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**FULL REPORT**

**SHUTTLECOCK LAUNCHER**

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Bachelor of Mechatronics Engineering  
June 2012**

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**June 2012**

“I hereby declare that I have read through this report entitle “Shuttlecock Launcher” and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Mechatronics Engineering “

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# **SHUTTLECOCK LAUNCHER**

**by**

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This report submitted in accordance with requirements of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering (Mechatronic) with Honours.

**Faculty of Electrical Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2011/2012**

I declare that this report entitle “Shuttlecock Launcher” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

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Date : .....

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## ABSTRACT

One of the problems related with practising badminton is that it requires at least two players. It is impossible for an individual to practice badminton without the assistance of another player. Thus, a shuttlecock launcher has been developed to launch the shuttlecocks that have been loaded into the machine. Studies had been carried out on other similar types of launching machine to understand the mechanism involved feeding, launching and control system. Accuracy of the ball motion generated by the mechanism from the first experiment by coordinate  $(x,y)$  m are  $(\pm 0.1445, \pm 0.0225)$  m,  $(\pm 0.1888, \pm 0.0965)$  m,  $(\pm 0.1500, \pm 0.6845)$  m and  $(\pm 0.2560, \pm 0.2162)$  m for drop, mid court, smash and lob shot. From the first experiment we can see that the distribution for the drop, midcourt and lob shot are still acceptable due to ideal distance is around 0.35m radius from the target except for the midcourt which the distribution is too extreme. The second experiment which is to check the accuracy of the launcher to the ideal area are 57.5%, 47.5%, 35% and 32.5% for drop, mid court, smash and lob shot. From the second experiment we can assume that the farther the distance, make less accuracy of the launcher. The result was compared with the existed trajectory equation.

## ABSTRAK

Salah satu masalah berkaitan dengan permainan Badminton adalah ianya memerlukan sekurang-kurangnya dua pemain. Ia adalah mustahil bagi seorang individu untuk bermain badminton tanpa bantuan individu lain. Oleh yang demikian, pelancar bulu telah dibangunkan untuk melancarkan bulu tangkis yang dimuatkan ke dalam mesin. Kajian telah dijalankan ke atas mekanisme yang sama untuk melancarkan bulu tangkis dan memahami mekanisme yang terlibat dalam membawa bulu tangkis kepada pelancar serta system kawalannya. Ketepatan pergerakan bola dari pelancar bulu tangkis yang telah dibuat, didapati dari eksperimen pertama dengan koordinat (x, y) m ( $\pm 0,1445$ ,  $\pm 0,0225$ ) m, ( $\pm 0,1888$ ,  $\pm 0,0965$ ) m, ( $\pm 0,1500$ ,  $\pm 0,6845$ ) m dan ( $\pm 0,2560$ ,  $\pm 0,2162$ ) m 'drop shot', 'mid court shot', 'smash' dan 'lob shot'. Dari eksperimen yang pertama kita dapat melihat bahawa taburan bulu tangkis untuk pukulan 'drop shot', 'midcourt shot' dan 'lob shot' masih boleh diterima kerana jarak yang ideal adalah sekitar jejari 0.35m dari sasaran, dan untuk 'midcourt shot' taburannya adalah terlalu ekstrem. Ujikaji yang kedua pula yang menguji ketepatan pelancar ke kawasan yang ideal adalah 57.5%, 47.5%, 35% dan 32.5% untuk 'drop shot', 'mid court shot', 'smash' dan 'lob shot'. Dari eksperimen kedua, kita boleh mengandaikan bahawa semakin jauh jaraknya, semakin kurang ketepatan pelancar. Keputusan ini telah dibandingkan dengan persamaan trajektori yang telah diwujudkan.



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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Nowadays, badminton is the third most famous sport in Malaysia [1]. In, 18th century badminton known as 'POONA'[2] which is come from the name of southeast city of India. The game attracted British military officer during the British colonization era soon it become of the famous game in British. The first game held in England in 1873 was played at Badminton the estate of the Duke Beaufort in Gloucestershire. Hence, the official name this game is named as Badminton.

In 1934, the International Badminton Federation (IBF) was formed with 9 member country. Then, the Thomas cup major trophy for men comes up from Sir George A. Thomas Baronet from the idea of awarding trophies held in England. In addition, for women it called as 'Uber Cup' come up from named of Mrs. H.S. Uber.

Badminton is one of the hot games to the country to get achieve in higher ranking for their player. Many of the support and equipment was provided to produce the world class professional players. Research and renovation of the badminton in industry is carried out in order to greatly develop to improve quality of badminton sport.

Basic equipment for playing the badminton is racquet, shuttlecock and court followed the specification of IBF. The badminton game can divide into two or four players games which give the name as single or double player games in one court that stated in IBF.

In general, there have many type of shot or service while playing the badminton. The basic shot that must be known is smash, drop shot, middle court and lob shot. Smash shot

happened when the opponent give the ball at high level in the midcourt area and hitting back with strong shot to the opponent's floor. For drop shot, we hit the shuttlecock downward and past the net toward the front areas of the opponent. Middle court, we hit the shuttlecock to the opponent midcourt and lob, we hit the shuttlecock and over the opponent.

## 1.2 Problem Statement

Nowadays, badminton is a one of the famous sport games in the worldwide. It is estimates there are that more from a billion enthusiasts especially in some of world class completion badminton game. Hence, there have increase great number of new player in the badminton game. Normally, in training session there must two persons to make the training session successfully. One of them feed the shuttlecock and another one hit back the ball. There are few shuttlecock launchers for the newcomer or beginner to practice and sharpen their technique. Furthermore, the most important skills are to master the basic shots and know how to hit back the ball in correct manner. Thus, a support tool can be applied in the Badminton training to facilitate the player training without the support of other player. Other than that, there are a lot similar applications in the market today, for example tennis ball launcher. It can be seen that this tennis ball launcher play a huge role in improving the player performance and development.

The problem now, is that for available machine is very costly around RM15000. It will make the difficulty to buy the machine especially from lace income family and to others newcomer. Furthermore, the delay time is significantly high for the available machine where they must adjust the height to change other shots to smash.

### 1.3 Objective

The objectives of this project are to:

1. Design and develop shuttlecock launcher that has cost effective.
2. Analyze the performance of the launcher with the existed trajectory simulation.  
(Accuracy test)

### 1.4 Scope

In this research, the search for information only focus on the theory and existing law that relate to the trajectory, motor and badminton sport. The information soon will be applied to study the model and designing machine.

1. The trajectory equation for the shots based on basic projectile motion by Dhina Pramita Susanti [3].

$$\text{Horizontal component, } x = x_0 + v_0 \cos \theta \frac{m}{k} \left( 1 - e^{-\frac{kt}{m}} \right) - \frac{\alpha}{k} \left( t - \frac{m}{k} \left( 1 - e^{-\frac{kt}{m}} \right) \right)$$

$$\text{Vertical component, } y = y_0 + v_0 \sin \theta \frac{m}{k} \left( 1 - e^{-\frac{kt}{m}} \right) + \frac{-mg + F_a - \alpha}{k} \left( t - \frac{m}{k} \left( 1 - e^{-\frac{kt}{m}} \right) \right)$$

where  $x_0$  and  $y_0$  are initial position,  $v_0$  is initial velocity,  $\theta$  is launching angle,  $m$  is mass of shuttlecock,  $g$  is gravitational force,  $t$  is time,  $F_a$  is buoyant force,  $k$  and  $a$  are constant

2. Type shots are covered
  - i. Lob shot
  - ii. Drop shot
  - iii. Smash shot
  - iv. Mid court shot



3. Design the electric and electronic part using MikroC and has been approved by Proteus.
  
4. Lastly, the develop launcher will validate by experimentally shot to check whether it same with the existed trajectory equation. Next, tuning the hardware until get the nearest result base on the trajectory equation and develop idea to increase the reliability of the hardware.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter will discuss the literature survey and other related information through this project focus. In this chapter, we want to identify the ideas that possible to the project and will give the readers an overview of sources that we had explored.

#### **2.2 Literature Survey**

Nowadays, there are several shuttlecock launcher have been developed. However, the existence model of shuttlecock is too expensive. So, we decide to deduce this price and develop new launcher with cost effective. The main important parts in shuttlecock launcher are the actuator, dispenser and feeder. Therefore, the literature review of this report will present the research of the:-

1. Actuator
2. Dispenser
3. Feeder

Based on the study, there are other sports had develop launcher machine for training purpose such as tennis, ping pong, takraw and paintball. Then, we analyzed the system of the machine. Then try to compare to the existed shuttlecock launcher in which more effective. Other than that, to reduce delay time between others shot with smash, we decide to do it at simulation.

### 2.2.1 Actuator

The actuator mechanism is a place where the ball ejected from the machine. This part will determine the path of shuttlecock trajectory by manipulating the angle and speed of launching. There are various systems of launching mechanism used. For the actuator, we focused on actuator from tennis, takraw and paintball.



Figure 2.1 Lobster Tournament Model 401

One of the systems is from tennis launcher. There are many types of product for tennis machine launcher. One of them is Lobster Tournament Model 401 tennis machine as a figure 2.1 above which is used pneumatic system (air compressor) to eject the tennis ball. It use piston as actuator to push the ball and it absorb the energy from the piston. The air compressor is usually greater than atmosphere pressure. It is converts electrical energy to kinetic energy which always used in pneumatic system. But there are some disadvantages. The accuracy of the air compressor is low is around 50% if we using the shuttlecock due to

the ball not solid like a tennis ball. Others than that, the price is very expensive and makes some noise [4].



Figure 2.2 Takraw Launcher

Figure 2.2 above shows that, the famous system applied by using the spinning wheel which is drive by motor. By using two motor to drive two spinning wheels, the motor will connected directly to the wheel. Thus, there is no loss of energy between the motor and the spinning wheel, but, it is difficult to synchronous both of the motor. Other than that, these two counter rotating wheels give speed to a ball. Equation (1) shows velocity where  $\omega$  is angular velocity (rpm) of the wheel and  $r_w$  is radius of the wheel [5].

$$v = \omega r_w \quad (1)$$



Figure 2.3 Compressor Gas Bottle

Paintball used expansion gas stored in compresses gas bottle as Figure 2.3 to eject the ball(markers) from the gun. Normally, Carbon dioxide or high pressure air type was used as a form of compressed air. But there are disadvantages using this system, we must refill back the gas bottle when it empty [6]. The pressure also decreases when the content is low.

### 2.2.2 Feeder

Feeder mechanism is the important part. This mechanism will feed the shuttlecock to launcher mechanism by depending on the preset time or condition. One of the feeder mechanism types is Double gate applied in tennis machine. Below is the step the ball feed to the actuator:

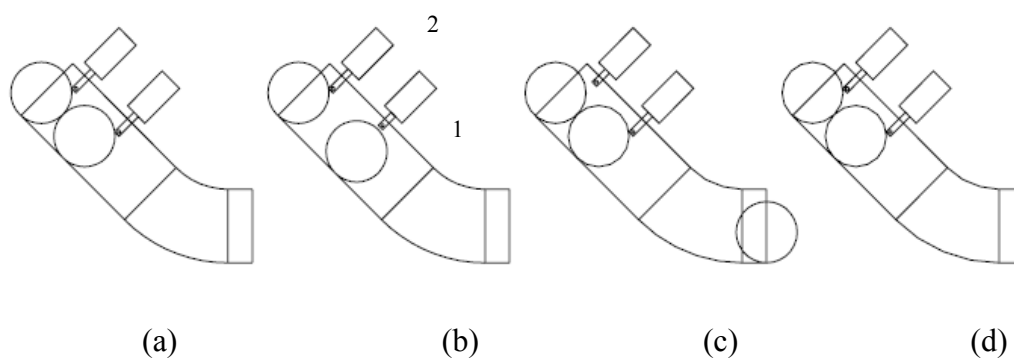


Figure 2.4 (a) Normal position (b) piston 1 retract (c) piston 2 retract (d) Final position

Figure 2.4 (a) shows that the ball is in initial position by using two pistons where both of the pistons in extend position. Figures 2.4 (b) shows piston 1 in retract position and piston 2 still in the same position. Then, the ball passes through to the actuator. Next, figure 2.3 (c) shows that piston 1 extend back to hold other ball and piston 2 retract to allow the ball pass to it. Finally, figure 2.4 (d) shows that the both piston in initial position and will continue with same process as previous [13].

Next, takraw machine used basic principle of uniform rotation, to bring single ball they used a rotating carousel to the ball shooter [5]. The rotating carousel was controlled by 18.33 RPM 12 VDC Gear Motor with running torque 35 in-lb, amperage of 1.5 amps and 12 volt DC [6]. The motor was select by using the calculation that has been made by the researcher. The equation (2) is given below:

$$\tau = I\alpha \quad (2)$$

where

$\tau$  = Torque (in. lb)

$I$  = Moment of inertia (lb. in<sup>2</sup>)

$\alpha$  = Angular acceleration (rad/s<sup>2</sup>)



Figure 2.5 Paintball Machine

From the Figure 2.5 above is the feeder concept by paintball. It is used gravitational force where the balls attract to the earth's mass bodies. For this case, the ball(markers) fall into the gun where the CO2 used to eject the ball.

### 2.2.3 Dispenser

The dispenser mechanism is a place for shuttlecock stored before enter the machine. This part will determine the maximum time of machine functioning by capacity of shuttlecock stored.

For the Lobster Tournament Model 401, there is basket placed 150 balls with open surface. The design is inclining to the feeder. It can be seen clearly in picture below:-

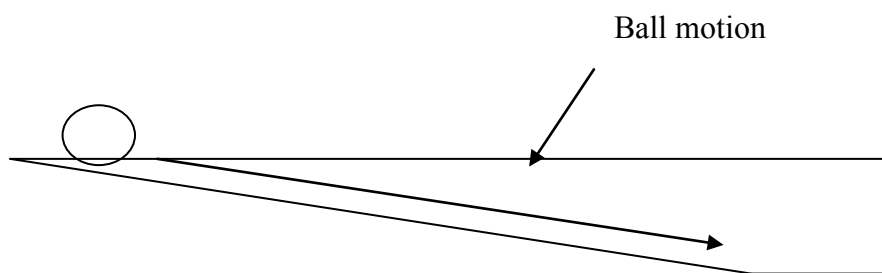


Figure 2.6 Side View of the Dispenser (Tennis)

Based on the Figure 2.6, the ball will land into the feeder due to its design and due to the ball shape spherical, then, the ball can roll into the feeder.



For the takraw launcher, basket was used to place around ten balls inside there. The dimension of the baskets or ball hopper is 20 inches in diameter at the top and six inches at the bottom. The shape is like a spiral shape. Next, dispensers of the paintball have been analyzed.

Normally, for full filling of the markers the dispenser of paintball can cope around to 100 balls in one time. Sometimes, the capacity can be changed but depends on the design. Next, the previous inventions or products are also important to decide the devices and mechanism to fix in our machine.

### 2.2.4 Existed Products

Then, from our further study, there are two existing product that we had met. First knight trainer and the other one is Apollo trainer. From the information we got, we compare the entire feature to see clearly what important parts in the both machines.

Table 2.1 Comparison Table For Two Existing Product (Badminton).

Feature	Knight trainer [7]	Apollo trainer [8]
		
Price	RM 15000	RM 17000
Randomizer	Yes	Yes
Shuttlecock dispenser	200	250
Max velocity(m/s)	44.257	58.1152
Method	Two rotating wheel	Two rotating wheel
Height (m)	1.0-1.80	1.0-1.69
Launch degree, (°)	-17 - 30	-15 - 65
Portability	Fully portable	Fully portable
Actuator driver	Motor	Motor
Type of shot	<ol style="list-style-type: none"> <li>1. Net shots</li> <li>2. Crosscourt net shot</li> <li>3. Mid court</li> <li>4. Lob smash</li> </ol>	<ol style="list-style-type: none"> <li>1. Drop shot</li> <li>2. Lob</li> <li>3. smash</li> </ol>
Remote control	No	Yes