



## **UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

### **IMPLEMENTATION OF NEW CONTROLLER TO CONTROL X-AXIS MOVEMENT OF TABLE TENNIS LAUNCHER**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours.

By

**SONIA A/P SAMUDASAN  
B071510769  
921030-10-6516**

**FACULTY OF ENGINEERING TECHNOLOGY**

**2018**

## **DECLARATION**

I hereby, declared this report entitled “Implementation of New Controller to Control X-Axis Movement of Table Tennis Launcher” is the results of my own research except as cited in references

Signature : .....

Author’s Name : .....

Date : .....

## **APPROVAL**

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours. The member of the supervisory is as follow:

.....

(Madiha Binti Zahari)

## ABSTRAK

*Dalam globalisasi moden ini, sukan adalah salah satu hiburan terkenal di kalangan masyarakat untuk mengembangkan kebolehan dan kemahiran fizikal mereka. Merujuk kepada kedudukan permainan dunia, permainan tenis meja memegang tempat kedua berbanding dengan permainan yang lain. Sehingga kini, di seluruh dunia boleh dikatakan seramai 300 juta pemain tenis meja di seluruh dunia dan sekitar 218 persatuan meja tenis diadakan di bawah Persekutuan Tenis Meja Antarabangsa (ITTF). Ini membuktikan bahawa permainan tenis meja adalah permainan terkenal yang dimainkan di kalangan orang ramai. Oleh itu, kewujudan robot pelatih tenis meja dapat meningkatkan kemahiran pemain tenis meja ini. Walau bagaimanapun, disebabkan harga yang tidak dapat dipertimbangkan, keperluan robot tenis meja dengan harga yang lebih murah adalah permintaan pemain yang termasuk dengan ciri-ciri seperti, dilengkapi dengan pelancar yang dapat meloncarkan bola untuk meningkatkan kemahiran pemain tenis meja dan menaik taraf gaya amalan dengan mempunyai tapak sebagai pengawal yang mampu menggerakkan robot tennis meja pada paksi X. Bagi mengawal bahagian pergerakan, Motor DC dan Arduino Uno adalah komponen utama untuk mengawal robot Meja Tennis untuk bergerak. Sebagai kesimpulan, robot Meja Tennis dengan pengawal paksi X mampu memperbaiki kemahiran pemain selain menyediakan platform yang lebih mencabar untuk para pemain.*

## **ABSTRACT**

In this modern globalization, sports is one of the famous entertainment among the societies to develop their physical abilities and skills. Referring to the world game ranking, the table tennis game holds the second place compared to the others games. Up to date, all over the world there are about 300 million of table tennis players around the world and around 218 table tennis association are held under International Table Tennis Federation (ITTF). This proves that the table tennis game is such a famous game played among the societies. Thus, the existence of the table tennis trainer robot able to improve the skills of the table tennis player. However, due to its unaffordable price, the need of a table tennis robot with a cheaper price are in demand that includes the features such as equipped with ball launching system which improves the table tennis player's skills and in order to upgrade the style of practice, a base as controller is needed which able the table tennis robot to have x-axis movement. While, for the motion part, the DC motor and Arduino Uno is the main component to control the moving table tennis trainer. As a conclusion, a table tennis trainer robot with x-axis controller able to improve the skill of players besides provides a more challenging platform for the players.

## **DEDICATION**

I dedicate my memoir work to my beloved family and friends. A sincere memoir to my loving parents, Mr. Timothy S/O Yesaiah and Mrs. Thavamani Ammal D/O Kali.

I also dedicate this memoir to the societies and other friends who have supported me throughout the progress of this project. I will always be thankful for all their sacrifices and their time for guiding me in this project, especially Lim Pei Shan for the many hours of proofreading.

## **ACKNOWLEDGEMENT**

Firstly, I would like to thank sincerely to those who had guide me to complete my project successfully. A sincere gratitude I would like to give to my supervisor Mdm.Madiha Binti Zahari from the Electrical Engineering Department from Faculty of Technology Engineering, Universiti Teknikal Malaysia Melaka (UTeM) who had helped me out in trouble-shooting problems, giving the best suggestion and recommendation regarding this project and also a proper planning to complete this project. A special thanks also to those who helped me indirectly such as my family members and friends for their encouragements and idea's towards completing this project from the beginning until the end. Besides that, I would also thank the other lecturer's, lab technicians and also the panels for giving their feedback and comments to improve this project to a better stage. Without all this guidance, I would never learn and build up my skills of knowledge in this field.

# TABLE OF CONTENT

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	viii
List of Figures	ix
List Abbreviations, Symbols and Nomenclatures	xi

## **CHAPTER 1: INTRODUCTION** **1**

1.1	Project Background	1
1.2	Problem Statement	2
1.3	Objective	3
1.4	Scope of project	3

## **CHAPTER 2: LITERATURE REVIEW** **4**

2.1	Introduction	4
2.2	Background of Table Tennis	4
2.2.1	Basic Equipment	5
2.2.1.1	Ball	5
2.2.1.2	Table Tennis	6
2.2.1.3	Blade	7
2.2.2	Training Techniques	7
2.3	Table Tennis Robot	8
2.3.1	Launcher	9
2.3.1.1	Wireless	10
2.4	Movement	12
2.4.1	Timing Belt	12
2.4.2	Conveyor	14



2.4.3	Robot Gripping	15
2.4.4	Pneumatic Actuator	16
2.5	Speed Controller	18
2.6	Controller	22
2.7	Software	24
2.7.1	Programming Language	24
2.8	Components	25
2.8.1	Heavy Duty Suction Cup	25
2.8.2	Bearings	25
2.9	Analysis of Methodology	27
2.9.1	Analysis of Repeated Data	27
2.9.1.1	Analysis of Precision	28
2.9.2	Analysis of Percentage Error	29
2.10	Conclusion	29
 <b>CHAPTER 3 : METHODOLOGY</b>		<b>30</b>
3.1	Introduction	30
3.2	Flow of Project	30
3.3	Problem Inspection	32
3.4	Evaluation and Selection Method	33
3.5	Component Preparation	36
3.5.1	Motor	36
3.5.2	Board	37
3.6	Flow Chart	38
3.7	Analysis Performance	

	41
3.7.1 Statistical Graph	41
3.7.1.1 Line Chart Graph (Positioning)	41
3.7.1.2 Line Chart Graph (Time Taken)	41
3.7.2 Percentage Error	42
3.7.3 Questionnaire	42
<b>CHAPTER 4 : ANALYSIS AND DISCUSSION</b>	<b>43</b>
4.1 Introduction	43
4.1.1 Summary of Survey	44
4.1.2 Design Selection	49
4.1.3 Analysis of Accuracy	51
<b>CHAPTER 5 : CONCLUSION AND RECOMMENDATION</b>	<b>74</b>
5.0 Introduction	74
5.1 Conclusion	75
5.2 Recommendation	75
<b>REFERENCES</b>	<b>76</b>
<b>APPENDICES</b>	<b>77</b>

## LIST OF FIGURES

2.1	3 Star Table Tennis Ball	6
2.2	Standard Size Table Tennis	6
2.3	Short and Long Pips	7
2.4	Antispin and Inverted	7
2.5	Front and Side View Delay, W.	8
2.6	Bluetooth Model HC-06	11
2.7	Zig Bee	11
2.8	WLAN	12
2.9	Timing Belt	13
2.10	Conveyor	15
2.11	Robot Gripping	16
2.12	Pneumatic Actuator	17
2.13	DC Metal Gear Motor	18
2.14	Stepper Motor	19
2.15	Brushless DC Gear Motor	20
2.16	Pneumatic Actuator	20
2.17	Diagram of Arduino Uno with Labelling	21
2.18	Arduino Nano with Labelling	22
2.19	Labelled Raspberry Pi 3	22
2.20	Ball Bearing	23
2.21	Comparison between Microcontrollers	24
2.22	Different types of Heavy Duty Suction Cup	26
2.20	Ball Bearing	27
3.2	Part 2	31
3.3	Part 3	32
3.4	Why-Why Analysis	33
3.5	Design Concept A	34

3.6	Design Concept B	34
3.7	Design Concept C	34
3.8	Dc Gear Motor	35
3.9	Arduino Uno	36
3.10	Gear	36
3.11	Flow Chart of Overall Project	38
3.12	Flow Chart of Table Tennis Project	39
3.13	Line Graph	41
3.14	Involvement in Sports	45
3.15	Frequency of Playing Table Tennis	45
3.16	Days of Practice in a week	45
3.17	Difficulties to Find Partner To Practice	46
3.18	Number of Individual feels bored to play Table Tennis	47
3.19	Table Tennis Robot as Partner to Practice	47
3.20	Affordability to Purchase Table Tennis Launcher	48
3.21	Opinion of Playing with a Robot to Improve Skills	48
3.22	Purchasing a Robot or a Coach	49
3.23	Opinion of playing with Robot Interesting or Not	49
4.1	SolidWork Design	50

## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

ITTF	-	International Table Tennis Federation
Dc	-	Direct Current
3D	-	3 Dimensional
Ac	-	Alternative Current
RPM	-	Rotation Per Minute
WLAN	-	Wireless Local Area Network
MYR	-	Malaysian Ringgit
PWM	-	Pulse Width Modulation

# CHAPTER 1

## INTRODUCTION

### 1.1 Project Background

Table Tennis is a sports that initially played as an indoor game. This game then became famous mainly among the Chinese communities. Countries like China, Germany, Sweden and South Korea are the main competitors of the country Malaysia. There are some percentage of failure in performance of playing a table tennis game due to several factors. Firstly, the period of training between coach and players plays an important role. The players only have sufficient time to practise with their coach. Thus, this causes difficulties for the players especially the beginner level as they need more time to practice the different skills.

Based on the quality purpose, to produce an efficient player there is a need of robot trainer whereby this trainer are the partner for the player to play and practice the game. According to the previous research, the existing table tennis trainer does not satisfy the players need. This is due to several factors such as high cost and not challenging.

Therefore, in this project a new controller which can control the horizontal linear movement is implemented on the existing table tennis launcher to create a more challenging platform for the players.

## **1.2 Problem Statement**

The main organisation of the table tennis should have goals to make sure that each table tennis player able to give a quality performance and maintain the same level during the competitions. This is to enable a higher number of players to perform well during the tournament when competing with the advanced countries.

Nowadays, athletes are very busy with their personal works which couldn't make them to attend the practice frequently. Therefore, the training system provided for the players are less effective. As the attendance are less during the practise, it automatically drops the quality of the player's performance. Thus, it drops the reputation of the table tennis sports and the name of the country.

By having a table tennis robot, it helps to improve the quality of the players. This is because players can practise anytime they are free less depending on another individual. A table tennis robot functions in several ways depends on the programs that had been installed. It can produce movement, launching system and speed control of the robot. In the next chapter , the different concepts of how a table tennis robot produce movement are analysed.

### **1.3 Objective**

Based on the problem statement that are stated, the objective of this project are :

- i. To design a motion controller integrating with existing table tennis launcher
- ii. To analyse the performance of the new controller for existing table tennis launcher.

### **1.4 Scopes of Work**

The scopes of work for the project include the following areas:

- i. The ball is able to launch in a straight direction.
- ii. The trainer movements will cover the table tennis approximately 5 feet.



## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

In this chapter, it contributes the outcomes from previous researchers related to the study of table tennis trainer project. To date, table tennis launcher with x-axis movement has still not yet been extensively studied. Therefore, this chapter includes the recent real time table tennis trainer in market besides analysing the movement mechanism concept that can be applied to the scope of this project. Other than that, revising the theoretical knowledge, methodological of the related project that had been carried by previous researchers had also been emphasized. The current studies contributes to our knowledge by addressing few important factors such as the speed to control a system, movement mechanisms and application of suitable microcontroller for table tennis trainer. Thus, this chapter will cover the background of table tennis, equipments used, suitable microcontroller and methods to control speed for producing x-axis movement.

## **2.2 Background of Table Tennis**

The earliest evolve of the table tennis occurred in the year of 1890. This game was played inside a building which is known as an indoor game. Initially, the game was played using a dining table and rackets with long handle covered by the rubber which develops as a great entertainment to the societies. At the year of 1920's, the table tennis game started to develop well in the eye of the societies. This game had been further espoused by J. Jacques, Son, England and Parker Brothers, United States by creating different types of names for this game. The first world champion was organized after the formation of International Table Tennis Federation(ITTF) in the year of 1927. In 1930, a fast grow of this game due to the creation of hard rubber racket which has the feature of a layer of rubber with short, hard pimples that cover the wood blade. This is the time began for the players to apply an average volume of spin to the ball. Thus, this game began to be famous which leads the formation of United States Table Tennis Association (USTTA) in 1933. This development then leads to a more latest idea and creation of sponge bat in 1950's. Then, table tennis game had been identified by the world through the Seoul Olympics 1988(Suarez, 2015).

### **2.2.1 Basic Equipment**

#### **2.2.1.1 Ball**

The sanctioned quality of ball are labelled ITTF which has 3-star either in white or orange in colour. The number of stars indicates the better quality of the ball which means higher number

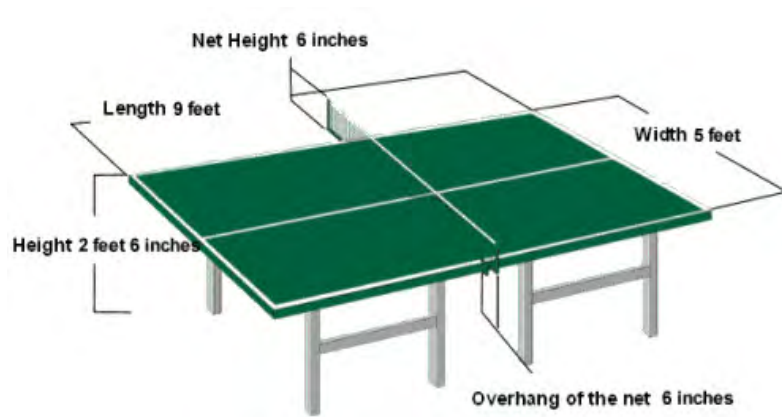
of stars represent better quality. The average weight of the ball is 2.7grams with 20millimetre radius. The coefficient of the ball is between 0.82 to 0.92. This is to enable the ball to bounce up about the height 250 millilitre when a ball hits a standard steel surface. Figure 2.1 below shows the example of a table tennis ball with 3stars (Allen, 2005; Suarez, 2015).



**Figure 2.1:** 3 Star Table Tennis Ball adapted from (Suarez, 2015)

### 2.2.1.2 Table Tennis

The measurement of the size of a standard table tennis is 9ft in length and 5ft in width. A high quality table is the table that is sanctioned by USATT or ITTF. The non reflecting table which is blue or green in colour has a white thin line surrounded at the corner and centre of the table. A metal net post is used to attached the net to the table. Figure 2.2 shows a standard recognized table tennis (Suarez, 2015).



**Figure 2.2:** Standard Size Table Tennis adapted from (Suarez, 2015)

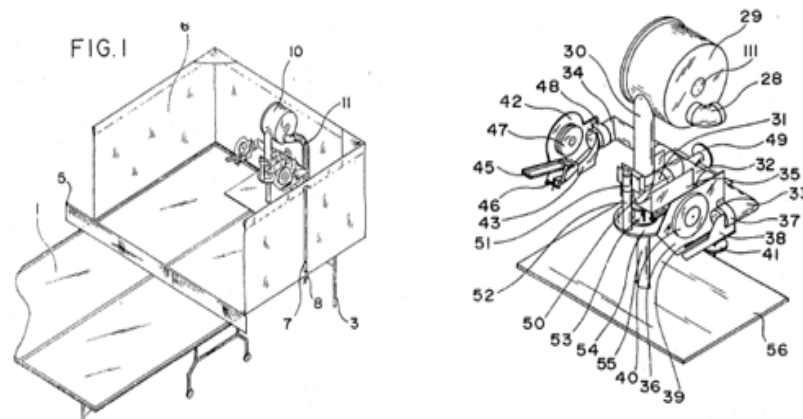
### 2.2.2 Training Techniques

There are several techniques players had been practise during their trainings. Firstly, a basic method were used to practise this game where by two players played the game simultaneously. This is a very common method and simplest method to allow the players to take a turns when playing. Second method is playing the game between the players and the coach whereby the coach can guide the players to correct and improve the skills and method of playing. This is an effective method for players to develop their skills, but the only disadvantage is the coaching fee's are usually high. Third method is the individual practise alone where player can shadow stroke the various shots and techniques as well as practicing serves. Besides that, players can also play this game by the method called "multi-ball". Multi-ball means only one player able to practise perhaps another player can only feed the balls. The final method is the "ball throwing machine" or also called as robots. There are different kinds of table tennis robots depending on the type of the programs being installed. This method is highly recommended to be used by players because the players can even practise the game without

accompanied by another person, whereby players can practise alone with the robot which substitute human being (Allen, 2005; Suarez, 2015).

### 2.3 Table Tennis Robot

For enhancement of training purposes, a table tennis robot which has oscillatory motion, different types of spin such as top and bottom spin, controllable speed and non-stop recycling of ball is obtained through the design by Daley, W as in Figure 2.3. The usage of this concept provide a more challenging practise for the players (Daley and St, 1988).



**Figure 2.3:** Front and Side View by Delay,W adapted from (Daley and St, 1988)

#### 2.3.1 Launcher

In order to provide self training, table tennis launcher is manufactured which enables the ball to shoot automatically to improve the players skills of playing. Most of the table tennis launcher trainer available in market operates by the concept of counter-rotating wheels. By modifying the rotation speed of

the wheel, the angle, height, depth and spin of the shot can be changed. According to the research, there are 10 different types of table tennis trainer available in the market today. Below are the figure 2.4 showing the various types of table tennis launcher existing in the current market. The specification of the launchers are attached at the appendix.

**Figure 2.4(a) :** Existing Table Tennis Trainer adapted from open source

Features	Newgy Robo-Pong 540	Oukei TW-2700 08B	Paddle Palace H2W Touch Pro	Butterfly Amicus	Killer Spin 700-02
Image		 Appendix A	 Appendix B	 Appendix C	 Appendix D
Complete Wireless Control	No	No	No	-	Yes
Controller	Analog	-	-	Analog	-
Recycling System	No	No	No	Yes	Yes
Frequency of Ball	Controllable	Controllable	Controllable	Controllable	Controllable
Speed Control	Yes	Yes	Yes	Yes	Yes
Type of Spin	Top, Side, Back	9 Different Spin	-	-	No Side Spin
Position of controller	-	Opposite of Player side	-	-	-
Movable/Static	Static	Static	Static	Static	Static
Price(MYR)	1092.48	Unavailable	7028.00	7823.00	4001.85

**Figure 2.4(b) :** Existing Table Tennis Trainer adapted from open source

Features	Newgy Robo-Pong 2050	I-Pong V300	Robo Pong 2040	Robo Pong 1040	Paddle Palace S4W PRO
Image		 Appendix E	 Appendix F		 Appendix G
Complete Wireless Control	No	Yes	-	No	No
Remote Control	Digital	-		Analog	Digital
Recycling System	Yes	No	-	No	-
Frequency of Ball	Controllable	Controllable	-	Controllable	-
Speed Control	Yes	Yes	-	Yes	Yes
Type of Spin	Top, Side, Back	Top, Side, Back	-	-	-
Position of controller	-	-	-	-	-
Movable/Static	Static	Static	Static	Static	Static
Price(MYR)	3716.00	538.37	2935.33	1366.58	5869.63

### 2.3.1.1 Wireless

There are various method to control the movement of a robot. One of the method is by wireless control. The first type of wireless control method is by using an application for android mobile interfaced by Bluetooth which is a simpler hardware to be build (Pahuja and Kumar, 2014). The second method of wireless control is by using ZigBee which consume low data rate(Rashid *et al.*, 2012).

The other type of wireless control is by using Wireless Local Area Network(WLAN) that consists of high data rate that supports navigation of robot(Winfield and Holland, 2000).

According to the previous researcher, HC-05 Serial Bluetooth model has been chosen as interface to control the moving robot as shown in figure 2.5 below. The reason for choosing Bluetooth HC-05 as wireless device is due to its low cost and ease of data exchange(Pahuja and Kumar, 2014). The advantage of this Bluetooth is it doesn't need a drive but able to communicate with other devices.



**Figure 2.5:** Bluetooth model HC-05 adapted from website mcuoneclipse by Erich Styger posted on June19,2015

Based on previous research, ZigBee wireless device has been used as interface for control motion as shown in figure 2.6 below. ZigBee can operate in 868MHz, 915MHz 2.4GHz of frequency rate. ZigBee consume low data rate and low cost(Lin, Liu and Fang, 2007; Rashid *et al.*, 2012).