UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WIRELESS SYSTEM FOR SHUTTLECOCK LAUNCHER

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

by

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This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (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:

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ABSTRAK

Pembangunan sistem kawalan tanpa wayar untuk pelancar bulu tangkis dengan tujuan latihan badminton direka untuk membantu atlet dan jurulatih bagi sesi latihan mereka. Pelancar bulu tangkis dengan sistem kawalan tanpa wayar ini terbahagi kepada tiga bahagian penting iaitu pelancar, penyuap, dan sistem pengawal tanpa wayar. Dengan pelancar bulu tangkis ini, beberapa jenis latihan boleh dilakukan oleh pelancar seperti pukulan jarak dekat, dan pukulan jarak jauh. Manakala, penyuap pula direka untuk meletakkan lebih 10 bulu tangkis dalam bekas dan seterusnya menghantarkan satu persatu kepada pelancar. Bagi sistem kawalan tanpa wayar pula, kawalan mikro Arduino Uno dan modul wifi Esp32 digunakan untuk mengawal operasi pelancar bulu tangkis dari jauh. Kawalan mikro Arduino Uno digunakan untuk mengawal motor servo. Manakala modul wifi Esp32 digunakan untuk komunikasi tanpa wayar dengan aplikasi blynk pada telefon pintar dan pengawalan kelajuan motor pelancar. Aplikasi blynk berfungsi sebagai pencetus isyarat untuk pelancar bulu tangkis. Pengawal mikro Arduino Uno dan modul wifi Esp32 boleh diprogramkan dengan menggunakan pengisian Arduino. Akhir sekali, bahagian perkakasan dan bahagian perisian program akan digabungkan sekali untuk membentuk pelancar bulu tangkis dengan system kawalan tanpa wayar. Pelancar bulu tangkis ini akan diuji terlebih dahulu trajektorinya untuk mengetahui tahap keberkesanan dan kecekapannya.

ABSTRACT

The development of wireless system for shuttlecock launcher is designed for helping badminton's athlete and coach during their training session. The shuttlecock launcher with wireless control system have three main part which is the launcher, the feeder and the wireless controller. With the shuttlecock launcher, certain type of training can be make such as short shot and long shot. Meanwhile, the feeder is designed to store more than 10 shuttlecock at a time and can separately feed the shuttlecock to the launcher one by one with sequence. For the wireless controller system, the Arduino Uno and Esp32 Wi-Fi module is being used to control the shuttlecock launcher wirelessly. The Arduino Uno is used to control the servo motor. Meanwhile the Esp32 Wi-Fi module is used to communicate wirelessly with the smartphone blynk application and launcher motor speed control. The blynk application will act as the trigger signal for the shuttlecock launcher. The microcontroller Arduino Uno and Esp32 Wi-Fi module can be programmed by using Arduino IDE. Lastly, the hardware part and the software will be combined together to develop the shuttlecock launcher with wireless control system. The trajectory of the shuttlecock launcher need to be test first to investigate the reliability and performance of the shuttlecock launcher.

DEDICATION

To my beloved parents, Leow Lai Ann and to my mother Siew Yook Tai, I express my sincere gratitude to them throughout my life for their devotion, support, and sacrifice. Since I was born until now, their sacrifice had motivated me. I never dream of going so far in my life, but I was motivated by their spirit and determination. I cannot find the right words to explain my commitment, encouragement and confidence in my ability to preserve my own dreams.

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In addition, a million thanks to both my parents and my family for their help, uncounted prayers and a lot of money to make sure I'm able to complete this task. Thank you for everything to my mother and father.

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CHAPTER 1

INTRODUCTION

1.1 Background

In ancient Greece and Egypt, a badminton-like game was known as battledore - in which tiny rackets was use to hit a feathered shuttlecock back and forth by two players. It became a success at a party held by the Duke of Beaufort in 1873 at his estate called "Badminton" in Gloucestershire. Although the game was initiated in England, it had been dominated in Asia and is one of the top famous sport in the world. Badminton World Federation (BWF) is born to governs international badminton competition which joined by many countries around the world.

In this modern era, most badminton players will usually get external coaches in order to improve themselves. Coach's knowledge sharing and practices are beneficial for the player. Some scenery like the shuttlecock is throw again and again at the athlete weak spot usually occur during practices. Badminton trainer robot should be invented so that coaches capable of training their player for this kind of repetition motion. Machine or robot can be invented to help athlete practice or training by their self without wasting coach energy. Player self-training and coaches assisting during training is the main focus of this project which will solve the problem stated.

Shuttlecock launcher - the invention or prototype that will replicate the coach activity. Coordinate selection is the based for shuttlecock launcher projection system. A badminton court like display will allow user to select the coordinate and direction of the shuttlecock to be launch to. Wireless communication system will be implemented for

exchange data between coordinate selection trajectory software and the shuttlecock launcher prototype. Start delay mode is added as an advantage so that the prototype can be operated by the player. This battery supply wireless controlled shuttlecock launcher capable of assisting coaches during training session which make it a perfect stand-alone badminton trainer for badminton training purposed.

1.2 Problem Statement

There is a limit as of how far a human ability can extended. One such as doing long period of repetition motion. Simply said a badminton coach will need high level of consistency, accuracy and efficiency in throwing the shuttlecock during training session since it will take quite some time for the training to end. In contrary, the potential of the beginner to buy the marketed shuttlecock launcher is lesser since it is costly and limited.

Moreover, bigger form factor and less mobility cause user that are using lightweight vehicle some issues in carrying the launcher. Disassemble and assemble of the shuttlecock launcher is needed every time and it will consume the user some time to carryout. Clash of available time between coach and athletes will resulted in athletes need to self-training without coach. The proposed solution is a wireless controlled shuttlecock launcher which is capable of duplicate the coach responsibility during training session. Training for athletes would be easy and efficient since the coach duty had been replaced by robot trainer.

In this industrial revolution 4.0 era of the technology, to help us make things easier, implementation of advance technology is needed. For example, intense sport game like baseball would require the athlete to hit the ball as far as the athlete can into the air. Ball launcher, the implemented technology in this sport is to replace the pitcher. This is

due to the ball threw at batter needs to be consistent. The situation is same as badminton training, whereas shuttlecock to be throw with consistent at the player. Since there are no applied technology in badminton sport, the suitable machine to replicate the coach motion for throw the shuttlecock repeatedly is shuttlecock launcher.

1.3 Description of Prototype

- Shuttlecock Launcher

Twin rollers design with gap in between that attached to the high speed motor for shuttlecock trajectory purpose.

- Wireless Control Circuit

Wireless control circuit is implement to control the motion of the body and to control the velocity of the twin roller for trajectory purpose wirelessly. The main purpose for wireless control is to make sure that the shuttlecock launcher can be operated as a standalone badminton trainer.

- Shuttlecock Feeder

More than 6 shuttlecock can stock in a cylinder shape container for the automation feeder process to operate smoothly.

1.4 Objective

- To design a remotely controlled shuttlecock launcher using wireless system.
- To test system capability in operating different training routine.

- To analyze hardware stability in achieving different trajectory angle.

1.5 Scope

There are several guidelines that are propose to make sure the project will reach the objectives. These are the scopes for this project:

- Design a wireless control circuit for the 3D motion and trajectory roller based on PWM control circuit and ESP 32/8266 Micro-controller circuit to manipulate the speed of twin motor with specific purpose.

- Design a programming sequence for wireless control by using ARDUINO software for motor speed control.

- Develop the prototype with specific angle using stepper or servo to achieve all the variance angle.

- Build an automatic shuttlecock feeder capable of storing more than six shuttlecocks and traject it during operation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The previous journal, article and all information or ideas that can be related to develop the shuttlecock launcher with or without wireless control will be talk about in this chapter. There are some importance criteria in developing this project such as the research and study of the feeder system of shuttlecock, the launcher, the wireless control system, the interest workspace and the dynamic of trajectory shuttlecock. In this chapter, the main objective is to obtain as much as possible the ideas, knowledge and explanation of all the previous journal and article and some overview for the reader regarding the source that have been discovered.

2.2 Badminton Theory

Badminton is the one of the famous and popular sport games in the world in nowadays. The popularity of the sport can be shown since the Badminton World Federation consist of member from over 160 countries. (Nakagawa, Kenichi; Hasegawa, Hiroaki; Murakami, Masahide; Obayashi, Shigeru; 2012). There are two categories in badminton games which are, single player games and double player games. For single player games, it will be played by two player fighting each other while for double player games, there are two type which are the same gender or mix gender that will played by four players. Tactic, skills and psychology present during the game session also contribute to the games popularity. One of the reason badminton is famous among people is because

the possibility of normal heart rate elevation by about 10% while playing badminton. (Lidija Petrinović Zekan, Dubravka Ciliga, 2002)

2.2.1 Dimension of the Badminton Court

There are a few types of materials that badminton court can be built on with, such as carpet, bituminous, wood, and concrete. The international certified dimension of badminton court is 6.1m in width * 13.4m in length and should be in rectangular shape. For the post pole, it height should be measured 1.55m from the ground of the court and in between is the net measured same wide as court width with 0.76m height. The center of badminton court approximately at 6.64 meters and 0.46 meters for the double side lines. For references lines of the court, it should be white or yellow color with 0.04 meters width. (May Kwan, 2013). Figure 2.1 shows the dimension of the badminton court.

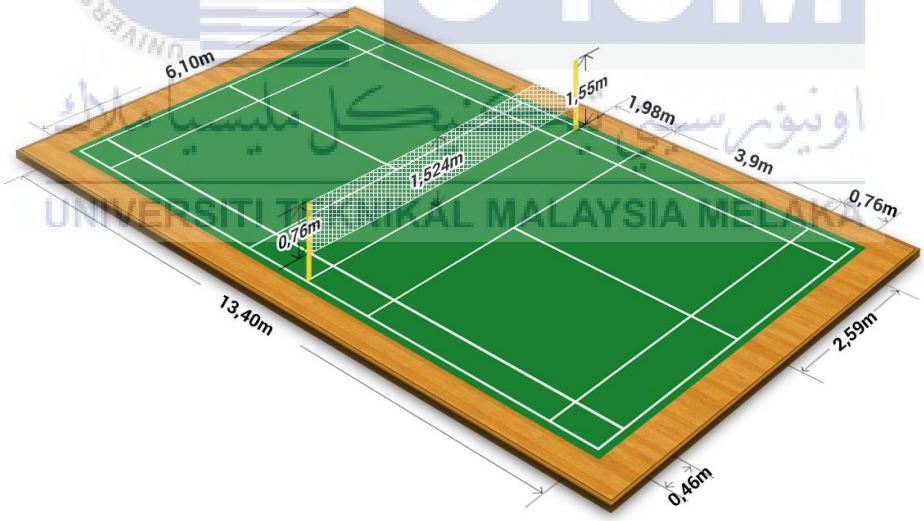

Figure 2.1: Badminton court layout

2.2.2 Dimension of Shuttlecock

Shuttlecock, the key component that is use in badminton sport games since the 18th century. Conical-like shape with 3 grams of mass from its main component – cork. Its feather skirt body take up 2 grams of mass with cross section of 30 cm total up to 5 grams of weight for each shuttlecock. The velocity of shuttlecock can easily reach up to 100 m/s during game session. The fastest smash in history was make by Tan Boon Heong from Malaysia with record of 117 meter per second speed according to the Guinness Book of World Records. (Texier, Baptiste Darbois; Cohen, Caroline; Quéré, David; Claneta, Christophe; 2012). Figure 2.2 shows shuttlecock dimension layout.

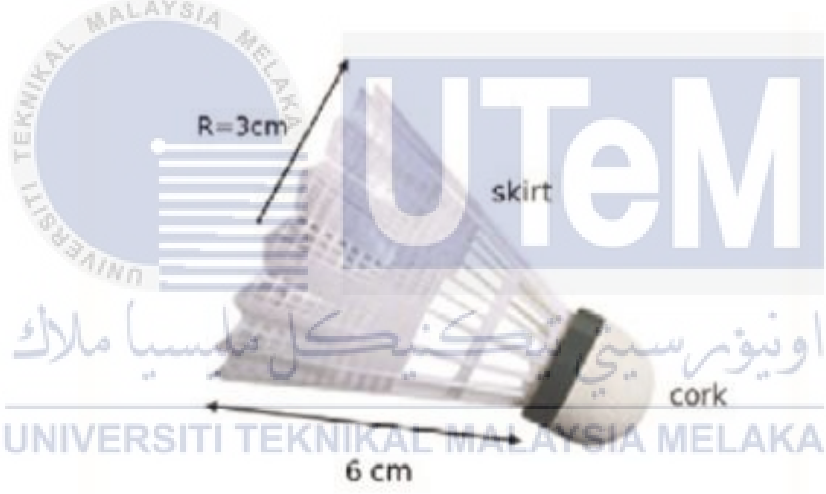

Figure 2.2: Shuttlecock dimension layout

2.2.3 The Flight Trajectory and Dynamic for Shuttlecock

There are common shot variance that will be played by badminton player during game, such as short shot, long shot and lob shot. The angle and speed of the swing when hitting the shuttlecock will caused different type of shot variance. Based on research (Lung-Ming Chen, Yi-Hsiang Pan and Yung-Jen Chen, 2009), prediction of trajectory

path, speed, direction and time of shuttlecock can be achieve if understanding of shuttlecock flight trajectory is studied. Since there is no research on shuttlecock trajectories path that will help players to estimate the arrival destination of shuttlecock, this lead them to do research on related field.

By continuing certain calculations concerning certain physics laws such as the second law of Newton and some mathematics equation, the shuttlecock's trajectory can be found such as the motion equation of the flying trajectory of a shuttlecock, the angle and the force of a stroke. But, we considered linear and quadratic air resistance laws to find a shuttlecock's trajectory and it could be expressed in terms of terminal speed.

The very interesting topic of research is an aerodynamic point of view. (Nakagawa, Kenichi; Murakami, Masahide; Hasegawa, Hiroaki; Obayashi, Shigeru; 2012). They investigated the effect of shuttlecock deformation on aerodynamic properties and the relationship between vortex behavior around a shuttlecock at high numbers of Reynolds and fluid forces by referring to their journal. The aerodynamic forces acting on a shuttlecock are measured by the three-component balance connected to the shuttlecock support stick.

High speed camera and a ND-YAG laser are used to capture the smoke pattern. The shuttlecock skirt's diameter is reduced and the shuttlecock skirt is deformed at high Reynolds number due to the dynamic pressure of the flow. For the shuttlecock with rotation, the skirt's diameter does not change with increasing number of Reynolds due to the high rotational speed of the shuttlecock at high number of Reynolds generating a large centrifugal force. No significant difference between cases with and without rotation in the flow field because the rotation of the spin does not affect the drag force. Figure 2.3 illustrates the shuttlecock's rotation rate and drag coefficients.

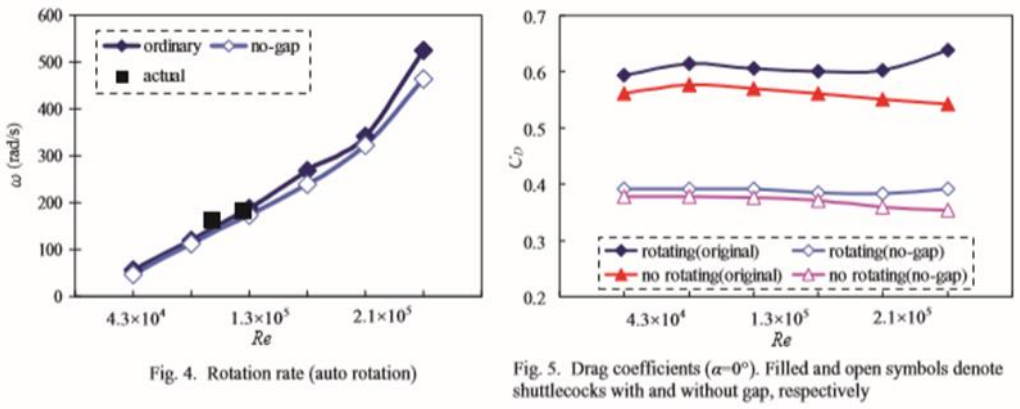

Fig. 4. Rotation rate (auto rotation)

Fig. 5. Drag coefficients (α=0°). Filled and open symbols denote shuttlecocks with and without gap, respectively

Figure 2.3: Rotation rate and drag coefficients

2.3 The Launcher

One of the main part of this project is this part. The launcher's mechanism will be developed to launch the shuttlecock into the air to the target that you want to achieve by doing some coding on the controller circuit that is the ARDUINO microcontroller. By manipulating the launcher's speed and angle, there are few trajectory types that the launcher can produce. The journal about the birdie launcher for shuttlecock, racquet swing launcher, impact launcher mechanism, and roller type launcher was explored to make my studies and knowledge about the launcher stronger.

2.3.1 Birdie Launcher

Birdie launcher has been made by a leaf blower as one of the launchers. They'll use compressed air to launch the shuttlecock through the tube into the air. Referring to the research conducted by (Bai, Ming Chui, Jennifer Hau Wai, Heckrodt Luke, Hirono Tetsuo, Ng Ivan,2006), the birdie launcher is designed with opening and closing plates to