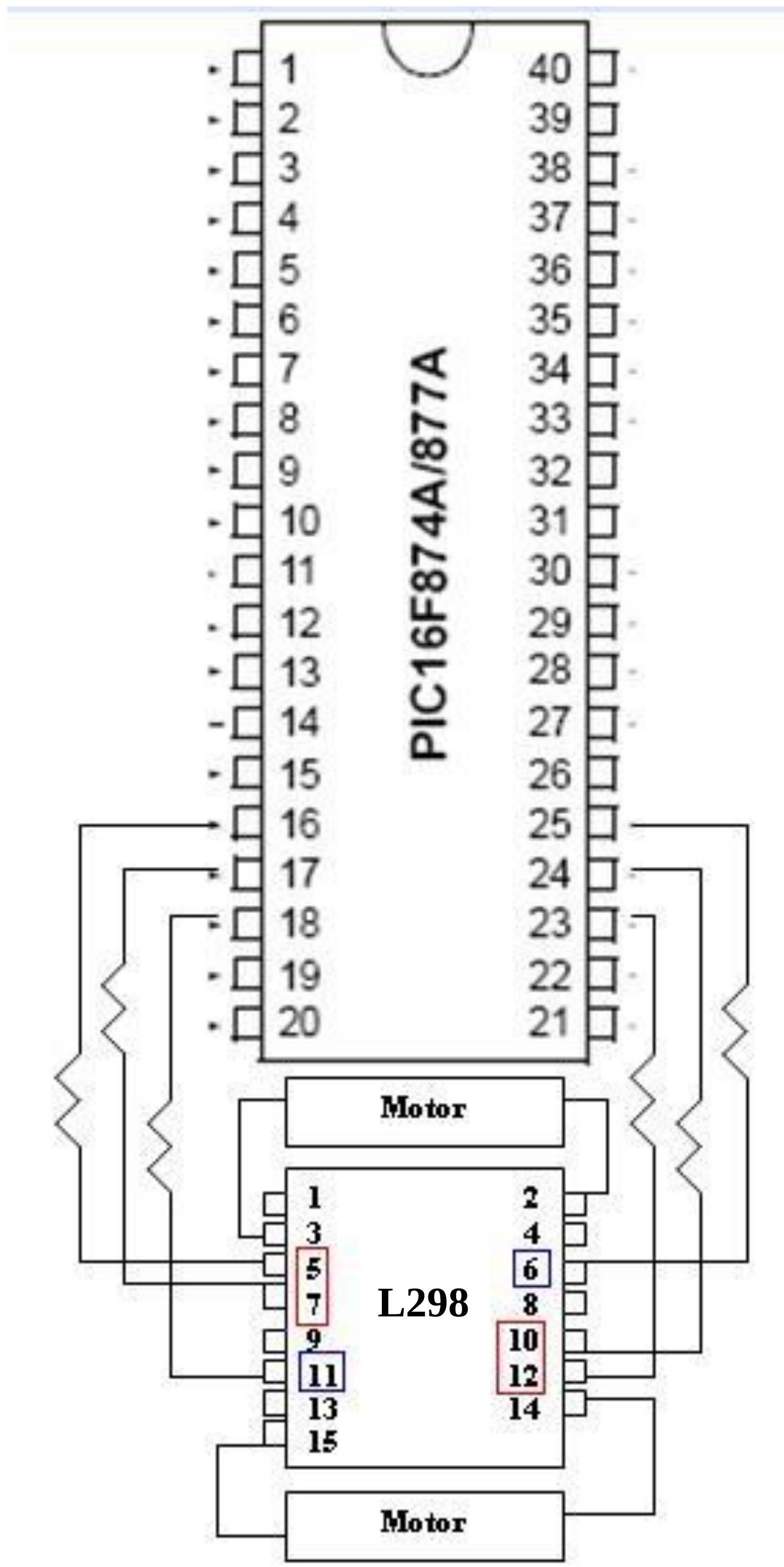


**Figure 3.14** The connection between the PIC16F877A and the driver L298

## 3.8 PIC Microcontroller

The PIC is a short form that means Programmable Integrated Circuit. It could run sequence and do mathematic calculations, on screen displays and a lot more almost like a very basic computer. PIC is sometimes is referred to as a replacement to computers in a circuit where the circuit needs to be mobile such as in a robot or even in a dish washer or a rostrum in this case. The PIC is easier to program as it complies with few programming coding languages which are C++ and M-code. The C++ is a universal programming language and it simplifies many of the long winded codes and still achieves the same result in the project. The PIC used in this project is the 40-Pin PIC16F877A which is neither for the high end users nor for the low ends users. It is a common PIC which can fulfill many features. The Programming was done using C++ programming software and complied and downloaded into the PIC. The programming of the microcontroller is downloaded using the Cytron USB ICSP PIC programmer UIC00A downloader.

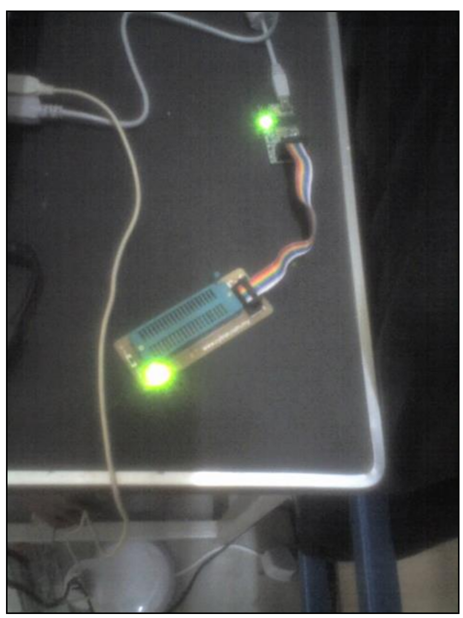

**Figure 3.15** Cytron USB ICSP PIC programmer UIC00A

## 3.9 The Rostrum's Assembly

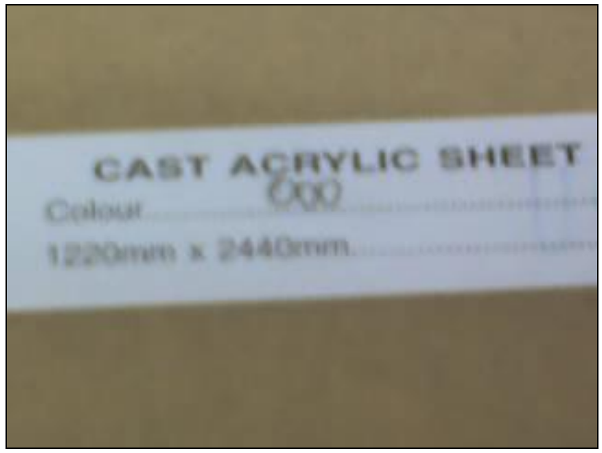


**Figure 3.16** Acrylic sheet's specification used in this project

**Figure 3.17** The rostrums main structure

The rostrum is assembled by hand and figure 3.16 shows the side walls or the main structure of the rostrum. The bone like structure is used to put on the side frames which would make the rostrum unique in its own way. The main structure consists of 6 main parts. Two of the main parts are the bone like tall figure while the 4 others are identical shaped parts which bind the two tall bone structures together using slot method.

**Figure 3.18** Full assembly of the main structure

The main structure is attached to smaller part which is going to be the moving part in the rostrum. It is made of 5 parts and the shape is as follows.

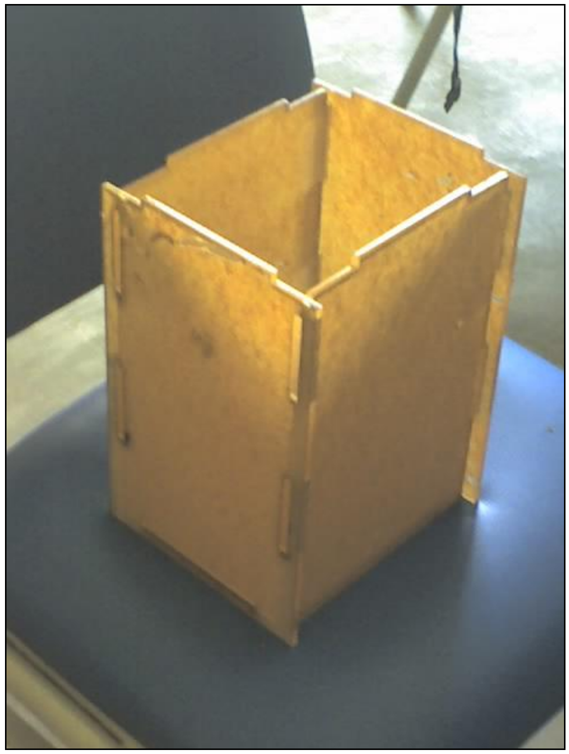

**Figure 3.19** Moving part of the rostrum

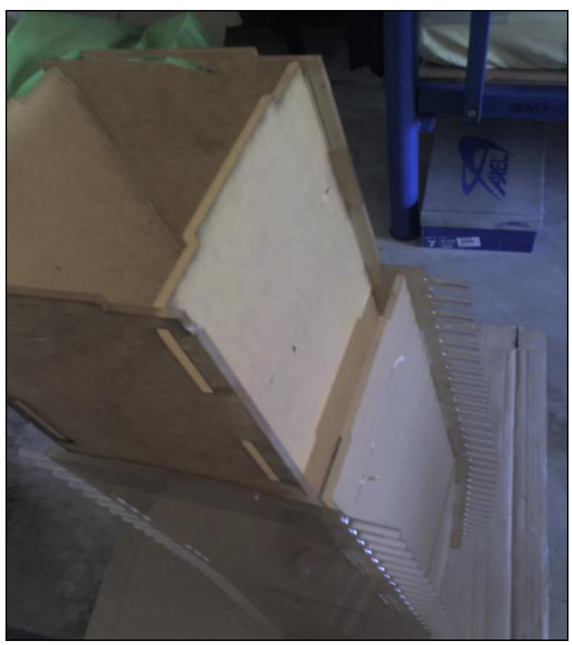

**Figure 3.20** Rostrum in extended mode without the fins

## 3.10 Conclusion

This chapter explains on how the automated rostrum is made from designing stage, mechanism selection, electronic circuit assembly, and software application to make the system works. The design concept explains the concept of how the rostrum is to function followed by the design and selection of the outer body of the rostrum. After that, the body of the rostrum is assembled with the electronic component.

# CHAPTER 4

# RESULTS AND DISCUSSIONS

## 4.1 Introduction

This chapter explains about the finding, analysis and discussion of the final product. The result explains the automated rostrum being able to extend and retract at the exact moment as it is meant to do. Analysis is the explanation on how the sequence of the automated rostrum can be fulfilled using the mechanism chosen and the electronic system. In the discussion, the detail problems faced by the product before and after it is tested are explained.

## 4.2 Specification

This section explains about the specification of the parts used to make the automated rostrum such as the acrylic used as the body and the DC powered power window motor. These specifications are obtained from manufacturers of the parts.

### 4.2.1 Rostrum Overview

The rostrum is made of acrylic and uses a single power window motor to move the rostrum upward using the lead screw.

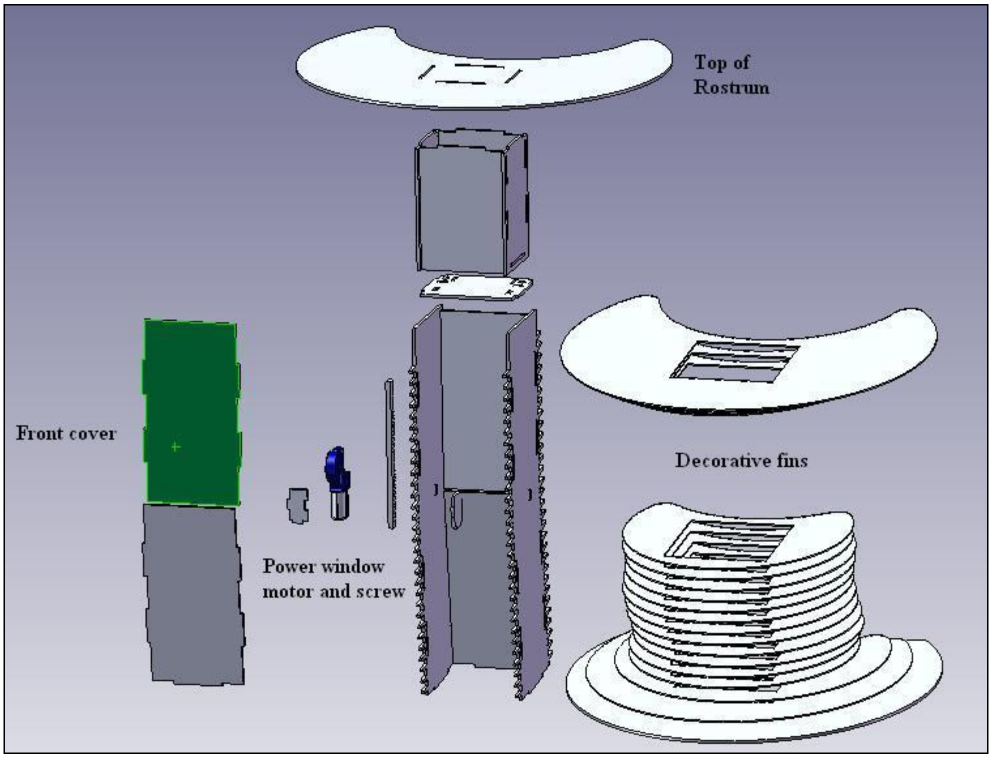


**Figure 4.1** Exploded view of the automated rostrum

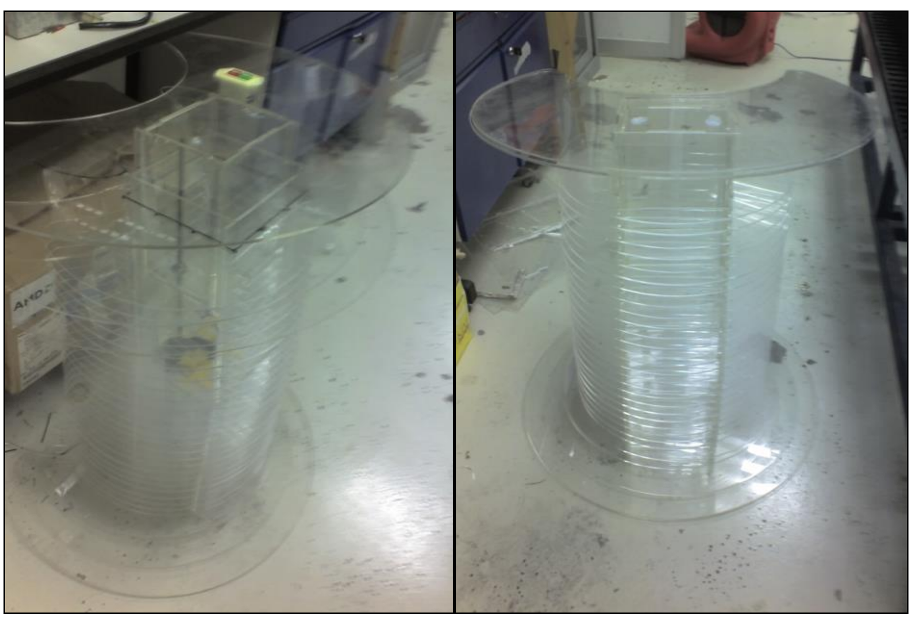

**Figure 4.2** Completed product

**Table 4.1** Specification of the rostrum

| **Entry** | **Specifications** |
|---|---|
| Material (Body) | Acrylic |
| Components | • 1 Power Window Motor (Proton Wira)<br>• 1 PIC Microcontroller 16F877A<br>• 3 piece of 3 mm acrylic sheet for fins<br>• 1 piece of 6 mm acrylic sheet for main structure<br>• 0.5m Lead Screw<br>• Electronic Components |
| Rostrum's Dimension | 759mm – 924mm(H) x 720mm(L) x 360mm(W) |
| Power Supply | 2 Power Supply of 12 V and 7 V |

### 4.2.2 Power Window Motor Specification

The power window motor is used together with the lead screw to move the rostrum upwards and downwards according to the situation.

**Figure 4.3** Power window motor (left) and motor connected to rostrum using the lead screw (right)

**Table 4.2** Specification of the power window motor

| Description | Specifications |
|---|---|
| Dimensions | 39.0mm x 31.0mm x 168.0 mm |
| Output shaft | According to requirement |
| Voltage | 12 V – 24 V |
| Ampere | 1.6 A – 2.0 A |
| No load speed | 50 – 100 rpm |
| Gear ratio | 1/65 |
| Weight | 510 g |
| Torque | 3.288 Nm |

### 4.2.3 Poly Methyl Methacrylate Acrylic Specification

The Poly Methyl Methacrylate Acrylic which is also known as acrylic is used in this project as the main body of the rostrum.

**Figure 4.4** The Acrylic

**Table 4.3** The PMMA specification taken from ides, 2008

| **Properties** | **Acrylic (PMMA)** |
|---|---|
| Specific Gravity (*g/cm³*) | 1.15 to 1.19 |
| Melt Mass Flow Rate (*g/10 min*) | 0.30 to 4.6 |
| Flexural Modulus (*MPa*) | 1120 to 3450 |
| Tensile Strength (*MPa*) | 36.6 to 81.1 |
| Tensile Elongation (*%*) | 0.0 to 7.3 |
| Rockwell Hardness | 44 to 102 |
| Notched Izod Impact (*J/m*) | 10.7 to 61.9 |
| DTUL at 66 psi (0.45 MPa) (*°C*) | 80.0 to 103 |
| DTUL at 264 psi (1.8 MPa) (*°C*) | 76.5 to 104 |
| CLTE, Flow (*cm/cm/°C*) | 0.000045 to 0.00011 |

### 4.2.4 Power Supply Specification

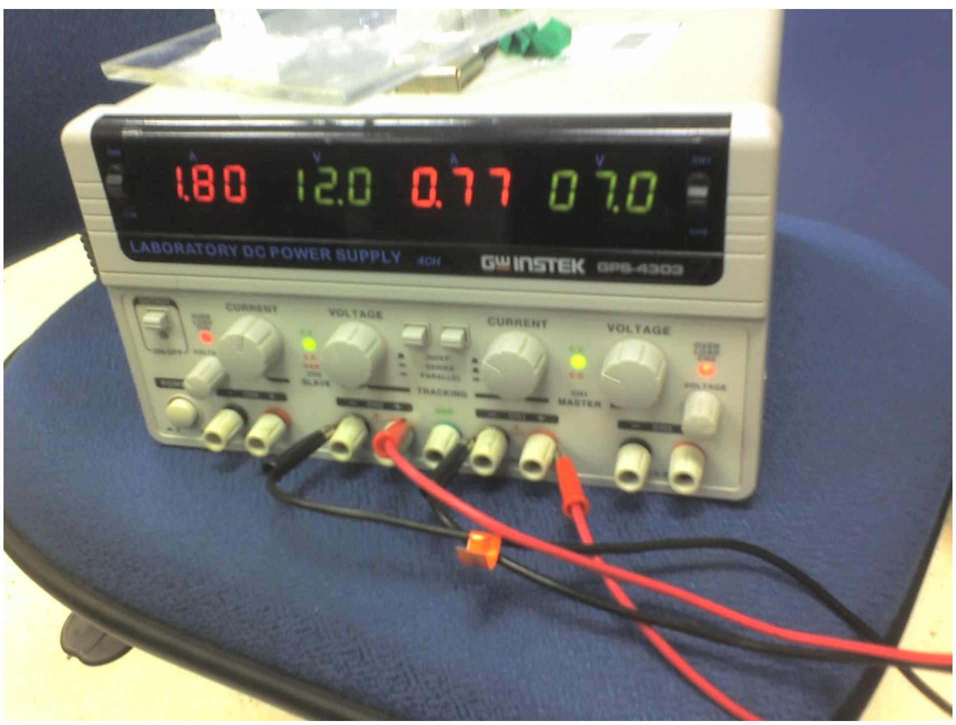


**Figure 4.5** Power supply with two separate outputs

**Table 4.4** The Power supply specification

| SPECIFICATIONS | | | | |
|---|---|---|---|---|
| | GPS-4303 | | | |
| OUTPUT MODE | | | | |
| | CH1 | CH2 | CH3 | CH4 |
| Voltage | 0 – 30V | | 2.2 – 5.2V | 8 – 15V |
| Current | 0 – 3A | | 1A Max. | 1A Max. |
| Tracking Series Voltage | 0 – 60V | | ---- | |
| Tracking Parallel Current | 0 – 6A | | | |

The power supply needed for this project are 5 V for the PIC, 7 V for the L298 driver, and 12 V for the power window motor. This power supply, GPS-4303 can supply 4 individual power source at one given time but only two of the power source’s ampere can be controlled which are channel 1 and 2 while channel 3 and 4 remain constant at 1.0 A.

### 4.2.5 Circuit Specification

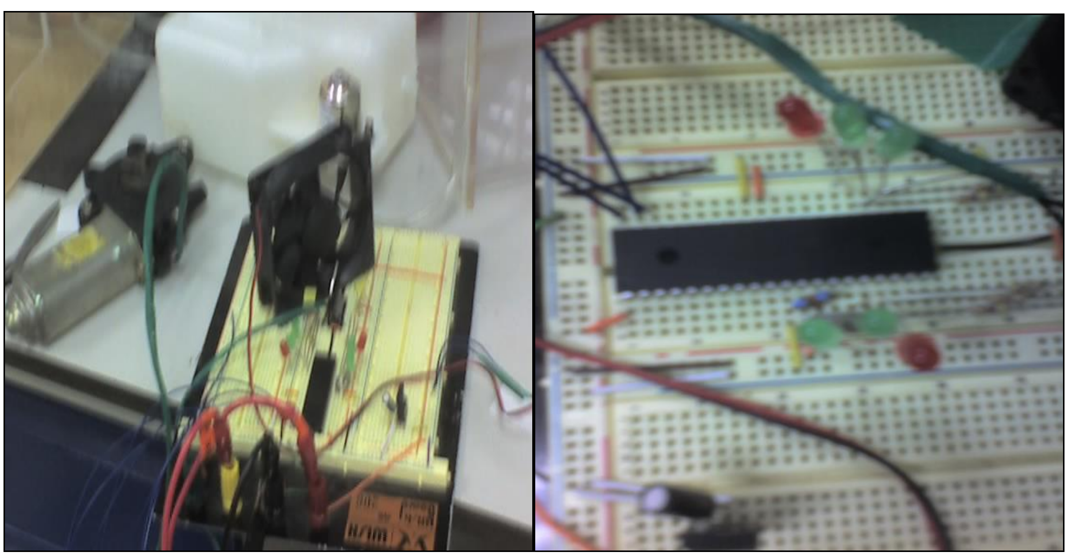

**Figure 4.6** The actual circuit

**Table 4.5** Circuit specification

| **Description** | **Specifications** |
|---|---|
| Components | • 1 PIC16F877A<br>• 1 Driver L 298<br>• 6 Resistor 470 Ω<br>• 2 Capacitor 12 pF<br>• 1 Capacitor 1µF<br>• 1 Power Regulator L 7805<br>• 1 Oscillator 20 MHz<br>• 2 Limit switch<br>• 1 Toggle switch |
| Parts | • 1 Power Window Motor<br>• 2 separate output power supply |

## 4.3 Sequence Analysis

The sequence analysis is the explanation of how the C programming and the hardware works in performing the desired output sequence.

### 4.3.1 C Programming

```
main()
{

  set_tris_B(0xff);  //input
  set_tris_C(0x00);  //output


  OUTPUT_C(0x00);

  while(1)
  {
  step1();
  step2();
  }

}
```

**Figure 4.7** Void Main

In the void main, the input and output are announced and the ‘while’ sequence is used so that the program keep on going in a cycle and never ends until the power is off. Step 1 and step 2 represent two cases in the rostrum movement. The sequence starts with reading and executing from void step1 and if the conditions in step1 are completed it continues to void step2. After executing the codes in step2 it starts over to step1.

```
void step1(void)
{


  while ((input(pin_B7)==1) && (input(pin_B6)==0))
  {

    OUTPUT_C(0b01011100);
    delay_ms(100);

  }
  OUTPUT_C(0b01001000); //stop all motor
  return;
}
```

**Figure 4.8** Void step1

In Void step1 as above, the conditions are for 3 limit switches or 2 limit switches and a toggle switch. The conditions are switch 1 labeled as Pin B7 needs to be pressed and switch 2 labeled as pin B6 needs to not be pressed. Switch 1, a limit switch is placed at the bottom of the rostrum. When the speaker steps on the big platform of the rostrum the switch 1 is on. Switch 2 is located at the top of the rostrum. This switch is used by the speaker to stop the rostrum at the desired height by pressing the toggle switch. Switch 2 can be changed with a laser beam and driver to do the same function as the toggle switch and it becomes fully automatic. The difference of the code for using the laser beam is (input(pin_B6)==1).

According to Void step1, the output will be 01011100 as long as the person stands on the rostrum base and the toggle switch is not pressed. The definition of the output will be explained in the next section. The output will remain constant as long as the condition is fulfilled. If either the speaker steps off the rostrum area or the toggled switch is pressed the output will change to 01001000.

```
void step2(void)
{
 while ((input(pin_B7)==0) && (input(pin_B5)==0))
 {
  OUTPUT_C(0b01101010);

 }
 OUTPUT_C(0b01001000); //stop all motor
 return;
}
```

**Figure 4.9** Void step2

According to Void step2, the output will remain 01101010 as long as switch 1 and switch 3 (named as Pin B5) are not pressed. Switch 3 is located at the maximum retracting point in the rostrum. When it is in retracted mode, switch 3 is on and if the rostrum starts to move upward, switch 3 is off. The same concept applies, if the condition is not fulfilled the output becomes 01001000. In both Voids, at the very end the term ‘return’ signifies that after the sequence in the void is completed, the computer returns to the Void main where it moves on to the next code or instruction.

### 4.3.2 The Hardware

The PIC16F877A acts as the brain of the whole system. The code in the previous section is downloaded into the chip and the chip reacts as the coding that has been coded into it. In this project port B are defined as the input and port c for output. 3 pins B (B5, B6, and B7) are used to read input from switches while 6 pins C (C1- C6) are releasing the output codes. The output codes are in 8 digits as the port C has 8 pins. The first and last pins are always 0 as the 2 pins are not in use at all times.

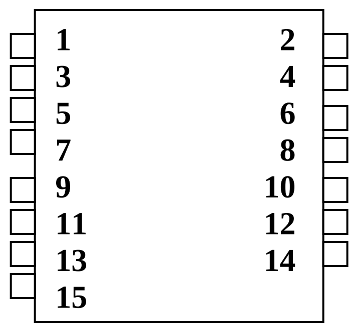


**Figure 4.10** Driver L298

The figure shows the basic diagram of the driver L298. The 6 outputs from port C become inputs for the driver L298. The driver is divided into 2 parts. Part 1 controls motor 1 using pin 2, 3, 5, 6, and 7. The pin no 6 is always on (on is numbered as 1 in the code) as it is the on/off button for the first half of the chip. Pin 5 and 7 are the input, pin 5 being the input 1 and pin 7 being input 2. The output is at pin 2 and 3. Pin 2 is output 1 and pin 3 is output 2. The second part of the chip controls the second motor. The on/off switch which is better known as enable switch is at pin 11. The input 3 is at pin 10 and input 4 is at pin 12. The outputs to the motor are pin 13 and 14. pin 13 is the output 3 and pin 14 is the output 4.

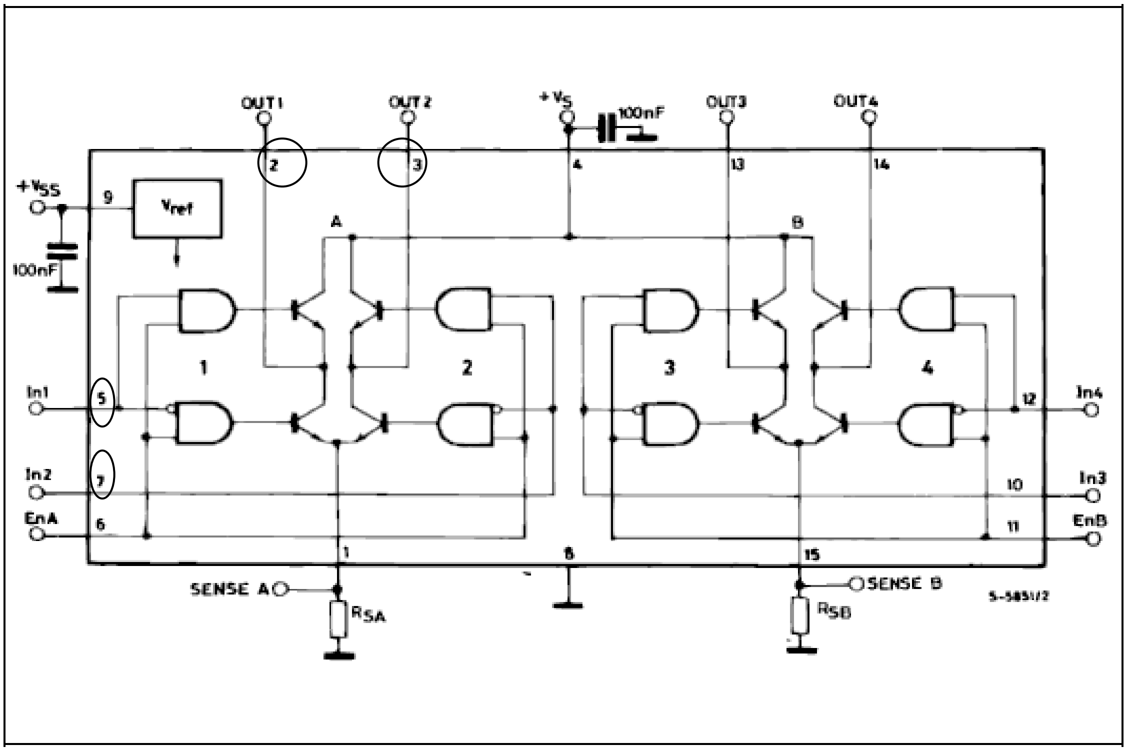


**Figure 4.11** Block diagram of driver L298

The diagram above shows the inside of the driver. Input 1 if it is high (numbered as 1), the output 1 will be positively charged while output 2 will be grounded and this will rotate the motor in 1 direction while if input 1 is low (numbered as 0), the motor move in the other direction.

The motor output in step1 is 01011100. The code is read backwards in the arrangement C7, C6, C5, C4, C3, C2, C1, and C0. Pin 7 and 0 are always off as the two pins are not in use and pin 3 and 6 are always on as these 2 pins are the enable pins.

| **Pin** | C7 | C6 | C5 | C4 | C3 | C2 | C1 | C0 |
|---|---|---|---|---|---|---|---|---|
| **Output** | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |

**Table 4.6** Output of Port C

C6 and C3 are the enable pins for the two halves of the chip. C4 is input 4 and C5 is input 3. C1 is input 1 while C2 is input 2. The shade of blue and orange differentiates the two halves of the chip.

### 4.4 Mechanical analysis

The power window motor used in this project produces 3.288 Nm of torque. This value is obtained via simple calculation and a simple experiment.

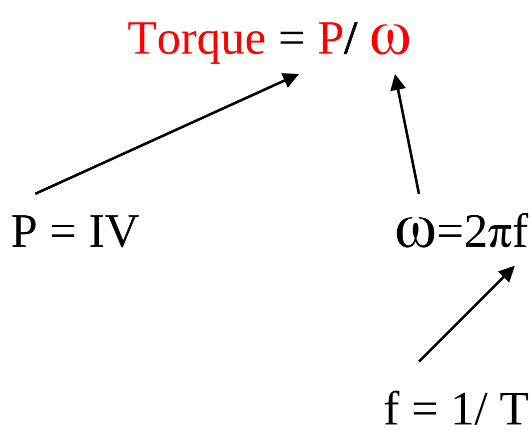


**Figure 4.12**

The value of T in sec is obtained via test run on the power window motor. The value is 0.956s. The value of I and V is already fixed. They are V = 12 V and I = 1.8 A. Replacing all values into the formula gives the torque of 3.288 Nm.

### 4.5 Discussion

In this project, a major part of the rostrum uses acrylic. Acrylic is very brittle and can easily break. It is not suitable for critical parts such as the mechanism and main support. Metal should be used to reinforce the main structure to make it stronger. All the electrical parts are sensitive and should be used and assemble with care.

## 4.6 Conclusion

In the first part of the chapter, the specification of all the parts used in creating the automated rostrum is explained. After that, the sequence analysis explained in detail how the C programming works with the hardware to fulfill its main purpose. The mechanical analysis explained about how the torque of the power window motor is obtained. As a whole the problem in this project is that the main body is not supported with stable steel frames and it moves very slow upwards using the lead screw mechanism.

# CHAPTER 5

# CONCLUSION

## 5.1 CONCLUSIONS

This is a project that involves mechanical system, electronic system and software as in the coding. The project started of with the background study of the world market and is the project needed. Then, in the designing stage few important choices were made. The type of mechanism was selected and the best and most attractive design for the body was done. The design for the electronic system in use was also chosen. Next, the fabrication process commenced. After all is completed, the assembly is done and tested. Thus, the objectives are completed. As this is a prototype level product, there are many possibilities of improving the rostrum for the better. It is yet at an infant stage and needs a lot of research and upgrading to make it ready to be marketable. This project even at this level achieved the objective of making an automated rostrum system for the height change. This system was tested on one type of rostrum in this project. It can also be used in other type of rostrums.

## 5.2 Recommendation

Throughout this project many difficulties were encountered. As this project is a prototype level project, many more upgrade can be done. Here are few suggestions for future upgrade of the automated rostrum system.

- The limit switch can be replaced with laser beam sensors for a more automated system.
- The power window motor can be changed with a motor with higher torque and RPM.
- The rostrum is supported using metal frame.
- The joining parts of the rostrum can use L elbow joints as an addition to the slots.

## REFERENCES


A. Colin Bell, Linda S. Adair, and Barry M. Popkin, 2002, *Ethnic Differences in the Association between Body Mass Index and Hypertension.*

A Piano Tuner, 2008, www.apianotuner.com/OtherProducts, 10/03/2008, 06:14PM

Angus Deaton, 19th January 2008, *Height, health, and inequality: the distribution of adult heights in India.*

B C Msamati, and P S Igbigbi, *Anthropometric profile of urban adult black Malawians.*

Dror Mandel, MD, Eyal Zimlichman, MD, Francis B. Mimouni, MD, FACN, FAAP, Itamar Grotto, MD, MPH, and Yitshak Kreiss, MD, *Height-Related Changes in Body Mass Index: A Reappraisal.*

Gongbing Shan, and Christiane Bohn, 18 July 2003, *Anthropometrical data and coefficients of regression related to gender and race.*

Ides, 2008, http://www.ides.com/generics/Acrylic/Acrylic_typical_properties.htm, 10/10/08, 09:27PM

Joanne Mikola, 2008, http://www.Lessontutor.Com/Jmhome.Html, 31/03/08, 08:01PM

Ignacio Osuna-Ramírez, Bernardo Hernández-Prado, Julio César Campuzano, and Jorge Salmerón, *Body mass index and body image perception in mexican adult population: the accuracy of self-reporting*.

Liudmila Dregval, and Ramutė Vaičaitienė, *2006*, *Anthropometrical data and physical fitness of Lithuanian soldiers according to the sociodemographic characteristics.*

Mart Lintsi, and Helje Kaarma, 25 May 2005, *Growth of Estonian seventeen-year-old boys during the last two centuries.*

Mart Lintsi, and Helje Kaarma, 1 July 2005, *Growth of Estonian seventeen-year-old boys during the last two centuries.*

Mirjana Aranđelović, and Jovica Jovanović, 2005, *the ergonomic aspect of the prevention of the diseases related to the work of computer operators.*

Nomad Technologies Inc., 2008, http://www.nomadonline.com/, 15/03/2008, 03:13PM

Pineau JC, Delamarche P, and Bozinovic S., 2005, *Average height of adolescents in the Dinaric Alps.*

The flower expert, 2008, http://www.theflowerexpert.com/, 31/03/08, 08:01PM

The Wikipedia, 2008, http://en.wikipedia.org/wiki/Human_height , 03/03/08, 07:50PM

Drumshields, 2008, www.drumshields.com, 2/02/08, 07:51PM

ewlBiz, 2008, http://www.ewlbiz.com/productcatalog, 12/02/08, 08:23PM

RJ Fine WoodWorking, 2008, http://www.rjfinewood.com/commercial/podium, 15/02/08, 11:01PM

Ratstands, 2008, http://www.ratstands.com/conductor, 15/02/08, 10:22PM

Yang XG, Li YP, Ma GS, Hu XQ, Wang JZ, Cui ZH, Wang ZH, Yu WT, Yang ZX, and Zhai FY, 2005, *Study on weight and height of the Chinese people and the differences between 1992 and 2002.*

# APPENDIX A

# PROGRAM LISTING

```
#include <16F877A.h>
#fuses HS,NOWDT,NOPROTECT,NOLVP
#use delay(clock=20000000)

  void step1(void);
  void step2(void);
  int suis1 = 0;
  int suis2 = 0;
  int suis3 = 0;
main()
{
  set_tris_B(0xff);  //input
  set_tris_C(0x00);  //output
  OUTPUT_C(0x00);

  while(1)
  {
  step1();
  step2();
  }
}
void step1(void)
{
  while ((input(pin_B7)==1) && (input(pin_B6)==0))
  {
    OUTPUT_C(0b01011100);                    //Rostrum moves up
    delay_ms(100);
  }
  OUTPUT_C(0b01001000);                      //stop all motor
  return;
}
```

```
void step2(void)
{
 while ((input(pin_B7)==0) && (input(pin_B5)==0))
 {
  OUTPUT_C(0b01101010);                    //Rostrum moves down
 }
 OUTPUT_C(0b01001000);                              //stop all motor
 return;
}
```

# APPENDIX B

## DATA OF HEIGHT ANALYSIS OF PEOPLE FROM SELECTED MAJOR COUNTRIES

| Country/Region | Average male height | Average female height | Sample population | Methodology | Year | Source |
|---|---|---|---|---|---|---|
| Argentina | 172.6 cm (5 ft 8 in) | 160.7 cm (5 ft 3.3 in) | People aged 18-19 | Measured | 2001 | [1] |
| Australia | 178.4 cm (5' 10.25") | 163.9 cm (5' 4.5") | People aged 18-24 | Measured | | [2] |
| Bahrain | 165.1 cm (5' 5") | 154.7 cm (5' 1") | Adults | Measured | 2002 | [3] |
| Belgium | 178.0 cm (5' 10") | 166.0 cm (5' 5.5") | People aged 18-24 | Measured | | |
| Brazil | 168.99 cm (5' 6.5") | 158.0 cm (5' 2.2") | Adults | Measured | 2003 | [4][5] |
| Canada | 174.0 cm (5' 8.5") | 161.0 cm (5' 3.4") | Adults | Measured | 2005 | [6] |
| Canada | 180 cm (5' 10.9") | 165 cm (5' 5.0") | People aged 18-24 | Self-reported | 1995 | [7] |
| China (PRC) | 164.8 cm (5' 4.9") | 154.5 cm (5' 0.8") | People aged 30-65 | Measured | 1997 | [8] |
| China (PRC) | 170.2 cm (5' 7") | 158.6 cm (5' 2.5") | Urban 17-year-olds | Measured | 2002 | [9] |
| China (PRC) | 166.3 cm (5' 5.5") | 157.0 cm (5' 2") | Rural 17-year-olds | Measured | 2002 | [10] |
| Côte d’Ivoire | 170.11 cm (5' 7") | 159.11 cm (5' 2.7") | People aged 25-29 | Measured | 1985-1987 | [11] |
| Croatia | 185.2 cm (6' 0.9") | 170.7 cm (5' 7.2") | 17-year-olds | | | [12] |
| Czech Republic | 180.3 cm (5' 11") | 167.3 cm (5' 6.0") | 18-year-olds | Measured | 2005 | [13] |
| Denmark | 180.9 cm (5' 11.2") | | 19-year-old conscripts | | 2006 | [14] |
| Estonia | 179.1 cm (5' 10.5") | | 17-year-olds | | | [15] |
| Finland | 176.7 cm (5' 9.5") | 163.5 cm (5' 4.3") | | Self-reported | 2000 | [16] |
| Finland | 178.2 cm (5' 10") | 164.7 cm (5' 4.7") | People aged 15-64 | Self-reported | | [17] |
| France | 173.2 cm (5' 8.1") | 161.8 cm (5' 3.7") | | | | [16] |
| France | 175.7 cm | 162.5 cm | | | 2006 | [18] |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (5' 9.2") | (5' 4.0") | | | | |
| Ghana | 169.46 cm (5' 6.7") | 158.53 cm (5' 2.4") | People aged 25-29 | Measured | 1987-1989 | [19] |
| Gambia | 168.0 cm (5' 6.1") | 157.8 cm (5' 2.2") | Rural Adults | | | [20] |
| Germany | 178.1 cm (5' 10") | 165 cm (5' 4.9") | Entire population | | | [21][22] |
| Germany | 181 cm (5' 11") | 167 cm (5' 6") | People aged 18-19 | | 2005 | [21][22] |
| Iceland | 181.7 cm (5' 11.5") | 167.6 cm (5' 6") | 20-year-olds | | | [23] |
| India | 165.3 cm (5' 5") | 152.1 cm (5' 0") | 20-year-olds | | 2005-2006 | [24] |
| India | 161.2 cm (5' 3.5") | 152.1 cm (5' 0") | Rural 17-year-olds | | 2002 | [25] |
| Indonesia | 158.0 cm (5' 2.2") | 147.0 cm (4' 10.0") | People at least 50 years old | Self-reported | 1997 | [26] |
| Israel | 175.6 cm (5' 9.2") | 162.7 cm (5' 4.1") | People aged 20-30 | | 1980-2000 | [27] |
| Italy - Middle & North | 176.9 cm (5' 9.5") | 163.2 cm (5' 4.2") | 20-year-olds | | 1994-2000 | [28] |
| Italy - South | 174.2 cm (5' 8.0") | 160.8 cm (5' 3.3") | 20-year-olds | | 1994-2000 | [28] |
| Japan | 172.18 cm (5' 7.8") | 158.92 cm (5' 2.6") | People aged 20-24 | | | [29] |
| Korea, South | 173.9 cm (5' 8.5") | 161.1 cm (5' 3.4") | 17-year-olds | | 2006 | [30] |
| Korea, South | 173.6 cm (5' 8.3") | | 19-year-old conscripts | | | [31] |
| Lithuania | 176.3 cm (5' 9.4") | | 20-year-olds | | | [32] |
| Malta | 169 cm (5' 6.5") | 159 cm (5' 2.6") | Adults | | 2003 | [33] |
| Malta | 175.2 cm (5' 9") | 163.8 cm (5' 4.5") | People aged 25-34 | | | [33] |
| Malawi | 166 cm (5' 5.3") | 155 cm (5' 1.1") | Urban People aged 16-60 | Measured | | [34] |
| Mexico - State os Morelos | 167 cmt (5' 5.7") | 155 cm (5' 1.1") | Adults | Self-reported | 1998 | [35] |
| Netherlands | 178.8 cm (5' 10.3") | 167.1 cm (5' 5.7") | | | | [16] |
| *Netherlands* | *184.8 cm (6' 0.8")* | *168.7 cm (5' 6.4")* | *People aged 20-30* | | *2004* | *[36]* |
| New Zealand | 177.0 cm (5' 9.7") | 165.0 cm (5' 5") | People aged 19-45 | | 1993 | [37] |
| Norway | 179.9 cm (5' 10.8") | 167.2 cm (5' 5.9") | Men aged 18-19 | | | [38] |
| *Philippines* | *163.5 cm (5' 4.4")* | *151.8 cm (4' 11.8")* | *People aged 20-39* | *Measured* | *2003* | *[39]* |
| Portugal | 172.8 cm (5' 8") | | 21-year-old conscripts | | 1998-99 | [40] |
| Poland | 176.9 cm (5' 9.6") | | 19-year-old conscripts | | 1995 | [41] |
| Singapore | 172.0 cm (5' 7.8") | 160 cm (5' 3") | People aged 17-25 | | 2003 | [42] |
| South Africa | 169.0 cm (5' 6.5") | 159.0 cm (5' 2.5") | People aged 25-64 | | 1998 | [43] |
| Spain | 173.1 cm (5' 8.2") | 161 cm (5' 3.3") | Entire population | Self-reported | 2003 | [44] |

| | | | | | | |
|---|---|---|---|---|---|---|
| Spain | 177.1 cm (5' 9.7") | 164.3 cm (5' 4.6") | People aged 18-29 | Self reported | 2003 | [44] |
| Catalonia, Spain | 173.0 cm (5' 8") | 164 cm (5' 4.6") | 18-year-olds | Measured | 2004 | [45] |
| Madrid, Spain | 177.0 cm (5' 9.7") | 164 cm (5' 4.6") | 18-year-olds | Measured | 2004 | [45] |
| Galicia, Spain | 177.0 cm (5' 9.7") | 164 cm (5' 4.6") | 18-year-olds | Measured | 2004 | [45] |
| Zaragoza, Spain | 177.0 cm (5' 9.7") | 162 cm (5' 4.6") | 18-year-olds | Measured | 2004 | [45] |
| Sweden | 180.2 cm (5' 10.9") | 167 cm (5' 5.7") | People aged 16-24 | | | [46] |
| Switzerland | 175.5 cm (5' 9") | 164.0 cm (5' 3.8") | | | | [16] |
| Taiwan | 172.04 cm (5' 7.73") | 159.68 cm (5' 2.8") | 18.5-year-olds | | | [47] |
| United Kingdom | 175.2 cm (5' 8.9") | 161.6 cm (5' 3.6") | People over 16 | | 2006 | [48] |
| United Kingdom | 176.7 cm (5' 9.6") | 163.7 cm (5' 7.4") | People aged 16-24 | | 2006 | [48] |
| USA | 175.8 cm (5' 9.2") | 162.0 cm (5' 3.8") | People over 20 | Measured | 1999-2002 | [49] |
| USA | 178.2 cm (5' 10.2") | 164.1 cm (5' 4.6") | Whites aged 20-39 | Measured | 1999-2002 | [49] |
| USA | 177.8 cm (5' 10.0") | 164.0 cm (5' 4.6") | African-Americans aged 20-39 | Measured | 1999-2002 | [49] |
| USA | 169.7 cm (5' 6.8") | 158.1 cm (5' 2.3") | Mexican-Americans aged 20-39 | Measured | 1999-2002 | [49] |
| USA | 179.25 cm (5' 10.6") | 165.05 cm (5' 5.0") | Whites born between 1980 and 1983 | Measured | | [50] |
| USA | 178.22 cm (5' 10.2") | 163.65 cm (5' 4.4") | African-Americans born between 1980 and 1983 | Measured | | [50] |
| Vietnam | 162.10 cm (5' 3.8") | 152.16 cm (4' 11.9") | People aged 25-29 | Measured | 1992-1993 | [51] |