THREE-WHEEL TABLE TENNIS BALL THROWING MACHINE

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THREE-WHEEL TABLE TENNIS BALL THROWING MACHINE

by

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List of Abbreviation

DC	Direct Current
PWM	Pulse Width Modulation
ITTF	International Table Tennis Federation
AC	Alternative Current
COM	Centre of Mass
DOF	Degree of Freedom
3D	3-Dimension
PVC	Polyvinyl chloride
CAD	Computer Aided Design
RPS	Rotation Per Second
RPM	Rotation Per Minute
LCD	Liquid Crystal Display

List of Symbols

F_g	Gravity Force
F_l	Lift (Magnus)
F_d	Drag Force
M_p	Drag Moment
V	Translational Velocity
ω	Rotational Velocity
C_d	Drag Force Coefficient
F_M	Magnus Force
C_l	Lift Force Coefficient
π	Pi
Δl	Ball Deformation due to the wheel pressure
t_{on}	On time
V_n	Velocity of wheel
V_{Ball}	Velocity of ball

MESIN MEMBALING BOLA PING PONG TIGA RODA

ABSTRAK

Sebuah mesin membuang bola ping pong tiga roda telah direka dan dicipta. Kajian telah dibuat terhadap mesin untuk mengetahui bagaimana putaran bola boleh dihasil berdasarkan kelajuan ketiga-tiga roda yang berlainan. Sebuah sistem kawalan diperlu untuk menghasilkan putaran bola dengan merujuk kepada masukan yang diterima. Projek ini bermatlamat untuk mereka-bentuk sebuah mesin membuang bola ping pong yang boleh ditanggung, boleh diprogramkan dan berfungsi baik. Mesin ini mempunyai 13 masukan dan 13 keluaran. Putaran yang dihasil berbeza dengan keluaran yang berbeza. Bekalan kuasa telah ditukar dari 240V AC to 12V DC. Arduino mega 2560 microcontroller adalah pengawal yang digunakan dalam projek ini. Sebuah motor berdaya-kilas tinggi telah digunakan untuk memutar piring kayu bulat yang berfungsi untuk mengawal kadar bola. Sebuah motor yang daya kilas yang rendah dan kelajuan tinggi telah digunakan untuk memutar kipas dan tiga buah motor berus berkelajuan tinggi dan daya kilas tinggi digunakan untuk menembak bola keluar dari mesin. Ketiga-tiga motor ini menerima isyarat PWM yang lain dan menghasilkan putaran yang berlainan terhadap bola ping pong. Sebuah potentionmeter digunakan untuk mengawal kelajuan motor. Mesin ini boleh menghasilkan putaran Top Spin, Back Spin, No Spin, Side Spin, Back Side Spin dengan pilihan sama ada spin yang berat atau ringan. Kelajuan yang berbeza memberi kelajuan bola dan bilangan putaran bola per minit yang berlainan. Untuk mencapai top spin berat, nisbah motor ialah Roda A: B: C= 6.8: 1: 1 manakala nisbah top spin ringan ialah Roda A: B: C= 1.8:1:1. Putaran sisi arah jam yang berat memerlukan nisbah kelajuan motor seperti Roda A: B: C= 3.5: 3.2: 0 manakala putaran sisi arah jam ringan memerlukan nisbah kelajuan seperti Roda A: B: C= 2.5: 1: 1. Nisbah kelajuan motor akan dikekalkan untuk menghasilkan putaran bola. Kelajuan motor boleh diubah dengan melaraskan tahap kelajuan.

THREE-WHEEL TABLE TENNIS BALL THROWING MACHINE

ABSTRACT

A three-wheel table tennis ball throwing machine is designed and fabricated. The study on speed combination of three-wheel is performed to produce several spin with different kind of three wheel speed combinations. A control system is needed to produce the ball spin based on the input delivered. This project is aimed to design an affordable, programmable and well perform three-wheel table tennis ball throwing machine. The machine has 13 inputs and 13 outputs. The outputs are different type of ball spins. The power supply providing power to the machine will current from 240V AC to 12V DC. The Arduino Mega 2560 microcontroller is used as the controller to control the motors. A high torque DC motor is used to rotate the round wooden disc where it can control the ball feed rate. A low torque high speed DC brushed motor is used to spin the fan so it can blow the ball to reach the shooting place. Three high speed high torque DC brushed motors are used to shoot the table tennis ball from machine. They receive different PWM signals and provide different results to rotate the table tennis ball. A potentiometer is used to control the speed of motor hence varies the reading of PWM in multiplication method. The machine can give Top Spin, Back Spin, Side Spin, No Spin and Back Side Spin with the choice of heavy or light spin. The different speed ratio of the motors are giving different ball spins and number of spins of ball per minute. To achieve heavy top spin, the ratio of motor speed is Wheel A: B: C= 6.8: 1: 1 while the light top spin is Wheel A: B: C= 1.8: 1: 1. The heavy clockwise side spin require speed ratio of Wheel A: B: C= 3.5: 3.2: 0 while the light clockwise side spin require speed ratio of Wheel A: B: C= 2.5: 1: 1. The speed ratio of motors are remain same to produce the ball spin. The motor speed can be varied by adjusting the speed level.

CHAPTER 1

INTRODUCTION

1.1 Research Background

Nowadays, the usage of ball training machines in ball related sports have become common and universal. The machine found is normally used in cricket [4] [29] [18], tennis [5], baseball [3], volleyball [6] and table tennis [1] [2]. In the game of cricket, the batsman is required to be trained playing different varieties of bowling in order to make the batting technically perfect. The machine is needed to provide accurate and consistent batting practice for players of all standards like professional, amateur and club level crickets [4]. The player can use it as a part of their regular practice for fine tuning of battery as well as eliminate flaws in their batting without necessity of bowler.

Besides the tennis, the table tennis is one of the ball sports which very general in using ball training machine. According to study, the simulated training is one of the well method to improve your techniques. One of the simulated trainings [7] is multi-ball training which need the assist of ball training machine in order to achieve the “high” level [8] of table tennis playing skills. In the tournament, it is important to forecast and return the circumrotating of table tennis ball [9]. Not only that, the low mass of body, elasticity of ball and its mini size also play their roles in determinant of the table tennis game [10]. The machine can putting the ball into same location and feed a lot of balls in short time. The machines also can improve techniques, footwork and fitness. The machine also provided better pressure than average training, practice for return the serve and most important it is economic if compared to hire a coach for training.

As we know, the market is filled with a lot of table tennis machines. However, some really expert table tennis machines using artificial intelligence, image processing and machine vision [11] are found. But they are only used for researching purpose in laboratory and no yet been commercialised. The commercialised machines could be categorised as one-wheel, two-wheel and three-wheel. The three-wheel machine is so far the high-end product if compared to other machine for example the Butterfly Amicus [2] and Trainerbot in table tennis. The three-wheel ball machine is most expensive and most advanced among the machines.

1.2 Problem Statement

The market is filled with various types of table-tennis training machine from basic to advance, low price to expensive and one-wheel to three-wheel. As we know, the advance table tennis machine would be three-wheel machine as it can produce any kind of spins and it cost from RM 1500 to RM 8000 depends on the function of it. Even though most of the three-wheel table tennis machine are found programmable, but the higher price which cost more than RM 1500 has made players to give up purchasing. Besides that, the three-wheel table tennis ball throwing machine should perform well such as the position of balls drop must consistent and accurate. Some DIY ball throwing machines are made [17] [29] [21], but they are not designed in three-wheel structure. The physical adjustment on the shooter is needed to produce the desired spin. The table tennis ball throwing machine is known by produce different spin with different speed ratio of motors. An experiment is needed to analyse the speeds ratio of motors required to produce the several spins.

1.3 Research Objectives

1. To design an affordable intelligent three-wheel table tennis throwing machine with shooting mechanism and expert control system running by Arduino Mega 2560 microcontroller.
2. To perform analysis on the velocity and spin of table tennis ball produced by three-wheel table tennis ball throwing machine.

1.4 Research Scope

The three-wheel table tennis throwing machine is proposed to design a table tennis throwing machine which the price is lower than RM 600. The machine is designed to produce total 7 type of spins which are “no spin”, “top spin”, “back spin”, “side spin”, “anti-side spin”, “back clockwise side spin”, and “back anti-clockwise side spin” with the choices of heavy spin or light spin. The Arduino Mega 2560 microcontroller will be used as controller in this project. The controller would be programmed to give the desired output.

A series of experiment would be carried out to verify the spins and angular velocity of shot table tennis balls. The machine will output in response to given the input. The input would be the signals of on/off switches. The machine will has eight switches to select spin inputs and a potentiometer to adjust the ball speed.

The scope of this project will focus on design of an intelligent three-wheel table tennis throwing machine which can produce seven type of spins. The wheels will be controlled by Arduino Mega 2560 microcontroller with designed programming. The most important, this machine will cost below RM 600.

1.5 Thesis Outline

This thesis consists of total six chapters. First chapter discusses about the project background, objective and scope of this project. Second chapter discusses about literature review of project includes design of machines, strategy studies of table tennis games, comparison between table tennis robots in market, mathematical analysis of ball machines and studies of ball spins. Third chapter explains the methodology and development of three-wheel table tennis ball throwing machines. This chapter is divided into three main part which are circuit design, mechanical design and machine programming. Forth chapter discusses about the result of project and discussions regarding to the results taken from the experiment. Lastly, the fifth chapter will conclude the project and giving some recommendations for future works.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter covers the study, analysis and interpretation of previous work, relevant fundamental theories and concept about this project. Besides that, the advantages and disadvantages of previous works will also discussed in this chapter. Section 2.2 discusses the analysis of spin in table tennis game. Section 2.3 discusses the effect of diameter 40mm table tennis ball. Section 2.4 discusses the comparisons between table tennis robots in market. Section 2.5 discusses the designing of ball throwing machine. Section 2.6 discusses the mathematical analysis of table tennis ball launcher. Section 2.7 discusses the high speed ball detection.

2.2 Analysis of Spin in Table Tennis Game

The spin really plays the main role in table tennis game. Some research are even done to analyse the effects of spin towards the game. The application of spin in table tennis game was started in the 1950s [14]. Before this, most of the players played their game using traditional “hardbat” which only had a pimpled rubber on the wooden blade without sponge. With this bat, the game would predominantly in ball placement and control instead of spin.

After the introduced of sandwich rubber, the spin slowly started a major change in playing method and it is the way how we play today. The use of spin has become most dominant factor in the sport today. Spin is what allows players to hit the ball when it is low or below the net, but still land on the table [13]. By applying the top spin towards ball, the play will able the ball drop towards the table faster.

The table tennis game without spin is not interesting because you are losing ability to curve the ball through the air and bounce it in the direction of the spin when it hits the table. With spin, the players can have more choices about what he want to do with the balls either top spin or back spin [14]. With the usage of spin, clever player can trick the opponent about the spin given by you. The benefits will be gained if the opponents guess wrong about the services made. For example, the player return the heavy backspin ball with light backspin method, in fact he is putting the ball to the net.

The spin is imparted onto the ball by using a tangential brushing action with table tennis blade. The faster the racket brushes against the ball, the more spin produced. The Figure 2.1 shows that racket direction is parallel with direction of travel of ball.

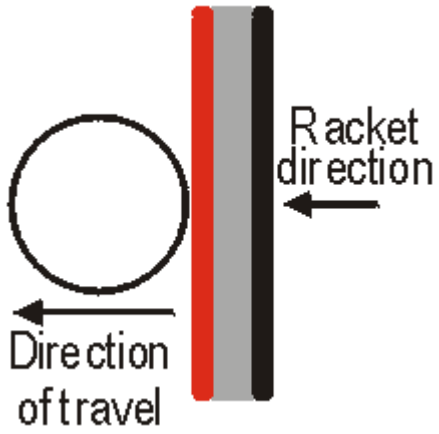

Figure 2. 1: Racket direction parallel with direction of travel of ball.

The ball will travel forwards more and have less or no spin if the method above is applied. While the Figure 2.2 shows the racket direction not parallel to direction of travel of table tennis ball is made. It is like brush the racket against the ball at angle of less than 90 degree using upward movement. With this method, the ball will spin more and not travel as far forward.

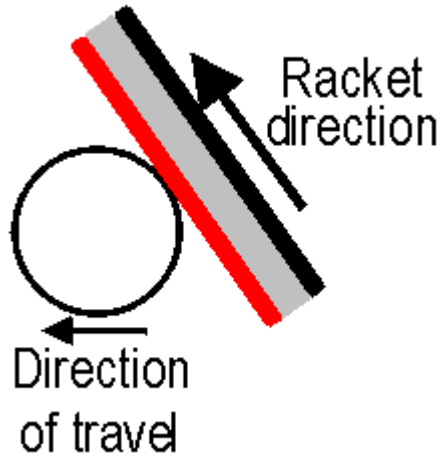

Figure 2. 2: Racket direction not parallel with direction of travel of ball.

2.2.1 Topspin

Topspin is produced by applying the stroke below the ball and brushing the racket against the ball in an upward and forward motion. This causes the ball to accelerate and dip due to a combination of ball rotation and air resistance. The Figure 2.3 shows the method to apply topspin towards ball.

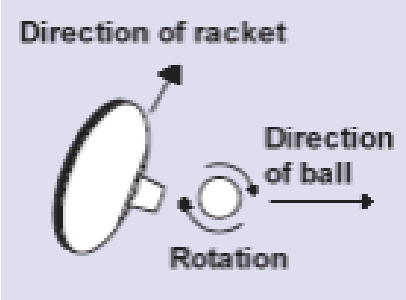

Figure 2. 3: Method to apply topspin.

When the topspin is imparted onto the ball, the forward spin increases the downward pressure on the ball. The ball will stay low and accelerate forwards after it bounces on the table. The Figure 2.4 shows the effect of topspin. When the topspin stroke makes contact with opponent's racket, the topspin will cause it to rebound in an upward direction.

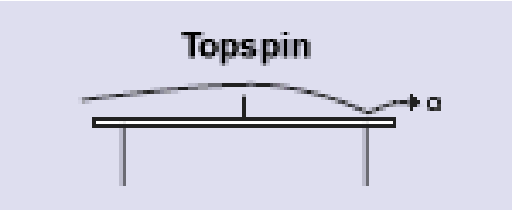

Figure 2. 4: Effect of topspin

2.2.2 Backspin

Backspin is produced by starting the stroke above the ball and brushing the racket against the ball in downward and forward motion. This creates drag on the ball down as it travels through the air. The Figure 2.5shows the method to apply backspin towards ball.

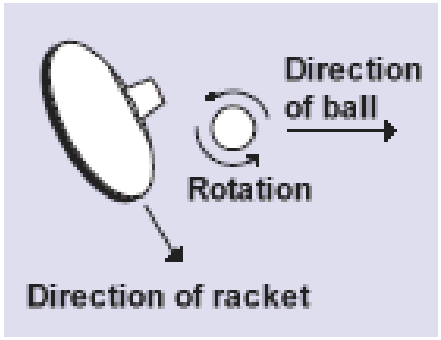

Figure 2. 5: Method to apply backspin

When the backspin is applied onto the ball, the backspin decreases the downward pressure on the ball. The ball will rise up more and not go as far forwards when it bounces on the table. The Figure 2.6 shows the effect of back spin. When the backspin ball contact with blade, the ball will be pulled in downward motion.

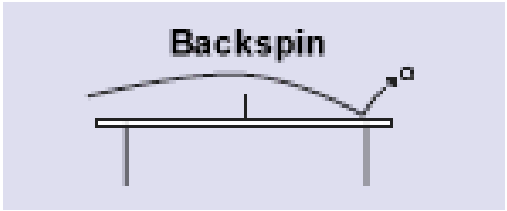

Figure 2. 6: Effect of backspin

2.2.3 Sidespin

Sidespin is produced when the player is brushing the racket against the ball in sideways motion. The different side spin will be produced by depending on how the player moves his racket either in right or left. However, the sidespin is usually applied in addition with topspin or backspin. This means, the sidespin can be combined with topspin or backspin and trick the opponents. The Figure 2.7 shows the method to apply sidespin.

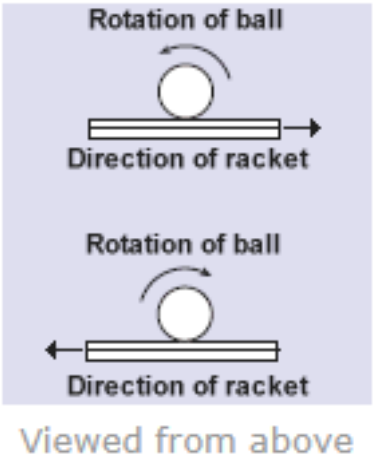

Figure 2. 7: Method to apply sidespin

When the sidespin ball contact with the racket, the sidespin will cause the ball to go either to the left or to the right. If the sidespin is combined with topspin, the ball will go to left or right and accelerates forward. If sidespin is combined with backspin, the ball will to left or right and no go as far forwards. The Figure 2.8 shows the effect of sidespin when racket travelling from left to right. The Figure 2.9 shows the effect of sidespin when racket travelling from right to left.

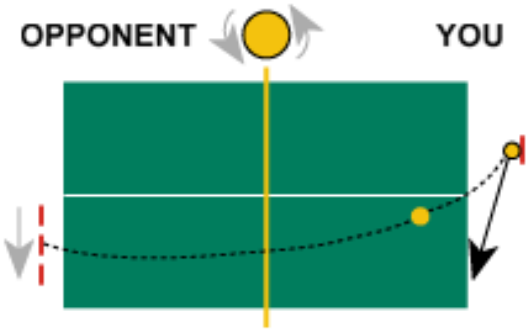

Figure 2. 8: Effect of sidespin when racket travelling from left to right

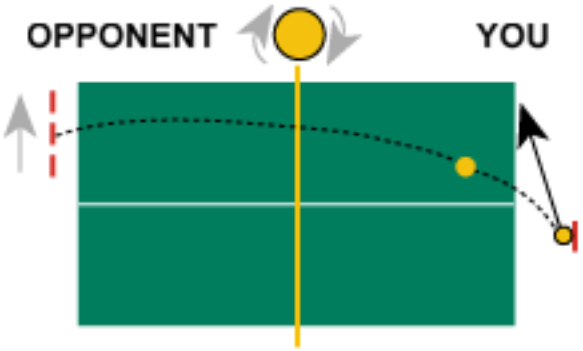

Figure 2. 9: Effect of sidespin when racket travelling from right to left

This literature review is helpful since the three-wheel table tennis throwing machine is deal with many kinds of spin.

2.3 The Effect of Diameter 40mm Table Tennis Ball

On October 2000, the ITTF started the usage of diameter 40mm table tennis ball in tournament [16]. Before this, the table tennis ball of diameter 38mm is used. A research about the effect of diameter 40mm table tennis on the technique of elite players is done [16]. The Singapore elite players are used in this research. They will receive both topspin and back spin balls from robot. The video cameras is applied to capture video data and later used to perform analysis. Both 38mm and 40mm diameter balls are used and calculated.

For this experiment, three synchronized video cameras (PEAK HSC-200) are applied to record the video images at 200 fields/sec for measuring the velocity of COM (centre of mass) and spin of the table tennis balls. The Figure 2.10 shows the setup of equipment. C1, C2 and C3 are video cameras. The captured analogue video is then converted into digital image and analysed by PEAK motion analysis.

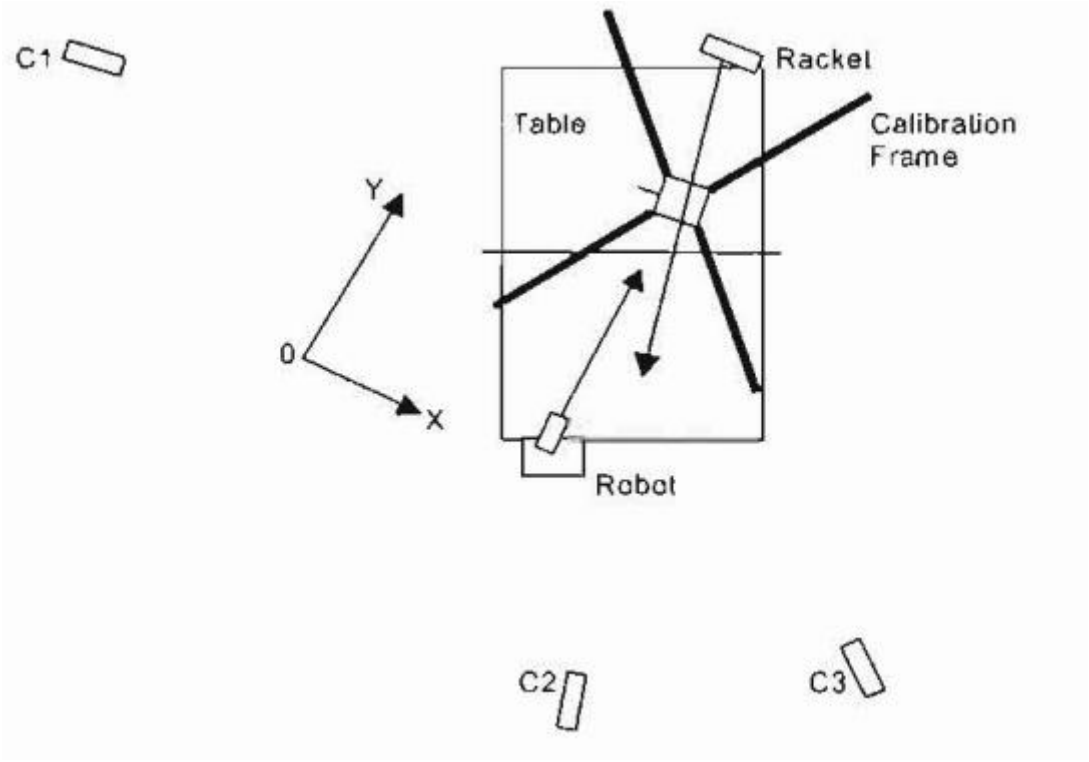

Figure 2. 10: Setup of Equipment

As the results from this research, the speed and spin of diameter 40mm ball are less than diameter 38mm ball. The reduction in speed is higher than loss of spin. The air resistance is attributed to this situation. However, the percentage reduction may be varied depends on the players and his techniques. Some of them can perform better with less loss in spin and speed. The research also found that the spin of ball contributes to the shape of ball's path and the result of collision with table and racket. Controlling the spin can has higher hit rates and make opponents hard to return the ball. The evaluations of this research may be used as tool for coaches and players to monitor the players' technique.

2.4 Comparison between Table Tennis Robot in Market

The table tennis robot comes with variety of shapes, sizes and prices [2]. In this section, the table tennis machines are separated into two sections which are Basic Type Table Tennis Robots and Professional Table Tennis Robots.

2.4.1 Basic Table Tennis Robots

Even this is basic table tennis robot, their price is never cheap. Probably, they are under RM 2200. This level of table tennis robot has good quality and some basic features needed by player which included speed selection and spin selection. Probably, this level of machine will be purchased by amateur player. The Table 2.1 shows the example and comparison of commercialised basic type table tennis robot.

Table 2. 1: Comparison between commercialised basic type table tennis robots

	Newgy Robo-Pong 540[1]	Newgy Robo-Pong 2050 [1]	iPong TOPSPIN [1]
Price	RM 1517	RM 3600	RM 400
Power Source	AC Adapter	AC Adapter	9V Battery
Ball Reloading	No	Yes	No
Controller type	Wired Remote	Wired Remote	Wire Remote
Head angle adjustment	Yes	Yes	Top and Bottom only
Spin Selection	Yes	Yes	No
Speed Selection	Yes	Yes	No
Programmable	Yes	Yes	No

The Figure 2.11 shows the Newgy Robo-Pong 2050. This type of robot becomes popular among the players due to its proper price and essential features.

Figure 2. 11: Newgy Robo-Pong 2050

The iPong TOPSPIN is shown in Figure 2.12. The iPong is the cheapest table tennis robots among all the brands. However, due to the price, it has limited function. But it still a top choice for basic learner and amateur player.

Figure 2. 12: iPong TOPSPIN

2.4.2 Professional Table Tennis Robot

The professional table tennis robot normally used for professional player and training centre. It is used to enhance the training method. The robot is able to level up the performance and training to make the practice effective. The professional type robot has almost same features as basic type robot but it has higher quality and some add on features such as three wheel and expert control system. The Table 2.2 shows the comparison between professional type table tennis robots.

Table 2. 2: Comparison of Professional Table Tennis Robot

	Butterfly Amicus Professional [2]	Oukei TW-2700-S9 [1]	AMDT Y&T V-989H Robot [1]
Price	RM 7811	RM 6245	RM 6635
Power Source	AC Adapter	AC Adapter	AC Adapter
Ball Reloading	Yes	Yes	Yes
Controller type	Wired Remote	Wireless Remote	Wireless Remote
Head angle adjustment	Yes	Yes	Yes
Spin Selection	Yes	Yes	No
Speed Selection	Yes	Yes	No
Programmable	Yes	Yes	No
Shooting frequency	Adjustable	Adjustable	Adjustable

The Figure 2.13 shows the Butterfly Amicus Table Tennis Robot. Even though the comparison between it and Oukei TW-2700-S9 look similar, but actually the Butterfly Amicus is made up from three-wheel machine. It can produce even top sidespin and back sidespin. It has more features in spin selection compared to Oukei TW-2700-S9. Butterfly Amicus do has Basic, Advance and Professional. They are sharing the same robot structure but the control system make the features and prices difference.

Figure 2. 13: Butterfly Amicus Table Tennis Robot

The Figure 2.14 shows the Butterfly Amicus Professional Controller Board. It has most advance control system compared to Butterfly Amicus Basic and Butterfly Amicus Advance.

Figure 2.14: Butterfly Amicus Professional Controller Board.

2.4.3 Intelligent Table Tennis Robot

A visual control system is designed for a table tennis robot with five degrees of Freedom (DOFs) [11]. The system consist of four parts which are ball sensing, trajectory predicting, motion planning and motion control. A high-velocity stereo vision system with parallel architecture is developed in order to track the motions of table tennis ball. Striking parameters such as position, velocity and time are predicted according to the predicted trajectory of the ball based on several measured positions. Based on the striking parameters received, the motion computer then performs the motion planning for robot. The motion computer receives the planning results and controls the motions of the robot via the servo drivers for X and Y axis. To control the motions of the rest three axes via drivers, a microprocessor is designed to produce pulses.

The Figure 2.15 shows the setup of designed table tennis robot. It consist of two smart cameras, a motion computer, a vision computer, a hub, a robot controller and the robot mechanism. The two smart cameras connected together with vision computer become a high velocity stereo vision system. They are communicate with vision computer via LAN.

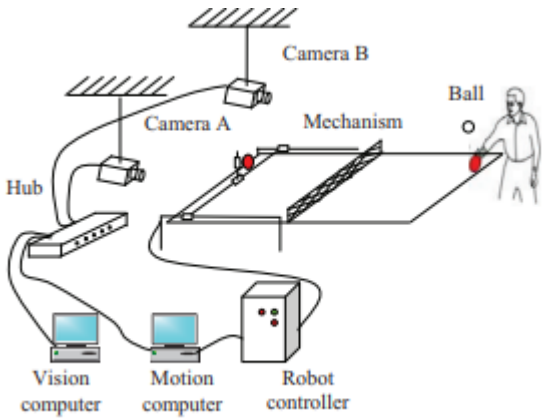

Figure 2. 14: The designed table tennis robot.

The paddle is installed at centre as the red colour thing opposite to the human shown in Figure 2.14. The paddle is able to move in X, Y, Z directions, slewed left and right, up and down. The robot designed has five DOFs and it is able to cover half of the table. The Figure 2.15 shows the block diagram of the robot playing table tennis.

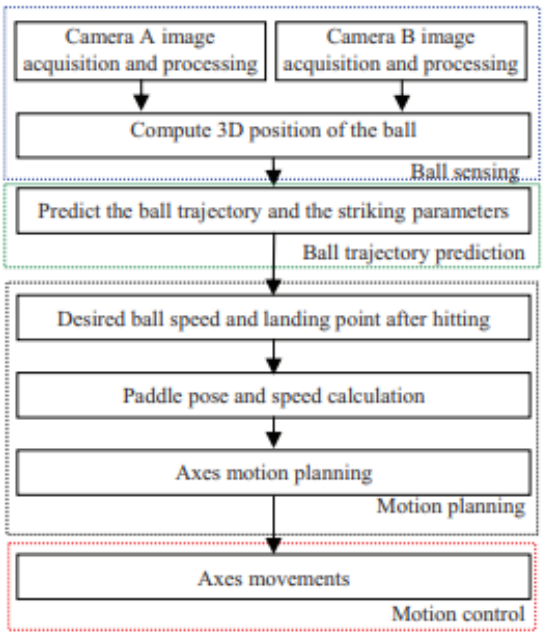

Figure 2. 15: Block diagram of robot playing table tennis

A series of experiment are well conducted to verify the efficient of robot. The robot work very well as it can continuously play 12 touches with human in a rally.

This table tennis robot is the most advance ever seen. By using machine vision and control system, it already can respond to the ball played by human. The future development is worth waiting. However, the setup of robot is really consumes time, and the setup price is far above the commercial robot. Besides that, the current developed robot is still unable to produce spin and counter spin.

2.5 Design of Ball Throwing Machines

A lot of ball throwing machines'design have been reviewed. No matter which sport, number of wheel used and control are reviewed. This section is separated into three which are one-wheel ball throwing machine, two-wheel ball throwing machine and three-wheel ball throwing machine.

2.5.1 One-Wheel Machine

Works by M.Hareesh Kumar and his team [21] is well presented. Their design including crank shaft piston, DC wiper motor and end effector. The Figure 2.16 shows the Smart Ping Pong Robot.

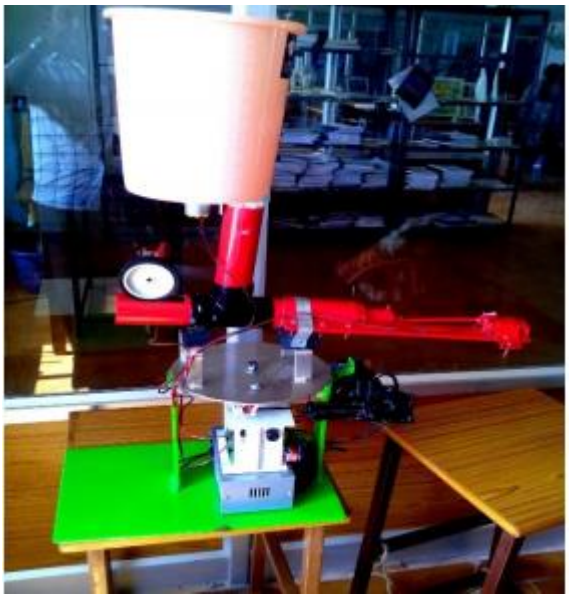

Figure 2. 16: Smart Ping Pong Robot

In this project, the piston is used to push the ball, which is fed from the basket to the end effector (ball delivery). The wheel that is rotating at 1000 RPM of speed will be used to push outward the ball stop at end effector. Besides that, the DC wiper motor is fixed at the bottom of the disc. The disc would rotated to angle of 45 degree left and 45 degree right. This robot can provide topspin, sidespin and backspin. The project has single degree of freedom that has a rotary action to deliver balls at different directions. The

basket in this project has capacity to hold 80-100 balls. That is a Geared motor rotating to make sure the ball is fed one by one down to manipulator and only one ball is fed at the time. Then only the piston pushes the ball towards end-effector which has a high speed DC motor.

Works by Newgarden,Jr. [22] is shown in Figure 2.17. The robot is capable of throwing balls at any desired rate and provide all types of spin to the balls being served. The robot uses two motors, one for ball ejecting wheel and one for feeding the balls to the wheel without any loss. The ball feeding device is mounted with a constant seped motor actuating the ball feeding device. The ejecting wheel is rotated adjustable so, the robot can produce topspin, backspin and sidespin.

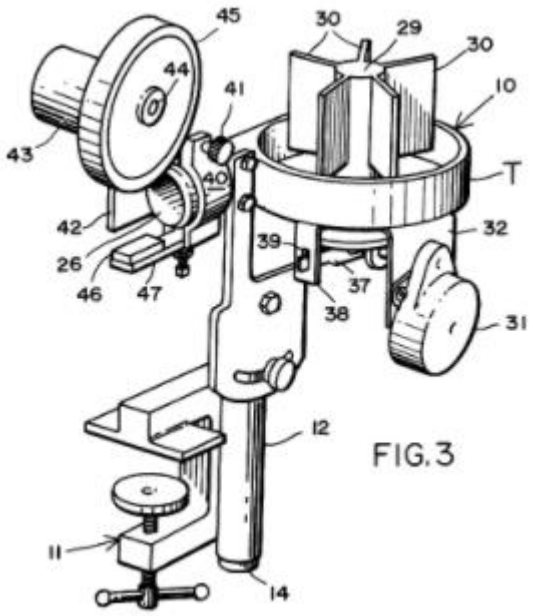

Figure 2. 17: Table Tennis Ball Serving Apparatus

The one-wheel table tennis robot is simple design and cheaper than others. However, the works mentioned above are not using any control system to produce spin. Besides that, the robots need to be manually adjusted every time before start using the robot

2.5.2 Two-Wheel Machine

The works by Shibendu Shekhar Roy and his team [18] is a two-wheel cricket bowling machine. The machine includes a pair of adjacent ball ejecting wheels where each wheel is provided with a groove or concave surface formed in a body of a viscos-elastic material. The wheels are mounted on a base for axial rotation in a common plane, the spacing between the wheels being less than the diameter of ball to be thrown so that the ball is gripped between the rotating wheels and ejected in forward direction. For this robot, the wheels can be adjusted independently. The machine transfer the kinetic energy to the ball by frictional gripping of the ball between two rotating wheels. The base is supported on a tilting assembly, which is mounted on a bracket so that the required angular adjustment of the rotational plane of the wheel about axis parallel to direction of ball and its perpendicular axis is possible. The electronic controls are provided for controlling the speed of rotational of the wheel. The Figure 2.18 shows the prototype of cricket bowling machine and the Figure 2.19 shows the flowchart of the cricket bowling machine control scheme.

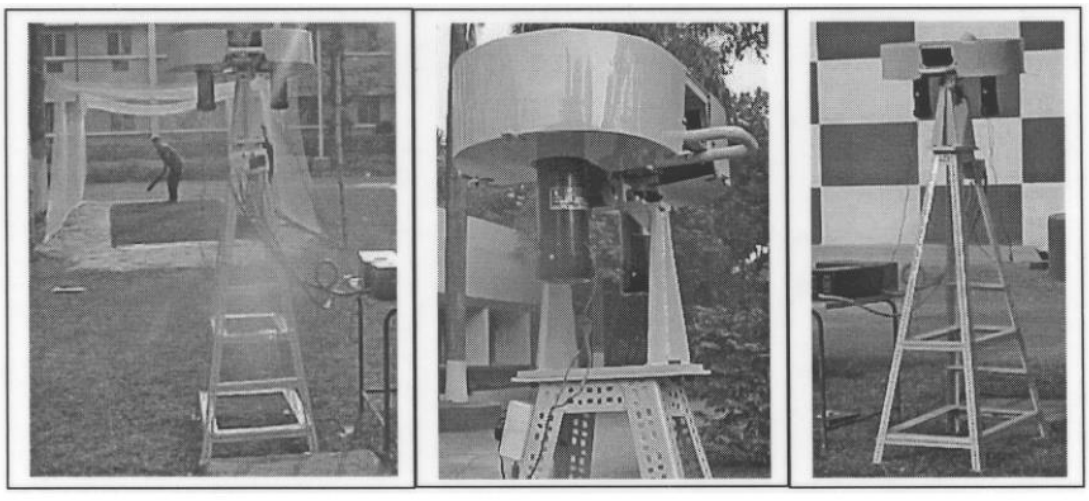

Figure 2. 18: Cricket bowling machine

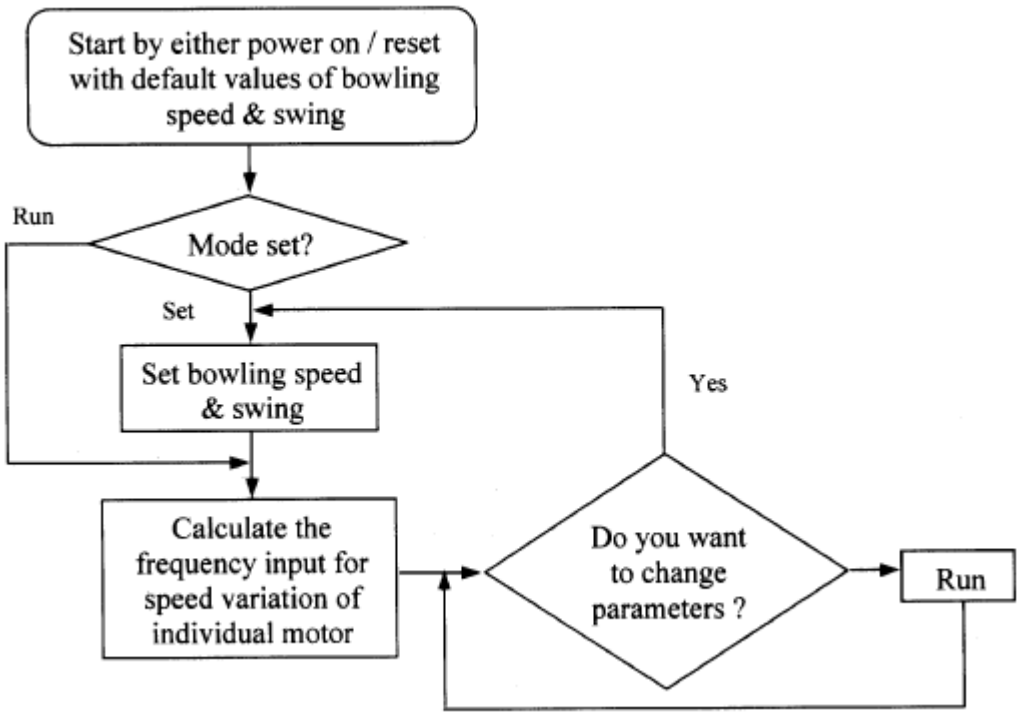

Figure 2. 19: Flowchart of cricket bowling machine control scheme

A differential speed is maintained between two wheels and at the same time to create a twist on the ball of different kind and the tilting platform is either inclined towards the left or towards the right with respect to fixed L-frame, according to the kind of the spin. The tilting platform is inclined upward or downward in order to control the length of bowing.

An experiment is carried out to verify the relationship between the speed of wheels and spin produced. The bowling speed and nature of swing are measured by professional broadcasting camera. The result is recorded in Table 2.3.

Table 2. 3: Experiment result of cricket machine

Sl No	RPM of left wheel	RPM of right wheel	Bowling speed km/h	Nature of swing
1	1500	1500	84	Straight
2	1800	1800	99	Straight
3	2000	2000	112	Straight
4	2250	2250	127	Straight
5	2500	2500	139	Straight
6	2900	2900	158	Straight
7	3000	2500	149	In-swing
8	2900	2000	137	In-swing
9	2900	1700	128	In-swing
10	1600	3000	127	Out-swing
11	2000	3000	138	Out-swing
12	1900	2900	133	Out-swing

This machine is well designed as the bowling speed is variable, positive adjustment of line and length of bowling are possible with repeatability, different varieties of bowling can be generated and the machine can used for different size of ball such as practicing ball, tennis and softball. The most important, it is portable and economic. However, the machine is still cannot produce much spin as three-wheel ball throwing machine, hence a three-wheel ball throwing machine for cricket is needed.

The works by Barath Ponnusamy and his team [17] is a well-designed low cost automated table tennis launcher. The launcher is using Arduino microcontroller. The launcher is controlled by the use of Android smart phones to enhance the user-friendliness and the use of wooden support and PVC pipes to fabricate greatly reduces the manufacturing cost. Their launcher is developed in 3D virtual prototype using SolidWorks software before they start the fabrication works. The fabricated prototype is able shoot the ball in three directions and it helps user to practice almost all types of stroke with the adjustable spinning direction. The Figure 2.20 shows the 3D modelling and fabricated prototype of launcher.

Figure 2. 20: 3D modelling (left) and fabricated prototype (right)

The launcher is mainly controlled by a programmable microcontroller, Arduino with the supports of motor driver, resistor and switch. The motor driver used to control the flow of electric current and polarity which allows DC motor spins in two different directions and in few modes. The launcher is programmed to receive Bluetooth signal from Android smartphones. The Bluetooth module act as bridge between Android phone and Arduino microcontroller which enable to control launcher via Android smart phones. The Figure 2.21 shows the Android application interface for this launcher. This launcher is capable to shoot ball in three different directions and in two different spins which concluded as 7 modes.