# **Intelligent Microphone Stand**

by

Ivan Tan Sheng Wei

16368

Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Engineering (Hons)

(Electrical and Electronics)

January 2016

Universiti Teknologi PETRONAS
32610
Bandar Seri Iskandar
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

**Intelligent Microphone Stand**

by

Ivan Tan Sheng Wei

16368

A project dissertation submitted to the

Electrical and Electronics Engineering Programme

Universiti Teknologi PETRONAS

in partial fulfilment of the requirement for the

BACHELOR OF ENGINEERING (Hons)

(ELECTRICAL AND ELECTRONICS)

Approved by,

_______________________________________

(ASSOCIATE PROFESSOR DR. TAIB BIN IBRAHIM)

UNIVERSITI TEKNOLOGI PETRONAS

BANDAR SERI ISKANDAR, PERAK

January 2016

# CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

---

IVAN TAN SHENG WEI

# ABSTRACT

Microphone stands are commonly used to hold a microphone in place to free the user's hand from needing to hold the microphone. However, microphone stands require manual adjustment if the height does not match with the height of the user. For events with more than one speaker or performer, the height requirement for the microphone stand varies. It creates problem when there are audience looking to the stage. When the event personnel proceed to the stage to adjust the microphone stand for the user, it will disturb the formality of the event and will cause disturbance.

This project focuses on developing a new intelligent microphone stand system that will be able to adjust its height autonomously. Currently, there are different types of microphone stand that are available in the market. Those types includes the tripod microphone stand, tripod microphone boom stand, desktop stand, round base stand, low profile stand and also the overhead stand. Each of the microphone stand offer different benefits. The microphone stand that will be used for the intelligent microphone stand will be the tripod microphone boom stand. The tripod boom stand has a stable tripod base and also an extension boom arm that is able to bring the microphone closer to the mouth of user.

The prototype presented here will be an intelligent microphone stand which is a continuation of a prototype built by the previous team. The previous team has successfully fabricated a microphone stand which is capable of raising and falling electrically controlled by a remote control. Hence, the intelligent microphone stand presented here will be built using several prefabricated hardware including a 12 tooth gear, gear rack and a servo motor holder.

The intelligent microphone stand is able to adjust its height autonomously according to the user's height with the help of sensors and also the height adjusting mechanism. The sensors system which mainly comprise of ultrasonic sensors will be used to sense the head of the user as a form of height measurement while servo motor and a gear system will be used for the height adjustment. The height adjustment of microphone stand will be done in less than 15 seconds and the microphone stand will maintain its position after it has finalized its height. After the user moved away from the intelligent microphone stand for more than 45 second, it will then reset to its original position and wait for next user to approach.

# ACKNOWLEDGEMENT

The author wishes to thank Associate Professor Dr. Taib Bin Ibrahim for his continuous guidance during the whole course of this project. His ideas, suggestions and endless advice are highly admirable and have greatly helped in this project.

The author would also like to give special thanks to Mr. Mohamad Yasin Bin Baharudin and Mr. Anwarudin Bin Abdul Razak Thomas from Electrical and Electronics department of Universiti Teknologi PETRONAS for providing ideas and also technical assistance in fabrication of the prototype. The assistance in terms of hardware design and the usage of tools is much appreciated as it plays a vital part during the fabrication of the prototype.

Subsequently, the author would like to thank the Jabatan Perkhidmatan Awam, JPA for sponsoring the resources required to pursue the author’s education in Electrical and Electronics engineering in Universiti Teknologi PETRONAS. The resources sponsored to the author provided the opportunity to conduct this project.

Last but not least, the author would like to thank all the families and friends that have directly or indirectly contributed to this project.

# TABLE OF CONTENT

CERTIFICATION OF APPROVAL ........ ii
CERTIFICATION OF ORIGINALITY ........ iii
ABSTRACT ........ iv
ACKNOWLEDGEMENT ........ v
TABLE OF CONTENT ........ vi
LIST OF FIGURES ........ 1
LIST OF TABLES ........ 2
CHAPTER 1: INTRODUCTION ........ 3
- 1.1 Background ........ 3
- 1.2 Problem Statement ........ 4
- 1.3 Objectives ........ 4
- 1.4 Scope of Study ........ 4
- 1.5 Relevancy of the Project ........ 5
- 1.6 Feasibility of the Project ........ 5
- 1.7 Conclusion ........ 5

CHAPTER 2: LITERATURE REVIEW ........ 6
- 2.1 Microphone and Microphone Stand ........ 6
- 2.2 Types of Microphone Stand ........ 7
- 2.3 Existing Projects ........ 10
- 2.4 Conclusion ........ 14

CHAPTER 3: METHODOLOGY ........ 15
- 3.1 Hardware Design and Fabrication. ........ 15
- 3.2 Program Algorithm. ........ 34
- 3.3 System Integration ........ 36
- 3.4 Project Conduct Flowchart ........ 36
- 3.6 Conclusion ........ 38

CHAPTER 4: RESULTS AND DISCUSSION ........ 39
- 4.1 Test ........ 39
- 4.2 Test Results ........ 40
- 4.3 Conclusion ........ 44

CHAPTER 5: CONCLUSION AND RECOMMENDATION ........ 45
- 5.1 Recommendation ........ 45

REFERENCES ........................................................................................................ 47
APPENDIX ........................................................................................................... 49

# LIST OF FIGURES

| | | |
|---|---|---|
| Figure 1 | Tripod Microphone Stand | 7 |
| Figure 2 | Tripod Boom Stand | 7 |
| Figure 3 | Over Head Microphone Stand | 8 |
| Figure 4 | Low Profile Microphone Stand | 8 |
| Figure 5 | Desktop Microphone Stand | 9 |
| Figure 6 | Round Base Microphone Stand | 9 |
| Figure 7 | Adjustable Fold Suspension Boom Arm Microphone Stand [6] | 10 |
| Figure 8 | Autonomous Microphone Stand | 11 |
| Figure 9 | Stage Microphone with Automatic Height Control Functions | 12 |
| Figure 10 | Automatic Elevating and Lowering Microphone Support | 13 |
| Figure 11 | Basic Hardware Design of Intelligent Microphone Stand | 16 |
| Figure 12 | Microphone Positioning | 17 |
| Figure 13 | Estimation for Microphone Positioning | 17 |
| Figure 14 | Ultrasonic Sensor | 21 |
| Figure 15 | Position Angle Calculation of Ultrasonic Sensor | 22 |
| Figure 16 | Angles in Parallel Lines | 22 |
| Figure 17 | Position Angle Estimation for Ultrasonic Sensor | 23 |
| Figure 18 | Ultrasonic Sensor Mount | 24 |
| Figure 19 | Gear and Gear Rack | 25 |
| Figure 20 | Servo Holder | 25 |
| Figure 21 | Supporting Mechanism Design | 28 |
| Figure 22 | Height Adjustment Support Mechanism | 29 |
| Figure 23 | Circuit Diagram for Complementary Circuit | 30 |
| Figure 24 | Casing for Central Controller | 31 |
| Figure 25 | Infrared Receiver Module V2 and Infrared Remote Control | 33 |
| Figure 26 | Program Algorithm | 35 |
| Figure 27 | Completed Prototype | 36 |
| Figure 28 | Project Conduct Flow Chart | 37 |
| Figure 29 | Volunteer Testing the System | 40 |
| Figure 30 | Test Procedure | 40 |
| Figure 31 | Graph of Height Adjustment Time for Height Mode 1 And 2 | 41 |
| Figure 32 | Graph of Time Analysis in Height Mode 1 | 42 |
| Figure 33 | Graph of Time Analysis in Height Mode 2 | 42 |
| Figure 34 | Graph of Accuracy Analysis for Height Mode 1 And 2 | 43 |
| Figure 35 | Remote Control Guide | 49 |

# LIST OF TABLES

Table 1 Comparison between Different Types of Sensors 20
Table 2 Height Modes Comparison 26
Table 3 Comparison between Servo Motor and Continuous Servo Motor [17] 26
Table 4 LED Indicator 31
Table 5 Power Requirement 32
Table 6 Experimental Value for Power Requirement 33
Table 7 Total Result for System Test 44

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

The conventional microphone stand has been around for decades. It has been widely used to hold microphone since its first appearance in the early 1878[1]. The most basic microphone stand is called a straight stand. This kind of microphone stand is normally used in speeches, talks and even some of the concerts. It can be used to hold various type of microphone whether it is wired or wireless. It is specialized to hold handheld microphone [2]. The most common straight stand being used now come with an extended structure towards the presenter named boom and it normally has a tripod base for portability and to conserve storage space.

Over the years, the development of microphone stand follows the development of microphone and also its users. In the beginning, microphones are only used for telephone. As microphones evolve, they have been used to record sound, to transmit and to amplify sound during speeches. Microphone stand started to have boom or an extension arm during 1945. The first patent of microphone stand with extension boom arm has been awarded to Lewis [3]. Until the present day, there are several kinds of microphone stand being developed with more adjustable features to suit the needs of modern day users. However, wearable wireless microphones have decreased the popularity of the conventional microphone stand. The wireless microphone especially wearable ones provide more freedom to the users and a stand is not required. Despite losing some of the popularity, the microphone stand with its clear advantages still has its demand and commercial values.

The problem with conventional microphone stand is that it requires manual adjusting of its height and distance when the speaker or singers height is not matched with the microphone stand. This will become an issue especially when the speech or talks involves the Very Important People such as celebrities and politicians. It will disturb the formality and tidiness of the whole event when the Very Important People is on stage and the working personnel has to go on stage to adjust the height manually.

## 1.2 Problem Statement

The conventional microphone stand with extension structure toward the speaker requires manual adjustment when the microphone did not reach the speaker's height. This manual adjustment may affect the formality of the event.

The problem of manual adjustment is that it disturbs the formality and causes embarrassing moments on stage. Furthermore, manually adjusting the microphone stand will increase the man power needed on stage and this creates problem when there are other issue to handle by the working personnel during the event.

## 1.3 Objectives

i. To design an autonomously height adjustable microphone stand with reasonable cost.
ii. To develop an autonomously height adjustable microphone stand.
iii. To ensure the functionality of the prototype to hold the microphone in a safe and stable way.

## 1.4 Scope of Study

The scope of study will be as shown below:

i. Literature review

Literature review of this project will be focus on the type of microphone stand, microcontroller and also the sensors that will be utilized.

ii. Design

The development of software for the entire system will be important to ensure the functionality of the intelligent microphone stand. The position of the sensors and microcontroller must be well planned and studied so that the performances of the microphone stand will still be in an optimum state.

iii. Development and fabrication

After designing stage, the fabrication of prototype according to the design will be done. During the fabrication, the sensors and motors will be calibrated to an optimum level.

iv. Testing

The fabricated prototype must be tested for stability and practicability. The prototype will be tested to ensure safety usage by users.

v. Findings

The findings of the prototype and project will be recorded and studied Recommendation for future work expansion will also be justify and suggested.

**1.5 Relevancy of the Project**

The problem of manual adjustment of the microphone stand has been around for a long time. Over the years, there are still no products sold in the market to address this issue. Not only will this project will be able to solve this issue, it will have high commercial value. The project also fits the requirements of Final year project for Universiti Teknologi PETRONAS.

**1.6 Feasibility of the Project**

The project is a feasible project and could be done in 2 semesters. The project is focused in producing a microphone stand that is able to adjust autonomously according to the user's height. In order to make sure that the progress can catch up with the entire deadline, the Gantt chart must be followed strictly. Along the execution of the project, there will surely be unseen challenges and obstacle. Those challenges must be faced and solve as soon as possible to complete the project on time.

**1.7 Conclusion**

This section provides a basic introduction and also the background for the entire project. The basic idea serve The introduction discuss about the problems that this project would like to solve. The objectives and scope of study discussed in this section will provide a clear target during the execution of the project.

# CHAPTER 2

# LITERATURE REVIEW

This chapter discuss on the literature review regarding several existing design of microphone stand. The understanding of the existing type of microphone stand will help in selecting the suitable microphone stand as the base design of the intelligent microphone stand. Furthermore, this section will review on some work and project that is similar to the one in this project. Comparison on the previous similar designs will made in order to propose a new design for the intelligent microphone stand system.

## 2.1 Microphone and Microphone Stand

Microphones are first being utilize as a tool to send voice in telephones and it is first being invented in 1876. In the early 1920s, the emerging of electrical disc and the invention of radio has help to develop a new kind of microphone called the carbon type microphone [4]. After that, microphone are then widely used to record sound, music and speeches into recordings or transmitted to radio via radio frequency until present day. The microphone has been widely used in the field of communication, entertainment and also in various events.

Microphone especially the expensive ones need to be protected and also be close to the source of sound or speaker for an optimum use. This is why with the emerging of microphone comes with the need of microphone stand. The most basic requirement for microphone stand is that it should be stable, safe and easy to use. Despite decrease in popularity, there are still demands of the conventional microphone stand because handheld microphones are still in use. As long as handheld microphone is in used, microphone stand will still be used to free the hand of the user from holding the microphone.

### 2.2 Types of Microphone Stand

Several types of the microphone stand:

1. Tripod stand

This kind of stand is the most basic and common for all purpose uses. Figure 1 shows the tripod microphone stand.

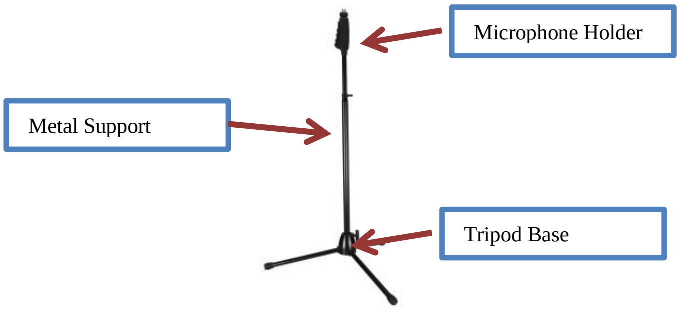


Figure 1 Tripod Microphone Stand

2. Tripod boom stand

This kind of stand is similar to the tripod stand but it has extension towards the user called a boom as shown in Figure 2. The boom offers a closer microphone to the user. This microphone stand will be use as a base design for the intelligent microphone stand.

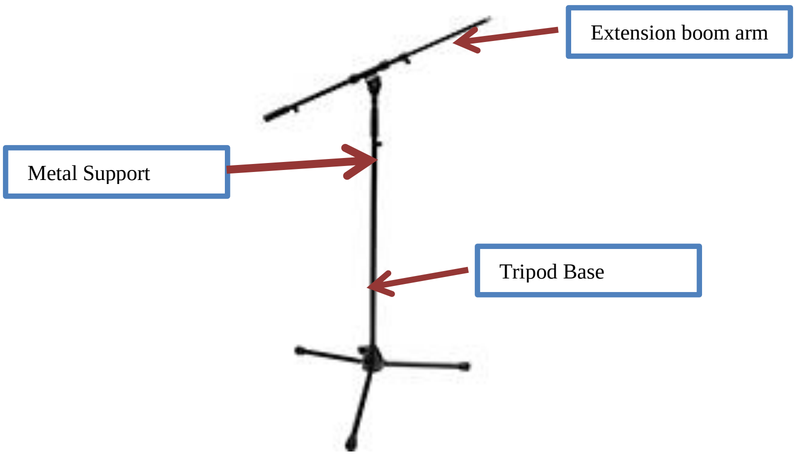


Figure 2 Tripod Boom Stand

3. Overhead stand

This overhead stand as shown in Figure 3 offers a large range of heights and angle to the users. It is taller and also longer than most of the microphone stand. It has the most stability and the highest cost to build.

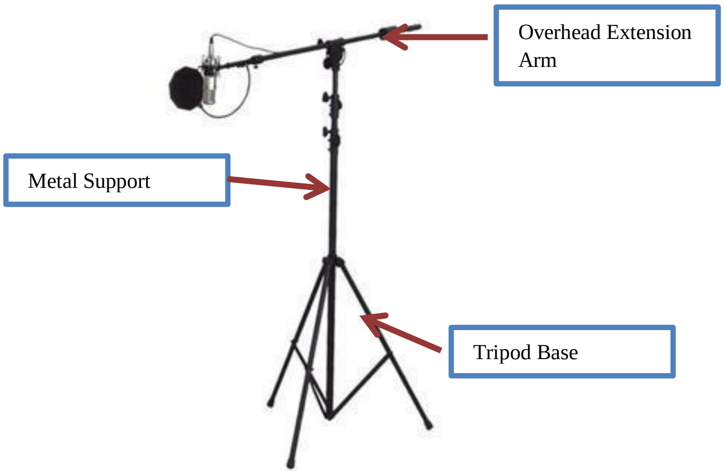


Figure 3  Over Head Microphone Stand

4. Low profile stand

The low profile stand as displayed in Figure 4 is similar to the tripod boom stand but it has a lower height specially built for drummers and guitars.

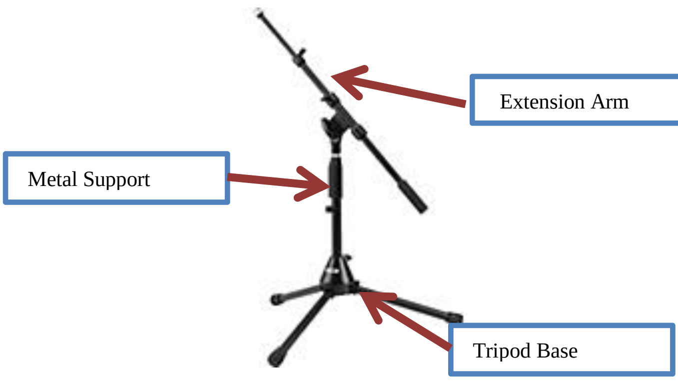


Figure 4  Low Profile Microphone Stand

5. Desktop stand

The desktop stand as shown in Figure 5 is the stand with the lowest cost. It is built to be placed on desk or table [5]. It is mainly used for podcasting or to be placed on speech podium.

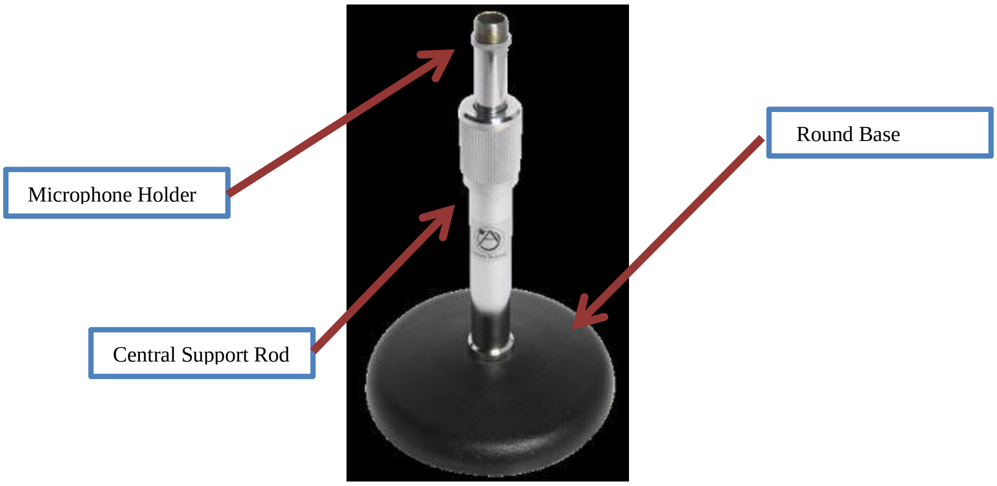


Figure 5 Desktop Microphone Stand

6. Round base stand

This kind of stand has a round base instead of a tripod base. It has lower probability of a trip over and it uses less space. Figure 6 shows the round base microphone stand.

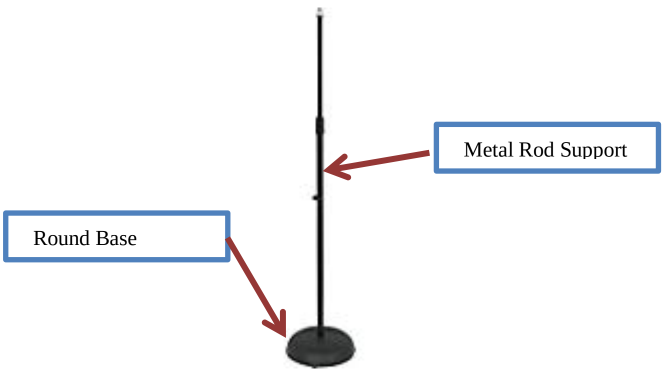


Figure 6 Round Base Microphone Stand

7. Fold suspension boom scissor microphone arm stand

This kind of microphone stand is mostly used in studio and is more costly to purchase. Instead of a straight extension boom, its extension arm is foldable as shown in Figure 7. This feature offers a smooth and soundless adjust of the microphone.

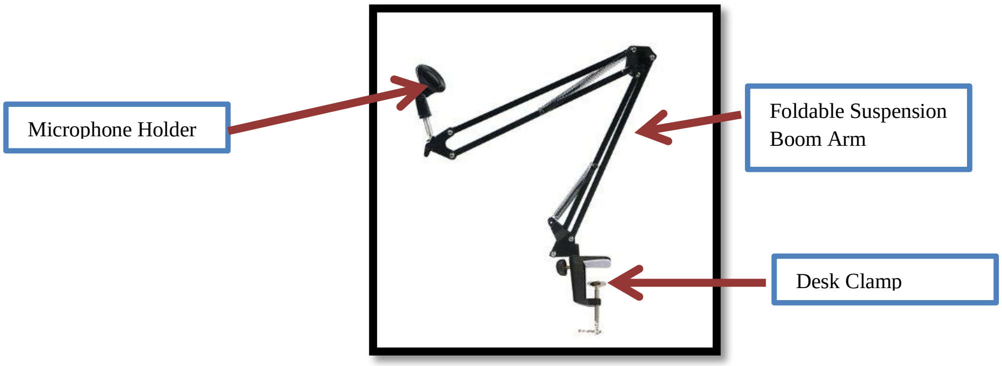


Figure 7 Adjustable Fold Suspension Boom Arm Microphone Stand [6]

The project's objective is to design and fabricate a more general use and low cost intelligent microphone stand. Following the requirement, a conventional low cost tripod boom stand will be chosen as the base of the design. This is due to the extension "boom" hand which can provide a closer microphone position to the user plus it has a tripod stand which is more portable and uses lesser storage space.

## 2.3 Existing Projects

### 2.3.1 Microphone Stand Capable of Falling and Rising Intelligently and Automatically

The autonomous stand patented by QY Jiang is a microphone stand that is able to rise and fall with the aid of sound sensor and small motor [7]. Figure 8 shows the design of the prototype. The design uses two sound sensors to collect sound of the speaker. The sound sensors are placed at different position. The difference amplitude of the sound signal will be used to determine the position of the microphone that will be optimum to the user. The mechanism used to control the height of microphone stand is screw jack mechanism paired with small motor.

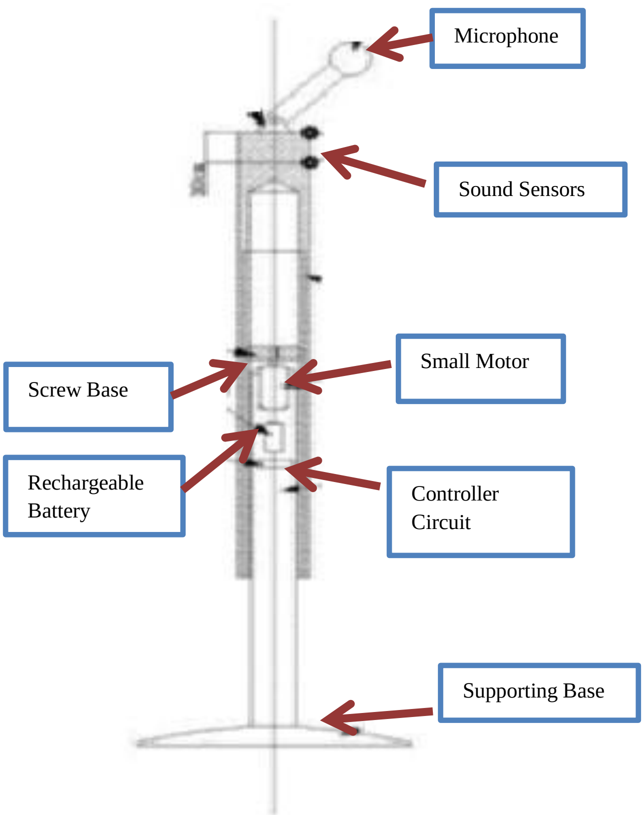


Figure 8 Autonomous Microphone Stand

### 2.3.2 Stage Microphone with Automatic Height Control Functions

The autonomous microphone stand patented by SG Chao and DG Wang [8] as shown in Figure 9. The stage microphone support in the project uses infrared sensor to detect the tip of the head of user in order to measure the height of the user for microphone stand height adjustment. The project uses gear and gear rack to increase and decrease the height of the microphone stand which is similar to the one used in this project.

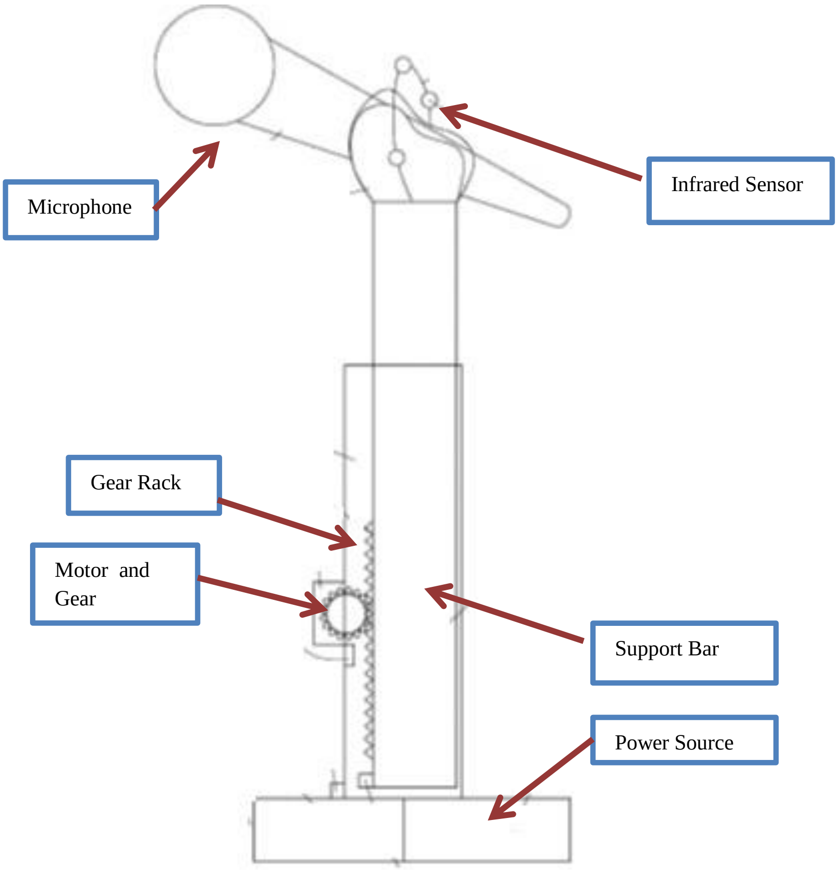


Figure 9 Stage Microphone with Automatic Height Control Functions

### 2.3.3 Automatic Elevating-Lowering Microphone Support

The microphone support patented by J Ding [9] that is capable of rising and lowering automatically is shown in Figure 10. The primary sensor used in the microphone support Passive Infrared (PIR) sensor. The PIR sensor is responsible to sense the tip of the head of the user. The microphone stand will then use the stimulus from PIR sensor to control the height of the microphone support. The microphone support uses screw jack mechanism for height control.

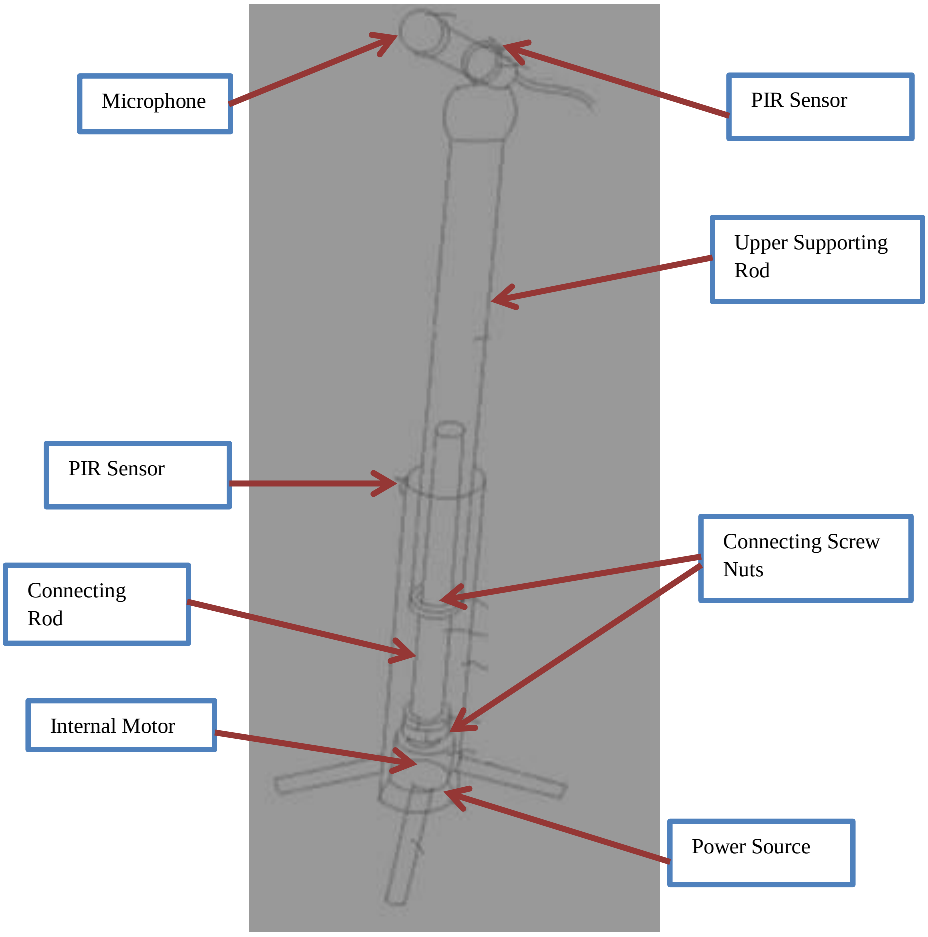


Figure 10 Automatic Elevating and Lowering Microphone Support

### 2.3.4 Comparison between the Automatic Microphone Stands

The 3 project similar to this project are having the same basic concept which they use sensors to measure the height of the user and a mechanism of rising and lowering will control the height of the microphone stand. The mechanism of rising and lowering of the patented projects however, differs from each other. For the patented project of QY Jiang [7] and J Ding [9], their microphone stand uses ball and screw jack mechanism to convert mechanical energy from the motor to increase and decrease the height of the microphone stand. On the other hand, the microphone stand patented by SG Chao and DG Wang [8] use gear and track mechanism to rise and lower down the microphone stand. Although the ball and screw jack mechanism will be more stable if compared to the gear and track mechanism, the gear and track mechanism is more cost efficient and it is easier to be manufactured. This is because the screw jack mechanism is built internally in the microphone stand while the rack for the gear mechanism is built externally of the microphone stand. This is the reason why the gear and track mechanism will be chosen to be utilised in this project.

## 2.4 Conclusion

This section discussed about the types of microphone stand and also several previous designs and works related. After the literature review, the microphone stand that will be selected as a base for this project will be the tripod boom stand. The tripod boom stand is commonly being used in event such as speeches and concerts. It has an extension arm which can be used to bring the microphone closer to the user's mouth. The height adjustment mechanism on the other hand will be gear and gear rack mechanism due to its ease of fabrication. The method for designing the entire system will be discussed in Chapter 3.

# CHAPTER 3

# METHODOLOGY

This section discussed about the methodology used in this project and also the activities during the execution of this project. The first part of the section will be focusing on the hardware design and fabrication process. The entire system is divided into several major parts with each part playing a specific role. The entire structure of the intelligent microphone stand will be designed first before each of the parts is design and fabricated. Subsequently, the software part of the system will be designed. After the hardware and software part of the system is completed, the software and hardware will be integrated. The process of designing and fabrication of the entire system will be discussed in this section.

## 3.1 Hardware Design and Fabrication.

The main structure and placement for each of the parts for the intelligent microphone stand is displayed in Figure 11. The system design for the prototype is divided into several major parts. The major parts that are needed to be designed and also fabricated are listed below.

i. Sensors System
ii. Height Adjusting Mechanism
iii. Controller
iv. Power Source
v. Backup System

Each part of the system is interconnected to each other with its own specific function. The power source will be used to power up the entire system. The controller will be controlling the entire operation of the system. The controller will get readings and signals from the sensors system and will use the values acquired to calculate and estimate the height of the user. Next, the controller will then send signals to the height adjusting mechanism to adjust the height of the microphone stand to fit the user's height. On the other hand, the backup system exists to increase the functionality of the intelligent microphone stand. It also serves as an emergency system in case the system has met with a critical error.

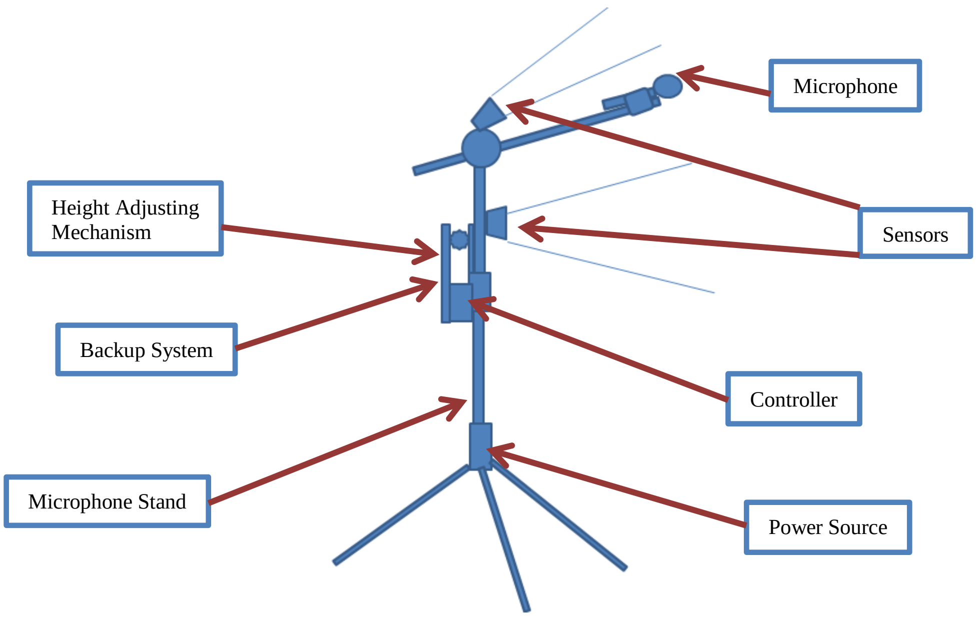


Figure 11 Basic Hardware Design of Intelligent Microphone Stand

### 3.1.1 Sensors System

The process of designing the sensing system begins with microphone positioning. This is because the position optimum position of microphone in reference with user will determine the design of the entire sensing system. After the optimum microphone positioning has been decided, the sensing system can be designed by selecting the suitable sensor and fabricating a suitable mount for the sensor.

#### 3.1.1.1 Microphone Positioning

One of the most important objectives for this project is to place the microphone at an optimum position close to the mouth of the user. Hence, the positioning of the microphone on the microphone stand must be determined. Before any calculation, there are several assumptions to be made. According to the research done by Nguyen, A.K.D in 2012 [11], the average length between the lips to top of the head is approximately 19 cm. Furthermore, several sources such as cybercollege.com, homestudio.com suggested that distance of microphone to the user's mouth is best at the range from 10cm to 16cm to avoid disturbance and distortion [12] [13]. For estimation purposes, the midpoint of the values which is 13cm will be used. To further improve the positioning of the microphone, cybercollege.com also suggests that the position of the microphone should be $30^0$ titled and not to be perpendicular to the user's mouth. The last piece of information missing is the horizontal distance, D between the microphone and user as shown in Figure 12 and Figure 13. Using formula (1), we can calculate the value D.

$\cos(30) = D/13$ (1)

D is equal to 11.25 cm , while the vertical height of the triangle H is calculated to be 6.5cm. The positioning of the microphone with respect of the user will be crucial for the positioning of the ultrasonic sensor and also the accuracy of the intelligent microphone stand.

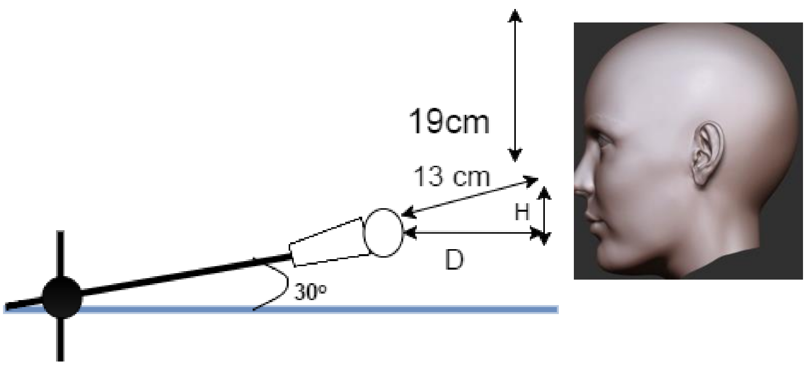


Figure 12 Microphone Positioning

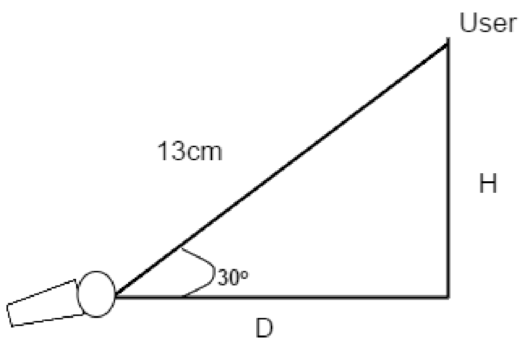


Figure 13 Estimation for Microphone Positioning

#### 3.1.1.2 Sensor Selection

Sensors are devices that detects and measure the changes of the physical environment. The changes or stimulant can be speed, object, motion and others [10]. These changes or value measured will then be converted into digital or analog value which will be stored in computer or microcontroller. With the aid these values, the computer or microcontroller are able to react to the environment.

Sensors are used in this project to detect the presence of human and also the height of the user of microphone stand. There are different types of sensors to be selected. Among them are Infrared sensor, ultrasonic sensor, passive infrared sensor and also sound sensor. The choice of using sensors will be determined by their application, advantages and also disadvantages. Before selecting the suitable sensor for this project, different type of sensors will be compared.

##### 3.1.1.2.1 Infrared Sensor

Infrared sensors use light pulse and also triangulation method to detect the distance of the object and due to this reason it have a narrow beam width. A narrow beam width is suitable to measure object that are in narrow space. Furthermore, by using light it can have a faster reaction time if compared to other medium. If compared to other sensors, infrared sensors have a lower max range and it is unable to detect the distance of an object accurately. From the research done by M. Tarek, it is found that the performance of infrared sensor will be affected by sunlight, the smoothness of the surface and also the colour of the object. The infrared sensors are weak at sensing dark colour and also uneven surfaces because these surfaces are unable to reflect light as well as smooth surface with light colours [14]. Infrared sensors have a huge price range. It can cost from RM2 to RM 100. The higher price range sharp IR sensor will cost RM 40 and above with higher accuracy and range of detection.

##### 3.1.1.2.2 Ultrasonic Sensor

Ultrasonic sensors use the reflection of ultrasonic wave that have the frequency of 40 kHz to detect the distance of an object. It works by sending an ultrasonic wave with frequency of 40 kHz and waits for the wave to be reflected from the surface. Then the distance of the object, D can be calculated using the formula D = (T * 340) / 2. Where T is the time taken for the wave to be reflected and 340 is the velocity of sound in air [15].

On the other hand, if compared with infrared sensors, ultrasonic sensors are slower because ultrasonic uses sound wave as a medium of detection unlike infrared sensors that use light as a medium to detect objects. However, ultrasonic sensors have wider beams which are suitable if the sensors are required to sweep a larger area such as sonar. Ultrasonic sensor if compared to infrared have a further max distance and are more accurate in terms of measuring the distance of the object. According to the research done by M.Tarek, ultrasonic sensors are more accurate than infrared sensor when it comes to measuring distance. Unfortunately, the performance of ultrasonic sensors will be affected by sound absorbent materials such as sponge. Ultrasonic sensors that have a max range of 4 m cost RM 6.

#### 3.1.1.2.3 Passive Infrared Sensor

Passive Infrared or PIR sensors are used to detect the movement of a human being or an object. It is built using a pyro electric sensor. Pyro electric is used to detect levels of infrared sensor. The sensor is best to be used to check presence or movement of a human because human emits a high level of infrared radiation. PIR sensors are low cost and low powered sensors which make them popular to be used for detection of motion and presence of an object [16]. 1 PIR Infrared sensor will cost approximately RM 8. However, if compared to ultrasonic sensor and infrared sensor, it has no capability of measuring the distance of an object.

#### 3.1.1.2.4 Sound Sensor

Sound sensor is used to detect sound strength or in another word the amplitude of sound from the environment. However, sound sensor is different from ultrasonic sensor as sound sensor only detects sound that is detectable by the human ear which will range from 2kHz to 20 kHz. Instead of sending a wave of signal and wait for reflection, sound sensors receive sound signals from the surrounding.

The utilisation of sound sensor to detect the height of the user is demonstrated in QY Jiang patented microphone stand [8]. It uses sound signals collected from several different sound sensor placed in different position to detect the height of the user. Sound sensor has part of the advantages of the ultrasonic sensor. Sound sensors are not affected by light source. However, it is affected by the sound created in a noisy environment. The performance of a sound sensor will be affected if it is used in a place full of people where there are excessive sources of sound. Sound sensors have a price range of RM7 to RM20.

Table 1 shows the comparison between various types of sensors based on several sources. After the comparison that has been done, the sensor used to measure the height of the user will be ultrasonic sensor. The model used is HC-SR04 as shown in Figure 14. The sensor is cost effective. It will not be affected by any light source and the colour of the surface. It also has a lower cost if compared to other sensors with a better performance.

The method used to measure the user's height is tip of the head sensing method. It uses the trigonometry theory which is a similar method used to measure tree. The sensors are placed at an angle such that it formed a right angle triangle with the user.

Table 1 Comparison between Different Types of Sensors

| Features | Infrared Sensor | PIR Sensor | Ultrasonic Sensor | Sound Sensor |
|---|---|---|---|---|
| Strength | -Narrow beam width<br>-Faster reaction time | -Measure presence of specific object | -More accurate with distance<br>-Wider Beams<br>- Higher max distance | Not affected by material, light source and surface of material. |
| Weakness | -Readings differs from surface<br>- Affected by light source<br>- High cost for good performance | -No measure of distance<br>-Difficulty in target selection | -Affected by strong sound absorbing material | -May varies according to different volume of the speaker<br>-Get affected by the surrounding sound |
| Cost | Rm2– Rm100 | Rm8 | Rm 6 | RM7- RM20 |

In the beginning of the process, the microphone stand will reset its position to the minimum. If the height of the user does not match with the stand, the sensors placed at the pre-calculated angle will detect obstacle which will be the head or body of the user. The sensor will then trigger the motor to increase the height of the microphone stand until there are no more obstacles detected. The microphone stand is also being specially arranged such that if the sensor did not sense the head of the user, the microphone will be close to the mouth of the user which is approximately 13 cm from the mouth of the user according as discussed in the previous section.

Furthermore, to ensure the accuracy of the height measuring system 2 ultrasonic sensors will be used in this sensing system. One more ultrasonic sensor is placed at the medium portion of the microphone stand. This ultrasonic sensor will be used to detect the presence of the human being. With the help of this sensor the intelligent microphone can be operating fully by itself once it is powered up without the interference from a human being. In total, there are 3 ultrasonic sensors used to build up the sensing system.


Figure 14 Ultrasonic Sensor

### 3.1.1.3 Position Angle Estimation for Ultrasonic Sensor

The angle to be estimated is angle X in degree which is the position angle for the ultrasonic as shown in Figure 15 and Figure 17. The first step in estimating the position angle for the ultrasonic sensor is to calculate angle U and angle V with the help of 2 imaginary parallel lines as shown in Figure 16. Subsequently, the estimation can proceed as shown in Figure 17. In order to calculate the angle X, length A and length B must be determined. Length A is the horizontal distance from the ultrasonic sensor to the body of the user which is measured to be 41 cm while length B is the vertical height calculated to be 37cm. With all the values, angle X for height mode 1 is estimated to be $102^0$, while height mode 2 is $94^0$. The middle point for this 2 angle which is $98^0$ is used as a reference for the ease of design. However, the angle calculated is only to be used as a reference when the prototype is being fabricated. The real angle must be calibrated based on the surrounding conditions during operation. Furthermore, the position of the ultrasonic sensor must be placed such that the microphone will not obstruct its line of detection

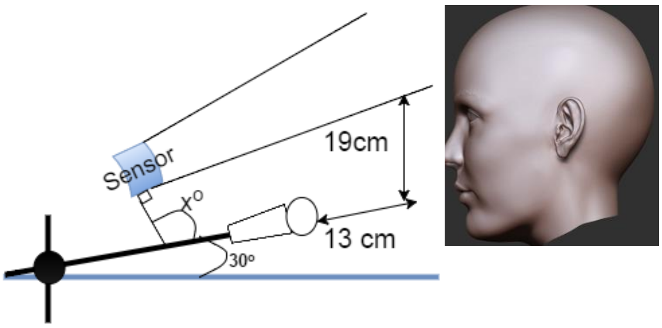


Figure 15 Position Angle Calculation of Ultrasonic Sensor

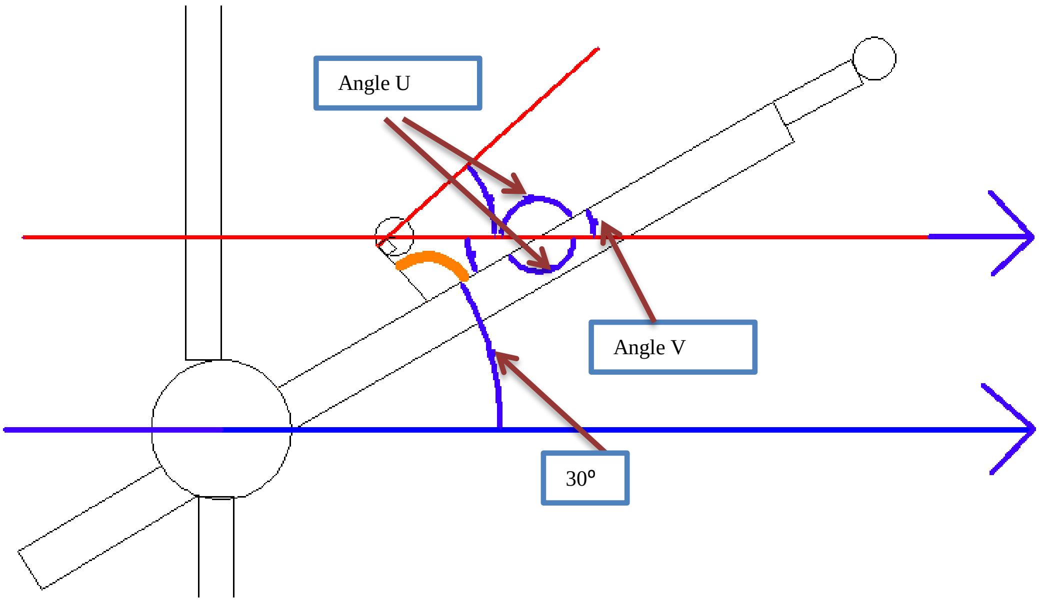


Figure 16 Angles in Parallel Lines

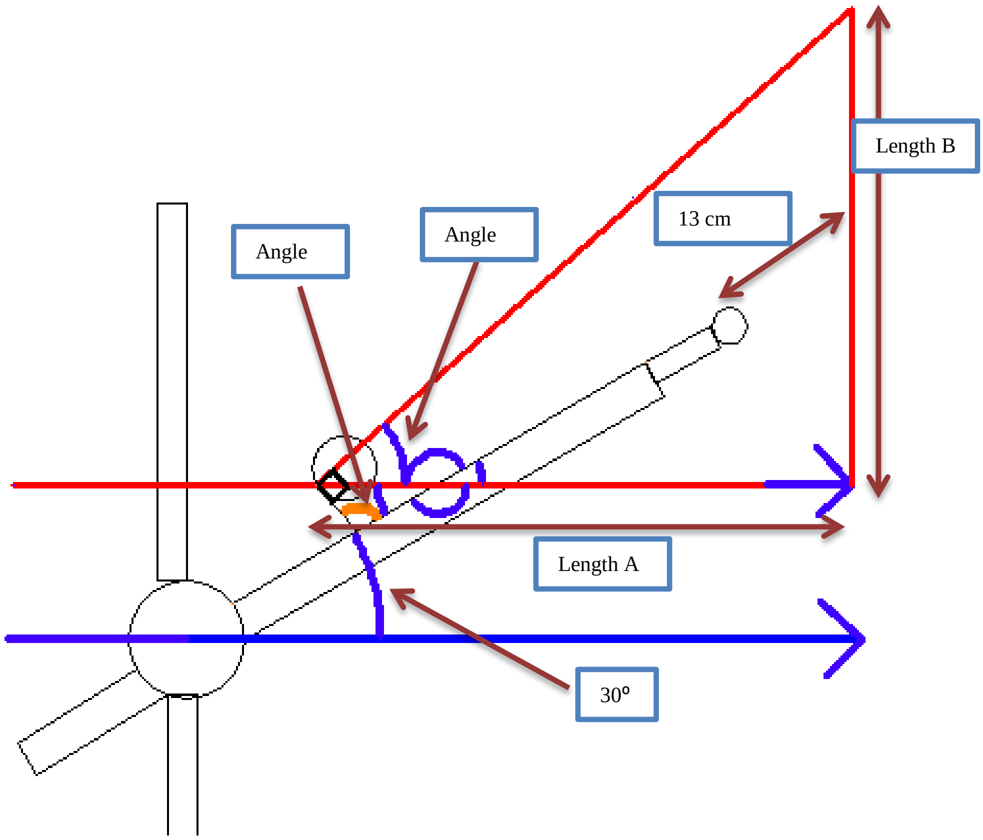


Figure 17 Position Angle Estimation for Ultrasonic Sensor

### 3.1.1.4 Sensor Mount

The 2 ultrasonic sensors that is used for height estimation require a proper mount on the microphone stand so that it can be positioned safely on the microphone stand and also increase the appearance of the entire system. The ultrasonic sensor mount have to fit in to several criteria. The mount must have light weight which must be less than 100gram to not burden the servo motor. Its angle of tilting must be adjustable so that it can be changed in the future for various applications and to fit various requirements. The ultrasonic sensor mount is fabricated using plastic mount and steel bracket connected by nuts and screws. The ultrasonic sensor mount is durable, adjustable and presentable. It is small in size and does not obstruct the view and the face of the presenter. The ultrasonic sensor mount is shown in Figure 18.

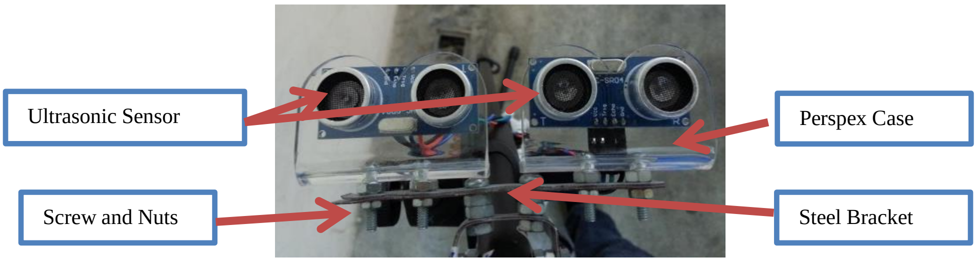


Figure 18 Ultrasonic Sensor Mount

### 3.1.2 Height Adjusting Mechanism

The height mechanism is built from the hardware which are fabricated by the previous team. This includes a gear, gear rack and servo motor holder. However, there are several enhancements that are needed to be made. First of all, a new servo motor will be selected to fit in all the requirements of the intelligent microphone stand. A servo motor is selected because it can provide high torque with lower current if compared to a dc motor and also to be able to fit it into the servo motor holder that has been prefabricated. However, the servo motor selected will require extra hardware which is the limiting switch to have a better control of the entire system

On the other hand, the microphone stand tends to sway from left to right when it is adjusting its height with the prefabricated hardware alone. Hence, a support mechanism must be built to address this issue. The support mechanism is designed and fabricated in order to support the operations of the gear and gear rack that is prefabricated. In total, the height adjusting mechanism is made of the gear, gear rack, servo holder, servo, supporting mechanism, and also the limiting switches and they will be discuss in the next part of the section.

#### 3.1.2.1 Prefabricated Hardware

The intelligent microphone stand uses gear and its gear rack to adjust the height of the user. The gear and gear rack used in this project is custom designed and fabricated using aluminium. The designing and fabrication of the gear and gear rack has been completed by the previous team. The gear that is fabricated is a 12 tooth gear. The gear rack is 15cm in length and it enables a total 13cm of height adjustment. Figure 19 shows the CAD drawing of the gear and gear rack system. Due to limitation of hardware, the intelligent microphone stand can only adjust its height for a range of 13 cm. Hence, there are 2 height modes designed for more height variability to allow more users to utilise the intelligent microphone stand. Height mode 1 is suitable for users with height of 155cm to 173cm while mode 2 is suitable for user from 166cm to 184 cm. The suitability for both mode accounts for a negligible difference of +-2cm for the placement of microphone. The settings and information regarding the 2 height modes are displayed in Table 2. On the other hand, the fabricated servo holder is shown in Figure 20. The servo holder is specially designed to hold the servo closed to the microphone stand.

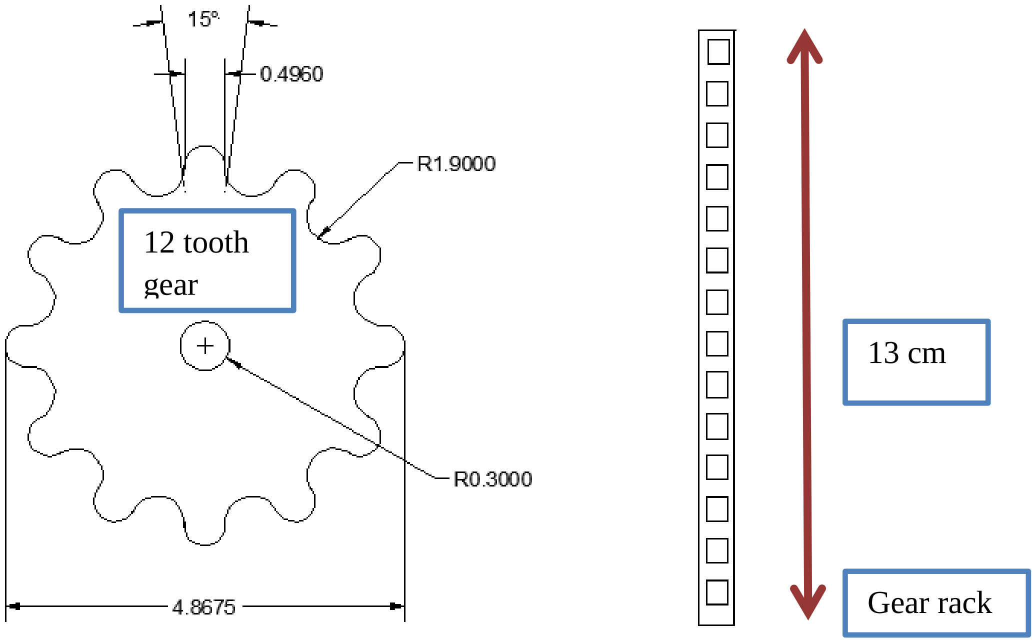


Figure 19 Gear and Gear Rack

**All measurements are in cm

Figure 20 Servo Holder

Table 2 Height Modes Comparison

| | Height Mode 1 | Height Mode 2 |
|---|---|---|
| User's height | 155cm to 173cm | 166cm to 184 cm |
| Microphone Positioning Angle | 30° | 45° |
| Microphone Positioning Length H | 6.5 cm | 9.0 cm |
| Microphone Positioning Length D | 11.25 cm | 9.20 cm |

**3.1.2.2 Servo Motor**

Servo motor is selected to convert electrical energy to mechanical energy which in turn will help to increase and decrease the height of the microphone stand. Servo motors provides accurate position and are able to hold the position with maximum resistive force. The type of servo motor selected in this project is continuous rotation servo motor. Looking from their appearance, the continuous rotational servo motor is same as a normal servo motor. However, a continuous rotational servo motor allows unlimited rotation of the motor. The properties that can be controlled are its speed, direction and also the time it is required to rotate. The user can use these properties to control the rotation of the servo motor. On the other hand, a normal servo motor only allows the rotation of 0 to 180 degrees. This will limit the height that is adjustable by the intelligent microphone stand. Due to this reason, a continuous servo motor is used in this project. Table 3 display the comparison between a normal servo motor and a continuous rotation servo motor.

Table 3 Comparison between Servo Motor and Continuous Servo Motor [17]

| Properties | Servo motor | Continuous Servo Motor |
|---|---|---|
| Motor type | Servo | Servo |
| Controllable properties | Angle of rotation | Speed of rotation and direction of rotation |
| Advantages | 1. Accurate control of the servo motor.<br>2. Ability to resist the reverse motion if connected to power source. | 1. Unlimited angle of rotation<br>2. Ability to resist the reverse motion if connected to power source. |
| Disadvantages | Limited angle of rotation | Requires extra sensor or limiting switch to control the angle of rotation |

Before the exact servo motor is selected its torque requirement will have to be calculated. The torque requirement is calculated by using formula (2)

$$\tau = r * F * \sin(\theta) \quad (2)$$

Where

$\tau$ is the magnitude of the torque

r = the radius of the gear = 2.5cm

F is the force applied to the gear, where in this case is the weight of the microphone holder and its supports. The magnitude of the force is calculated using formula (3).

F = (mass of microphone holder + microphone + sensors set) * gravity acceleration (3)

F = 0.810kg * 9.8 ≈ 8.1N

$\theta$ is the angle between the force vector and the lever arm vector. In this project, the weight of the microphone holder and support is applied exactly $90^{o}$ with the tooth of the gear.

$\theta = 90^{o}$

With the help of the weighing scale, the mass of the object exerted on the gear tooth is 0.810 kg. On the other hand, the distance between the center to the edge of the gear is 2.5cm. Using the formula from (2) and (3) the torque requirement for the servo motor will be approximately 20.5N.cm or 2.05kg.cm. With this torque requirement, a continuous servo motor can be selected.

As a result, servo motor DS3109 is selected. It has a minimum operating voltage of 4.8V and 1.8A current at lock. With this operating power it can provide a maximum torque of 9kg.cm which is more than enough to support and to adjust the height of the intelligent microphone stand.

However, the only drawback is that a continuous motor will need limiting switches to control the motion of the motor. As a result, 2 limiting switch are added to the system to limit the motion of the continuous servo motor. 1 limiting switch will be place to indicate the maximum height while the other will indicate the minimum height it can reach. The limiting switch will be triggered by a metal hook attach to the moving rod of the microphone stand.

### 3.1.2.3 Gear Rack Support System

The gear and rack system that is fabricated is not strong and robust enough to support continuous use of the intelligent microphone stand. The swaying from left to right of the microphone extension arm greatly affects the system's stability. Hence, a support system is design to support and enhance the movement of the system. Figure 21 shows the support mechanism design CAD drawing. The supporting mechanisms will not only provides support for the gear and gear rack while providing a mounting spot for the 2 limiting switch required by the system. With the support mechanism, the height adjustment mechanism of the microphone stand will be more stable. The support system will be fabricated using affordable and robust material such as PVC. The design of the support system will have to prepare a space for the limiting switches and should not obstruct the wiring of the entire system.

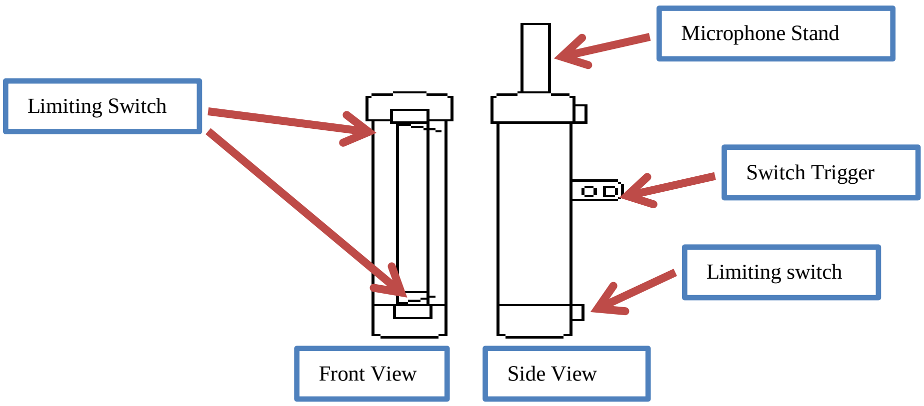


Figure 21 Supporting Mechanism Design

The supporting mechanism is fabricated after it has been designed. It has a great appearance while increasing the stability of the height adjusting mechanism. The supporting mechanism is fabricated using Polyvinyl chloride, PVC. PVC is a strong and light material commonly used in piping system. The supporting mechanism has a black paint finishing which it can effectively blend in with the intelligent microphone stand itself. Figure 22 shows the fabricated supporting mechanism.

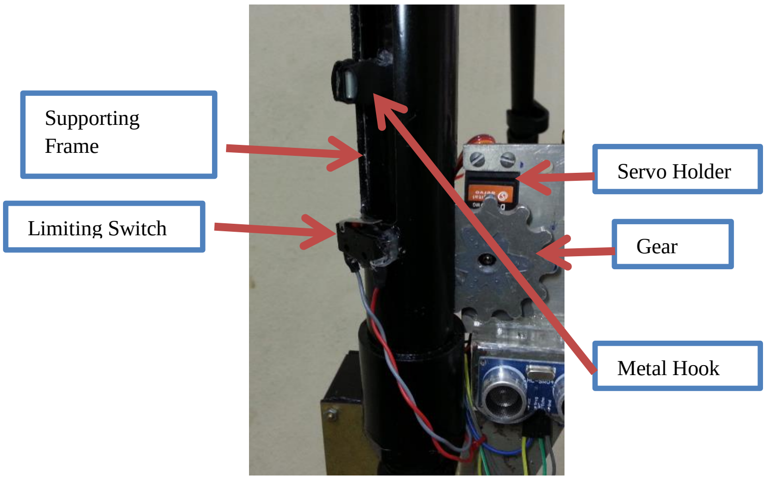


Figure 22  Height Adjustment Support Mechanism

### 3.1.3 Controller

The central controller is the part where all the processing and controlling take place. The controller will take in readings from the sensor and provide feedback through the height adjusting mechanism. The central controller consists of the microcontroller, controller circuitry and also the Perspex casing to protect the entire controller. Furthermore, to improve user experience there will be LED indicator to indicate the operational mode of the intelligent microphone stand.

#### 3.1.3.1 Microcontroller

Microcontroller is used to control the overall system of the intelligent microphone stand. The controller that will be focused in this project will be Arduino Uno. This is because Arduino Uno is the best controller to get start with electronic projects. Arduino supports a wide range of  sensors and it uses C/C++ programming language which will be easier to be programmed. The board offers a total of 14 digital inputs and outputs pins which will be sufficient to support all the sensors and switches that are needed by the intelligent microphone stand system. It consumes less power and can be supply with a minimum voltage of 5V [18].

Furthermore, Arduino is an open source hardware. This means that there are ample of supports and assistance regarding bugs and errors that will occur along the way of the project. All the advantages of the Arduino Uno board make it a suitable microcontroller to be used in this project.

### 3.1.3.2 Controller Circuitry

The microphone stand requires several components to support its functionality. Among them are resistors and limiting switches. Furthermore, the Arduino controller only provides 2 ports that supply power which are the 5v and Vin ports. However, the sensors, receivers and switches require 5v inputs. Hence to enable port sharing among all the sensors and receiver, an external circuit is required.

The external complementary circuit has 2 major functions which are to share VCC and GND ports of the controller among sensors and also to provide the external components needed by the controller to carry out the task. Figure 23 shows the circuit diagram of the complementary circuit. The completed circuit will be soldered to the soldering board.

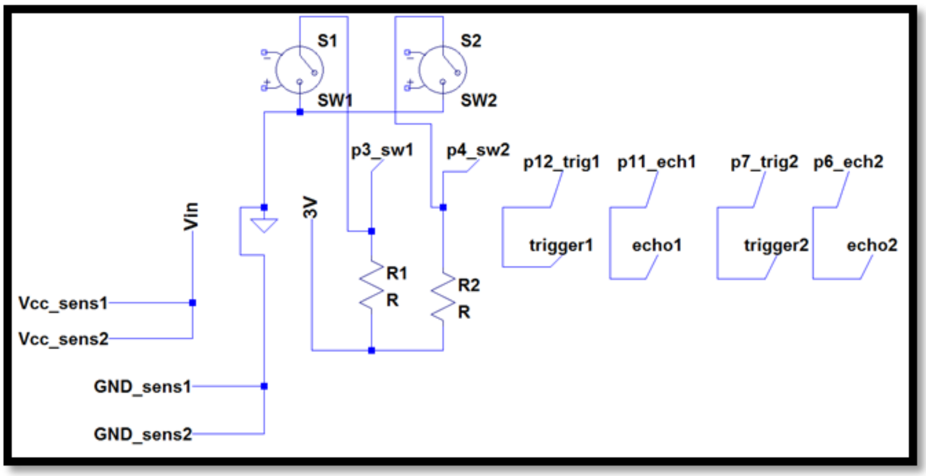


Figure 23 Circuit Diagram for Complementary Circuit

### 3.1.3.3 Controller Protection

The controller and the rest of it components are placed in a cardboard box during development phase of the intelligent microphone stand. The controller is the heart of the intelligent microphone stand and hence it would need a durable and presentable casing.

After the improvement, the Arduino will be placed in an acrylic box. The rest of the circuit and the controller will then be placed and protected in a Perspex box custom made to protect the core of the system. The protection cover is created to protect the circuit from any potential damage coming from the surroundings and also from transporting. The casing is made from black Perspex perfectly cut using laser cut technology. The box is assembled using hot glue and screw providing a robust and presentable finishing to the controller box as shown in Figure 24.

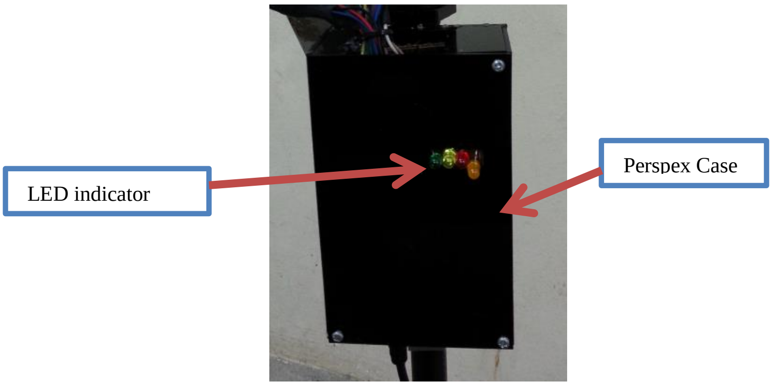


Figure 24 Casing for Central Controller

### 3.1.3.4 LED Indicator

There are 2 modes of operation and also 2 signals incoming from the surrounding. To increase and improve the user experience, a LED indicator circuit will be included as an indicator for the operation mode and also to indicate when there are signals received from the IR receiver and ultrasonic sensor. The indicator circuit will have 4 LED lights with each have a different colour and different indication which is shown in Table 4.

Table 4 LED Indicator

| LED Colour | Green | Yellow | Red | Blinking Orange | Blinking Red |
|---|---|---|---|---|---|
| Indication | Autonomous Mode | Semi-Auto Mode | Idle Mode | Ultrasonic sensor object detection | IR receiver receiving |

#### 3.1.4 Power Source

The whole system will obtain its power from the Arduino as most of the components require a small amount of current. The operating voltage for all the components of the system will be 5V. The most current drawn is by the servo motor. The maximum current that the servo motor will draw is at 9kg.cm torque is 1.8A. However, the torque that is needed from the servo is 2.05kg.cm. At this torque, the operating current for the servo will be well below 1.0A according to the specification. The microcontroller itself will consume a current less than 0.1A while 1 ultrasonic sensor will consume a current of 15mA. Table 5 shows the power requirement for each of the component. A total current of 1.60 A is required from the power source to the entire system. This means that a power source of 5v and 1.60 A is required. The microcontroller can be powered via USB cable type B or through a DC power jack.

Table 5 Power Requirement

| Component | Current (A) | Voltage (V) |
|---|---|---|
| Servo (at max load = 9kg) | 1.8A | 5 |
| Servo (at load = 1kg) | 1.0A | 5 |
| Servo (average current estimation) | 1.4A | 5 |
| Arduino Uno | 0.15A | 5 |
| HCSR04 Ultrasonic sensor X 3 | 0.045 | 5 |
| | | |
| Total requirement | 1.595 | 5 |

##### 3.1.4.1 Power Source Selection

The power source selected is Xiao MI brand power bank with 10000 mAh capacity. It has a 5v and 2A output rating. Before the decision is made the real power requirement for the system is measured. Table 6 shows the experimental value for power requirement of the system. The total requirement will be 1.35A. The maximum output of the power bank is 1.9A and 5V. The power source meets the system requirement and also provided some extra power as redundancy.

The capacity of the power source is 10000 mAh at 5V with 93% conversion rate. This means the real output is 9300 mAh. Assuming at each hour, there are total of 6 presenters each presenting for 10 minutes each. For each presenter the system will goes through a 20 second adjustment time, 10 second of reset position time and

570 second of idle time. The power requirement that hour will be 377mAh. Theoretically, the power source can be used to power the entire system for up to 23 hours continuously before it is needed to be recharge. The power bank will be powering the system via USB type B cable.

Table 6 Experimental Value for Power Requirement

| Component | Current (A) | Voltage (V) |
|---|---|---|
| Servo (idle , 0.6kg load) | 0.09A | 5 |
| Servo (increasing height, max) | 1.1A | 5 |
| Servo (decreasing height , max) | 0.3A | 5 |
| Arduino Uno with LED indicator | 0.2A | 5 |
| HCSR04 Ultrasonic sensor X 3 | 0.05 | 5 |
| | | |
| Total requirement (maximum) | 1.35 | 5 |

### 3.1.5 Backup System

Upon completion on the main autonomous system, a backup system comprising of an infrared receiver module and also an infrared remote control will be added to the overall system. Figure 25 shows the remote control and Infrared receiver set added to the system.


Figure 25 Infrared Receiver Module V2 and Infrared Remote Control

The remote control will have several functions. The functions are as below:

i. To switch functioning mode of the intelligent microphone stand from autonomous to semi-automatic and vice versa
ii. To control the height of the microphone stand in semi-automatic mode
iii. To stop and freeze the whole system in its current height

iv. To reset the whole intelligent microphone system and resume to its original position.

This backup system is created to complement the autonomous intelligent microphone stand. By default, the intelligent microphone stand will be in autonomous mode and in its lowest position.

**3.2 Program Algorithm.**

Following the completion of design, the algorithm of the overall program can then be planned. An algorithm is first being develop before any program code is written. The program will be created only after the algorithm is completed.

Figure 26 shows the entire algorithm of the program that will be implemented on the intelligent microphone stand. The program will begin by checking the presence of a human being. When a human being is detected, it will then use the sensor to detect the height and also distance of the user. Next, it will use the servo motor with the help of metal track to move the microphone higher and closer to the user. The motor will stop once it is unable to detect the head of the user which is a sign where the microphone has reached an optimum height. After that, the program and the controller will go into idle mode after it has confirmed it position for more than 30 seconds. The remote control will then be used to reset the position if the user of the microphone stand is changed. However, if the functioning mode of the intelligent microphone stand is changed to semi-automatic mode, the ultrasonic sensor will be deactivated and the height will then be controlled only by the remote control. The remote control can be used to control the height of the intelligent microphone stand using a step by step adjustment or continual adjustment.

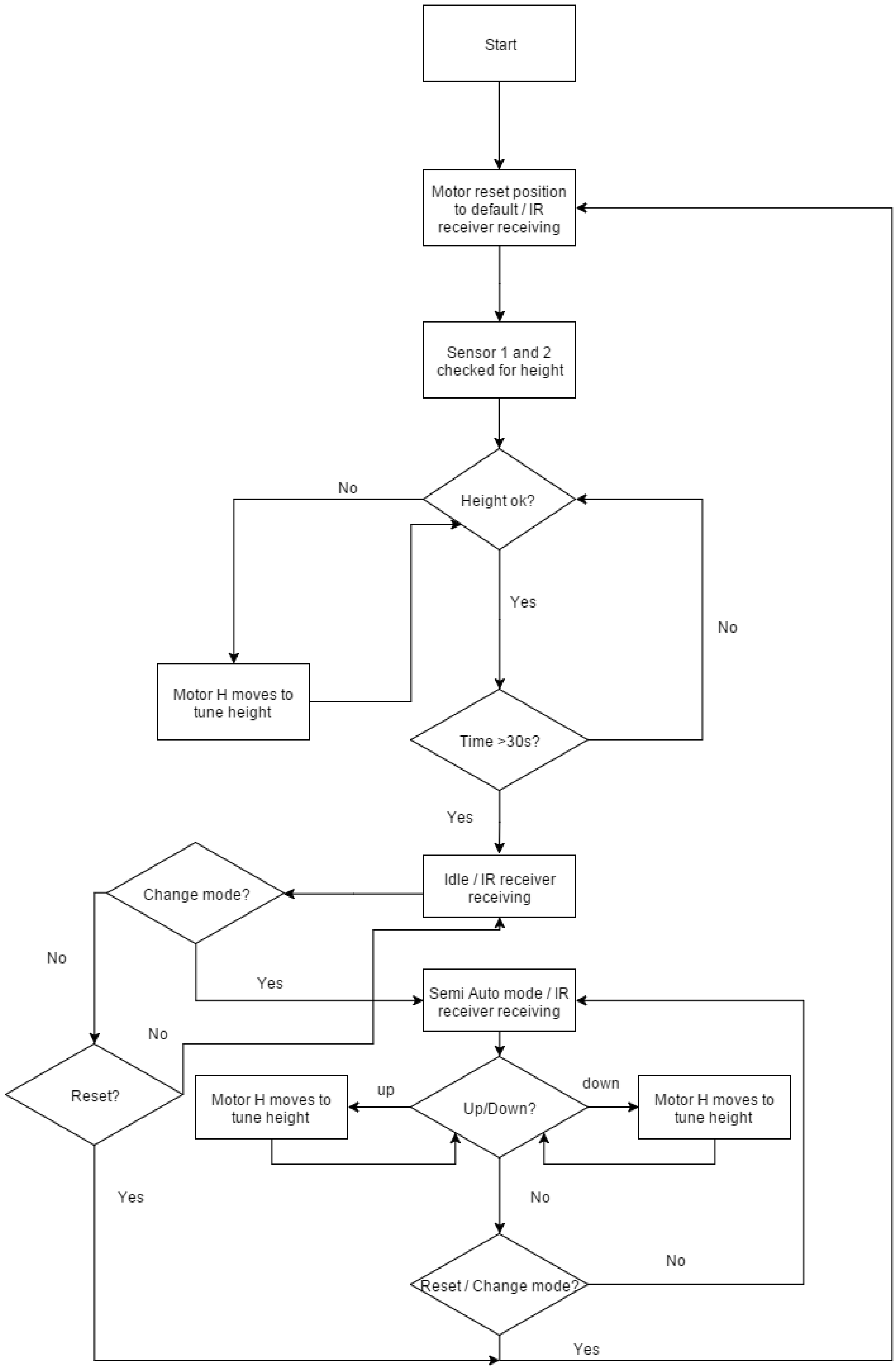


Figure 26 Program Algorithm

### 3.3 System Integration

After the hardware part and software part of the system has been completed, the integration between the 2 parts will be executed. All the hardware parts will first be mounted and combined together and the program will be loaded to the microcontroller. For system integration part, the issue with hardware and software must be solved. The final prototype of the intelligent microphone stand is shown in Figure 27. The completed prototype will then be tested for its performance.

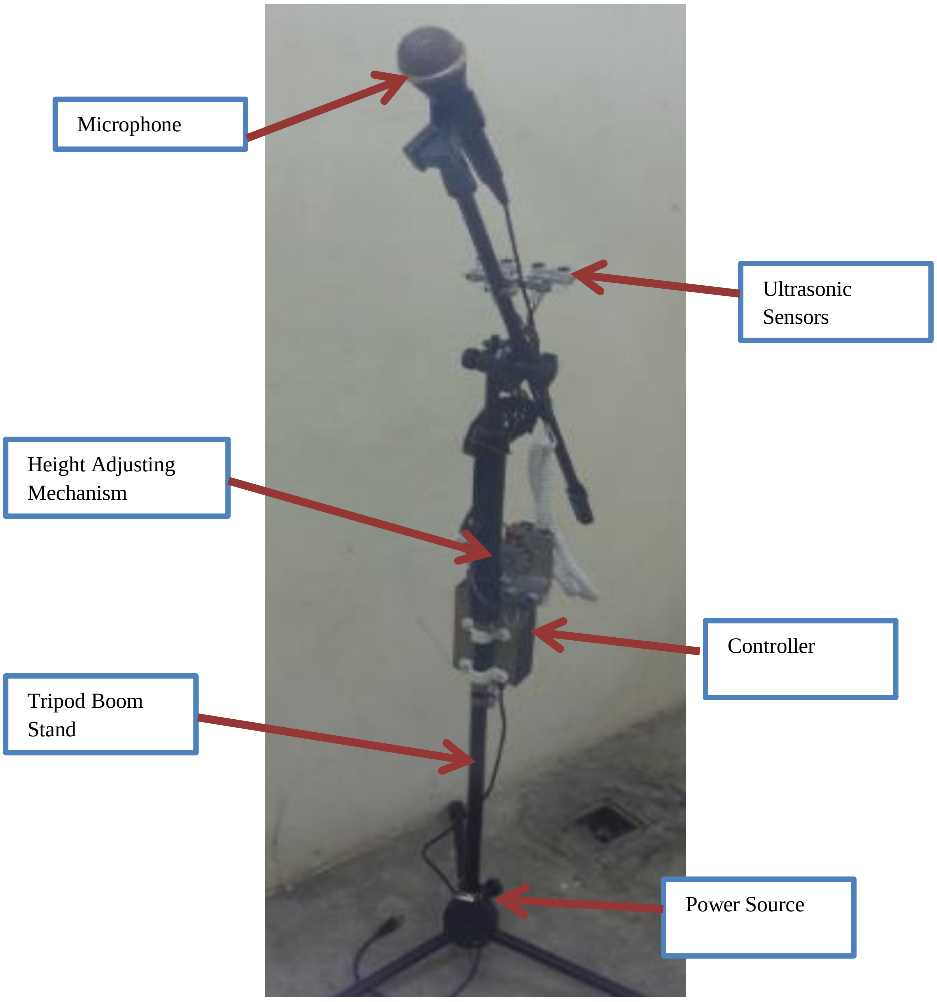


Figure 27    Completed Prototype

### 3.4 Project Conduct Flowchart

Figure 28 shows the activities in designing and fabrication of the intelligent microphone stand. Each of the activities shown in Figure 28 is being carried out to ensure the success of the project.

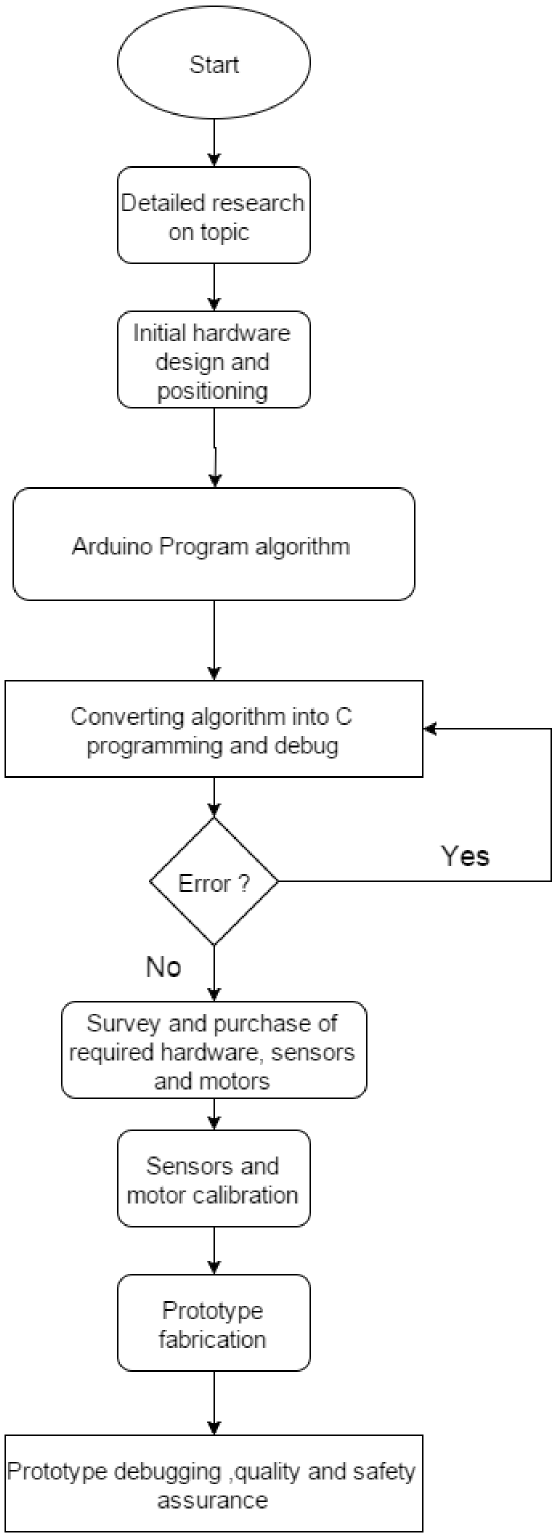


Figure 28 Project Conduct Flow Chart

### 3.5 Conclusion

As a conclusion, the intelligent Microphone stand is made up of 5 major parts which are the sensors system, height adjusting mechanism, controller, power source and backup system. This 5 parts is integrated together to build up one complete system. Once the software is loaded inside the Intelligent Microphone Stand prototype, the system is ready for operation. Once the power source is connected, the prototype will be functional. Each part of the system is carefully designed and fabricated to ensure its durability while providing a presentable appearance. The main objective of the prototype will be to adjust its height autonomously according to the user's height. After the prototype has been fabricated, it will be tested for functionality and reliability. The results will be discussed in Chapter 4.

# CHAPTER 4

# RESULTS AND DISCUSSION

The main objective of this project is to test the intelligent microphone stand that has been fabricated to ensure it has sufficient reliability and performance. In the point of view of the user, the intelligent microphone stand has to adjust itself quick enough to avoid any awkward situation and it must be able to adjust the microphone to its optimum height. The users will also expect the system to work continuously without any major issue. This is the reason why the test for the Intelligent Microphone Stand prototype will be focused on reliability, speed of adjustment and also the accuracy of adjustment.

In this section, the test conducted to the completed prototype and also its results will be discussed. This section will also focus on the overall performance of the fabricated prototype.

## 4.1 Test

The fabricated prototype is placed into tests after it has been fabricated. The test will have to test its repeatability, accuracy and also the time taken for the intelligent microphone stand to adjust its height. A test was designed to verify the characteristic. The test will require test subject which are volunteers to use the intelligent microphone stand. The volunteer is requested to approach the intelligent microphone stand from a distance. When he/she approaches the intelligent microphone stand, the timer will begin. The timer stops when height adjustment stops and the time taken for the intelligent microphone stand to adjust its height is then recorded. Its final height is also recorded. This test is done 20 times for each volunteer. The procedure of the designed test is shown in Figure 30. There are a total 7 volunteers participated in this test. Height mode 1 and height mode 2 are both being tested and analyzed. Figure 29 shows the volunteer during the test of the prototype.

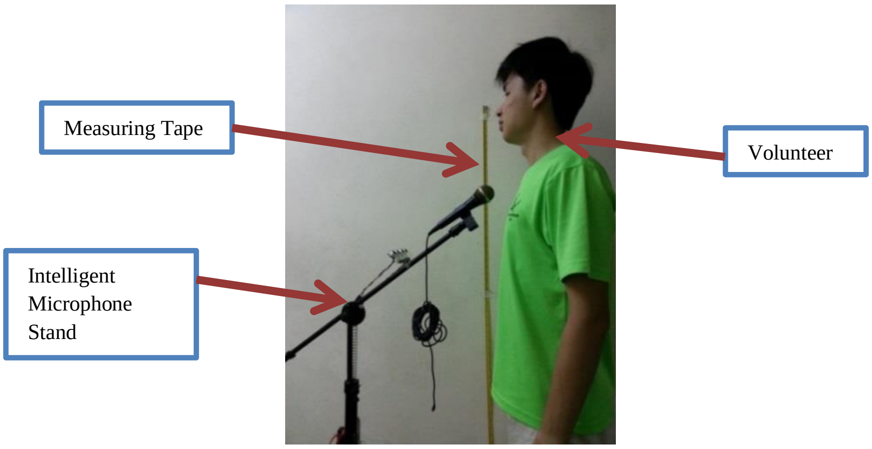


Figure 29 Volunteer Testing the System

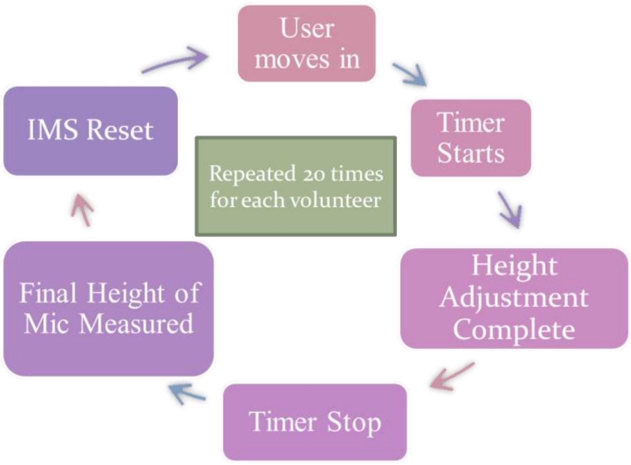


Figure 30 Test Procedure

## 4.2 Test Results

### 4.2.1 Reliability Analysis

The total participant that has participated in this test is 7. Each of the participants will test the intelligent microphone stand for 20 times. Along the testing process, no major error happens to the system. In another word, the prototype has been tested for more than 140 times and it is still functioning without any error. This shows sign of system stability and reliability.

### 4.2.2 Time Analysis

The test results for time taken for the prototype to adjust its height are shown in Figure 31, Figure 32 and Figure 33. Figure 31 shows the raw data for the time taken for the intelligent microphone stand. Figure 32 and Figure 33 shows the time analysis from the result obtained from the test for autonomous height mode 1 and height mode 2. The average time taken for overall height adjustment is 10.1s with a standard deviation of 1.71. This means that the maximum time taken for the intelligent microphone stand is approximately 12 s while minimum will be approximately 8 s. The target time for this project is less than 30 s and a maximum time for adjustment of 12 s is within the requirement and is acceptable. Furthermore, 12s is quicker than needing the stage personnel for manual adjustment which will normally take several minutes. However, there is a control test which a volunteer with maximum height is requested to test for both mode 1 and mode 2. The average time taken is 8 second, while the average time for the other volunteer is 10.1s. This difference of 2s could be cause by the sensors detection issue when it comes to the border or the edge of the human head. The sensor will take extra time to adjust its height when it reached the tip of the human head. However, the difference of approximately 2s second is acceptable.

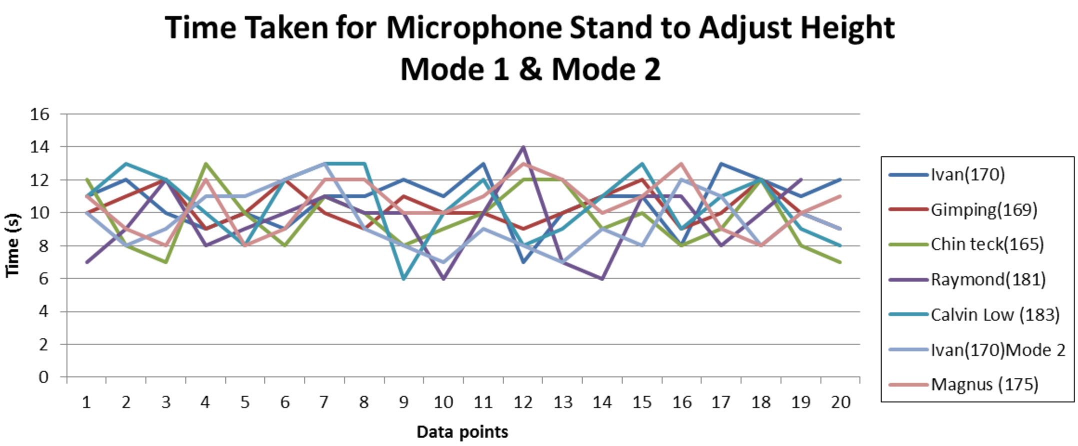


Figure 31 Graph of Height Adjustment Time for Height Mode 1 And 2

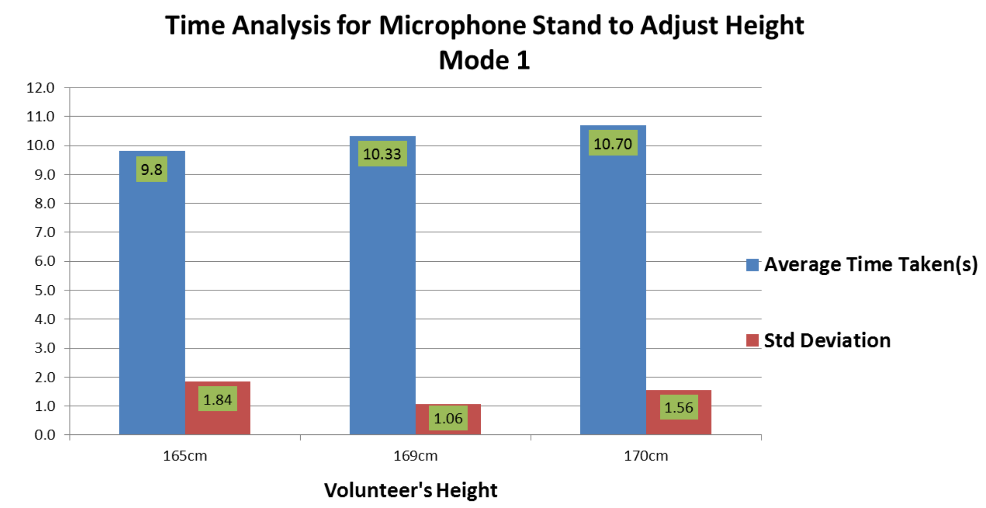


Figure 32 Graph of Time Analysis in Height Mode 1

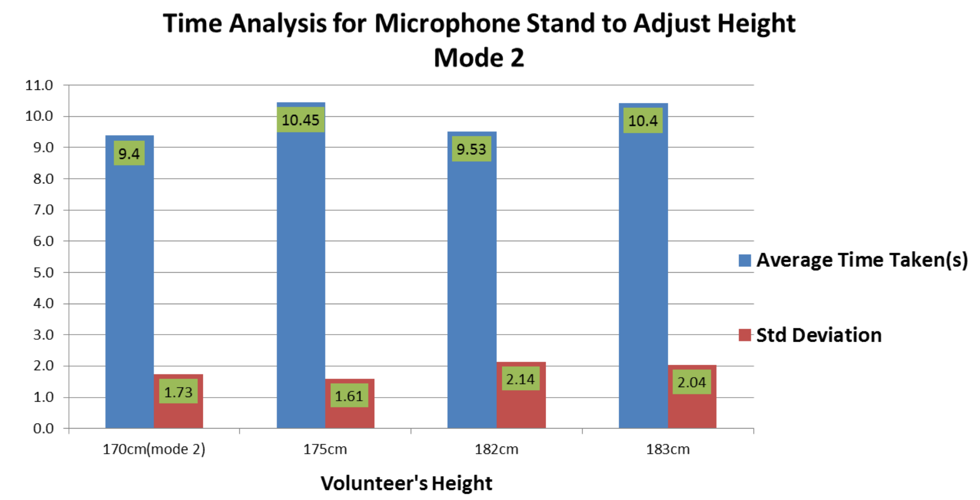


Figure 33 Graph of Time Analysis in Height Mode 2

### 4.2.3 Accuracy Analysis

For accuracy analysis, a target height for microphone placement for each volunteer is first calculated. Formula (4) is used to calculate the target height is shown below.

$$Target\ height = User\ height - 19 - H \quad (4)$$

19 is the standard distance from top of the head to lips in cm while H is the height of the triangle formed between the user and microphone which is calculated from the

previous section. Each time the volunteer test the intelligent microphone stand, the final height of the intelligent microphone stand will be recorded and compared with the target height. The difference between the target height and the recorded height allowable is +-2cm. Each time the recorded height matches the range within the target heights, 1 point will be awarded as the accuracy score. The total score will then be converted to a percentage for analysis. The result from the test is then plotted in graph as shown in Figure 34. The results show that the intelligent microphone stand prototype has obtained accuracy scores which are greater than 90% with an average of 94%. Furthermore, from the results tabulated in Table 7, the maximum mismatch of heights is 1.5 cm out from the target range. The mismatch of the height could be caused by overshoot of the system due to the reaction time of controller and also the sensitivity of the sensor at the tip of the human head. However, this mismatch does not cause any critical failure for the system and it is hardly noticeable by the user.

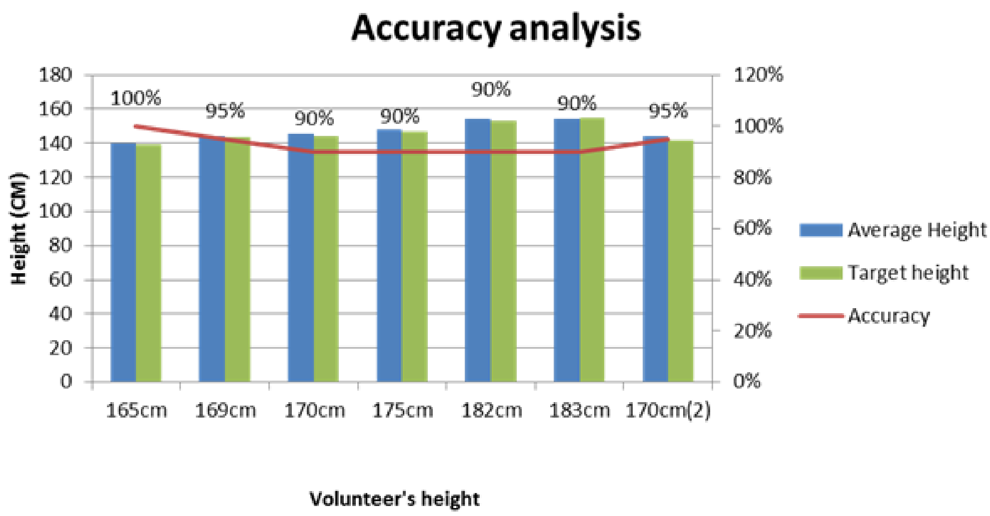


Figure 34 Graph of Accuracy Analysis for Height Mode 1 And 2

Table 7 Total Result for System Test

| | Height mode 1 & Height mode 2 |
|---|---|
| Total Average Time for Height Adjustment | 10.1 s |
| Total Standard Deviation for Height Adjustment Time | 1.7 s |
| Total accuracy | 94% |
| Maximum height mismatch from target point | 3.5 cm |

### 4.3 Conclusion

The test designed for this project is to test the performance and stability of the intelligent microphone system. The prototype has been able to achieve good results in the test conducted. The excellent performance of the intelligent microphone stand will be useful in the future when it is converted into a commercial product. The robust system plus with the features it provides will definitely attract customer's attention.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATION

The prototype for this project has been completed successfully and its functionality has been tested. The results from the test indicate that the prototype has the characteristic required. It has the stability and repeatability required while providing fast adjustment time at an average of 10s with an average percentage up to 94%. The functionality of the prototype increases its commercial value. All the objectives of this project have been achieved.

The prototype presented in this project provides a solution for users which that try to solve the issue that occur when there is a height mismatch between the user and also the microphone stand. Furthermore, the prototype fabricated has a remote control system to increase its functionality. Users can choose either to let the microphone stand to adjust itself autonomously or adjust it by using a remote control from a distance up to 10 M away from the intelligent microphone stand. The two modes allow flexibility in terms of adjusting the intelligent microphone stand for the event planner and also avoid any embarrassing moment due to height mismatch of the microphone stand.

## 5.1 Recommendation

For future development, the intelligent microphone stand prototype fabricated can be converted into a commercial product. In order to convert the prototype into a commercial product, it has to be marketed and its packaging must be focused. A casing for the whole system can be created to keep the intelligent microphone stand and also to transport it. Furthermore, to mass produce the intelligent microphone stand, a partnership with a trusted vendor must be established to ensure the quality of the product is the same with the prototype.

Other than that, the concept used to build the intelligent microphone stand can be used for other types of microphone stand such as the round base microphone stand, overhead microphone stand and more. Since different type of adjustable microphone stands have their similarity in terms of height adjustability, they can use the concept and technology and method of adjusting autonomously such as the one used in this project.

# REFERENCES


[1] M. Bellis, "The history of microphones", 2014. [Online]. Available: http://inventors.about.com/od/mstartinventions/a/microphone.htm. [Accessed: Oct. 9, 2015].

[2] E-home recording, "The ultimate guide to microphone stands for stage and studio" in studio,. [Online]. Available: http://ehomerecordingstudio.com /microphone-stands/. [Accessed: Oct. 12, 2015].

[3] Lewis, F. S. "Microphone stand" US Patent 2532173. Nov. 28, 1950.

[4] H. Robjohns, "A brief history of microphone", 2001. [Online]. Available: http://microphone-data.com//media/filestore/articles/history-10.pdf. [Accessed: Oct. 11, 2015].

[5] J.Daggy, "Information about microphone stands", 2008. [Online]. Available: http://daggy.name/fohp/index.htm. [Accessed: Oct. 13, 2015].

[6] HowiseACC. "Acelectronic desktop mic studio microphone suspension boom scissor arm stand holder", 2014. [Online]. Available: http://www. amazon.co.uk/Broadcast-Microphone-Suspension-Scissor-Recording/dp /B00HWR742Q . [Accessed: Oct. 13, 2015].

[7] QY. Jiang , X.T. Qiang and HC Hong . "Microphone stand capable of falling and rising intelligently and automatically", China Patent 202652474. Jan 2, 2013.

[8] S.G. Chao and D.G. Wang "Stage microphone with automatic elevating and height control functions", China Patent 203942623. Nov 12, 2014.

[9] J. Ding. "Automatic elevating-lowering microphone support", China Patent 203015069. November 12, 2013.

[10] I.Wigmore. "Sensors", 2012. [Online] Available: http://whatis.techtarget.com /definition /sensor. [Accessed: Oct.13, 2015].

[11] P.Alan, "Human engineering design data digest", Department Of Defense Human Factors Engineering Technical Advisory Group, 2008, pp.72- 75.

[12] W.Ron. "Microphones", 2016. [Online]. Available: http://www.cybercollege. com/tvp039 .htm. [Accessed: Jan. 12, 2016].

[13] Homestudio.com. "8 common microphone mistakes", 2016 [Online]. Available: http://www.home studiocorner.com/8-microphone-mistakes/. [Accessed: Feb. 22, 2016].

[14] T. Mohammad. "Using ultrasonic and infrared sensors for distance measurement" World Academy of Science, Engineering and Technology, vol. 3, 2009.

[15] L. Hodges. "Ultrasonic and passive infrared sensor integration for dual technology user detection sensors". [Online]. Available: http://www.egr

.msu.edu/classes/ece480/capstone/fall09/group05/docs /ece480_dt5_application_note_lhodges.pdf. [Accessed: Dec. 12, 2015].

[16] Ladyada. “PIR motion sensor”, 2012. [Online]. Available: https://learn.adafruit.com/downloads/pdf/pir-passive-infrared-proximity-motion-sensor.pdf. [Accessed: Dec. 12, 2015].

[17] Modmypi.com. “What's the difference between dc, servo & stepper motors?”, 2013. [Online]. Available: http://www.modmypi.com/blog/whats-the-difference-between-dc-servo-stepper-motors. [Accessed: Dec. 12, 2015].

[18] Arduino.cc. “Arduino uno general info and specs”, 2016. [Online]. Available: https://www. arduino.cc/en/Main/ArduinoBoardUno. [Accessed: Feb. 22, 2016].

# APPENDIX

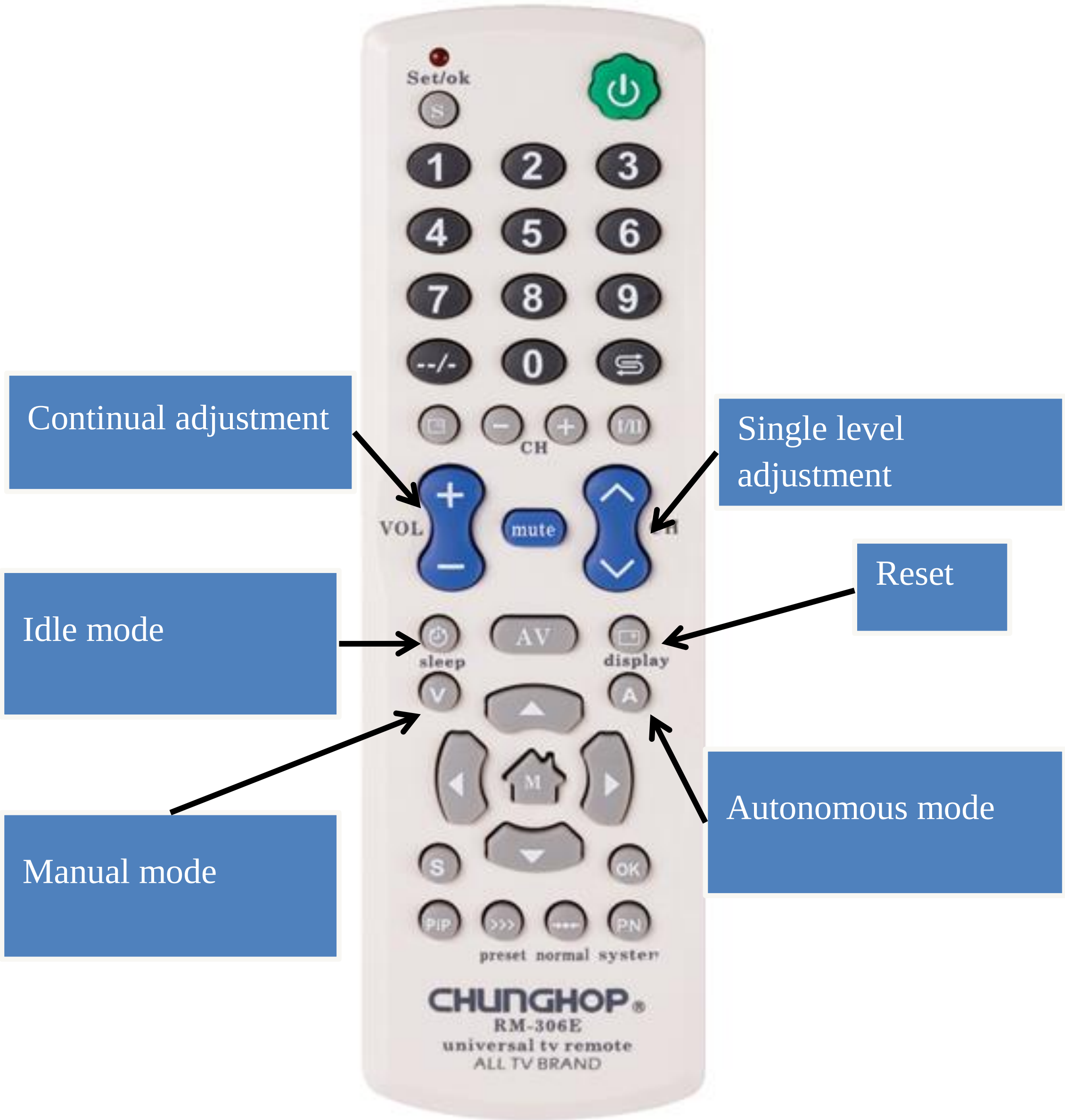


Figure 35 Remote Control Guide