UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN, ANALYSIS AND DEVELOPMENT OF TENNIS BALL LAUNCHER FOR A TENNIS COURT ROBOT

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

by

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DECLARATION

I hereby, declared this report entitled " DESIGN, ANALYSIS AND DEVELOPMENT OF TENNIS BALL LAUNCHER FOR A TENNIS COURT ROBOT" is the results of my own research except as cited in references.

Signature : ……

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Date : …….

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

……..

(Project Supervisor)

ABSTRAK

Ciptaan " Tennis Ball Launcher for Tennis Court Robot" ini adalah untuk berfungsi sebagai teman berlatih kepada pemain tenis yang berhasrat untuk berlatih tenis bersendirian. Mesin ini akan membantu pemain tenis untuk menjimatkan masa serta kos mereka.

Seperti mana yang kita tahu, bermain tenis berseorangan adalah mustahil kerana ia memerlukan sekurang- kurangnya dua pemain untuk memulakan permainan tenis. Kos untuk mengupah seorang jurulatih tenis juga amat tinggi.

" Tennis Ball Launcher" ini dicipta bertujuan untuk menyelesaikan masalah-masalah yang dihadapi pemain tenis. Mesin ini adalah direka menggunakan perisian Catia serta difabrikasi menggunakan mesin berteknologi tinggi seperti mesin pemotong laser, mesin kimpalan MIG dan lain-lain. Sistem mesin ini telah dianalisis dengan kaedah analitik serta menjalani ujian prototaip sebenar untuk memastikan integritinya dan boleh berfungsi sepenuhnya. Mesin ini telah berjaya dihasilkan dalam masa yang ditetapkan.

Mesin ini akan dikawal meggunakan alat kawalan jauh dan mempunyai dua mod iaitu automatik dan manual untuk menlancarkan bola. Mesin ini dapat menyimpan minimum 50 dan maksimum 90 biji bola. Mesin ini dapat beroperasi selama 51 minit dalam keadaan roda pelancar pada kelajuan maksimum. Mesin ini adalah mesra pengguna, berkos rendah serta mudah alih.

Semoga " Tennis Court Robot" dapat memberi keselesaan serta menarik minat orang ramai untuk main tenis supaya dapat membantu dalam membentuk lebih banyak pemain tenis perfesional di dalam Malaysia.

ABSTRACT

The development of Tennis Ball Launcher system for Tennis Court Robot is to serves as a training " partner" for a tennis player that practicing tennis alone. This machine will help the tennis player to save their time and cost.

As we all know, there is impossible to play tennis alone because it need at least two persons to play the games. Hiring a coach to teach tennis is quite expensive.

The Tennis Ball Launcher is developed to solve the problems faced by the tennis player. This machine was designed by using Catia software, underwent fabrication process by using high tech laser cutting machine, MIG welding machine and so on. The analytical analysis method, and actual testing of prototype is done to the system of this machine to ensure its integrity and fully functional. This machine was successfully developed within the time frame.

The machine is operated by using remote control. It has option modes which is auto or manual mode to launch the ball. The machine can store minimum 50 balls and maximum 90 balls. It can operate up to 51 minutes with constant maximum launcher wheels speed. This machine is user friendly, low cost and portable.

It is hope that this machine will bring convenient, attract more people to play tennis to help develop more professional tennis player in Malaysia.

DEDICATION

I Wee Wei Huat would like to dedicate my final year project report to my beloved family, project supervisor and friends. And hereby would like to express my deepest gratitude to my beloved father Mr. Wee Kin Ho and my mother Mdm. Voong Jun Nyin for their unconditional love, advices, support given to me and has been my pillar of strength during the up and down of my academic journey.

Not to forget my sincere appreciations to my project supervisor Mr. Herdy Rusnandi for whatever knowledge and unconditional support rendered to me from the beginning till the end of my final year project.

Last but not least, I would like to say thank you to my friends and lectures for their involvement directly or indirectly towards my success and accomplishment of my final year project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

DC	-	Direct current.
AC	-	Alternative current.
RPM	-	Revolution per minute.
g	-	Acceleration due to gravity force; 9.81m/s^2.
u	-	Initial velocity.
x	-	Displacement.
t	-	Time.
km/h	-	Kilometre per hour.
Kg	-	Kilogram.
Cm	-	Centimetre.
V	-	Volt.
Dxf	-	Drawing interchange format.
mm	-	Millimetre.
MIG	-	Metal inert gas.
PVC	-	Polyvinyl Chloride.
CAD	-	Computer aided design.
τ	-	Shear stress.
SF	-	Safety factor.

Nm	-	Newton metre.
r	-	Radius.
T	-	Torque.
F	-	Force.
ω	-	Angular speed.
A	-	Ampere, current.
°	-	Degree, angle.
Ah	-	Ampere hour.
h	-	Hour.

CHAPTER 1

INTRODUCTION

1.0 Background

Back to the history, tennis is believed and it is originated in the monastic cloisters in Northern France in the 12th century. But the game is called jeu de paume (The game of palm) because it is played by using the palm of hand with the ball struck on the hand. Until the 16th century when the rackets were introduced into the game, then the game was started to be called "tennis". But today tennis is sport that simple recognized by everyone from any countries. If we turn on the television or reading a newspaper, there is a plenty of news about tennis in the sport section everyday.

Tennis can be played by everyone including adults, kids, or even people sitting on the wheelchair as long as they can hold the racket. The rules of tennis are quite simple, two or four players will hit the ball back and forth to each other and the player will gain a point if their opponents cannot return their ball within the court margin. Therefore at least two players is needed to play tennis.

The problem is when some beginner players want to have a private practice session alone, it is impossible to play or practice tennis game alone. Therefore a machine as a feeder and launcher is needed to serve as the "partner" for the player to practice the tennis alone. This method could improve the beginner player ball hitting technique and enable the player to practice some technique shot like topspin and backspin.

During training, the trainer will feed as many of possible the tennis ball to the player. Usually up to 10 balls are used during one practice session. The players will try to return any balls that launch to their direction, the tennis balls will be scattered all around the court after the practice session.

Figure 1.1.2: Tennis balls in court after the practice session.
(source: http://tennisnyc.com/cardio09.jpg)

To pick up the tennis balls during or after the practice session is very tedious and tiring job. The standard size for the tennis court is 23.77 meters long, width 8.23meters for single matches and 10.97 meters for doubles matches. From the size of the tennis court, we know that the tennis court is not small. If the players have to pick up 30 tennis balls that scattered all around the tennis court, this job will be wasting time and will lead the players to exhaustion.

There are an existing tennis ball launchers and collectors in the market. Some of these machines use mechanical system to operate and some of it using mechanical in combination with electronics and electrical systems. These machines are only dedicated to one function only which is to pick up or to launch the tennis balls only and usually these machines are expensive. There is no machine in the market that serves as the tennis ball launcher and collector purpose in one machine.

In this project, a tennis court robot is developed to serve as the ball launcher and feeder during the practice session. This robot also can serve as the tennis balls collector to collect the balls after or during the practice session.

1.1 Problem Statement

Tennis requires at least two players to start a game or the practice session. The main concern for the tennis ball training session is time. To train the beginner players from zero to be able to return the tennis ball to their opponent and until able to perform some high level shots is not easy. The more the time spends in the practice session, the more the cost will be spent.

However, there is impossible for the beginner player to practice the tennis alone. For those who new to the tennis game it will cost a lot of money to hire a trainer to train them. Even if the players can effort to hire a trainer, it will be wasting time on collecting the tennis balls that scattered all around the tennis court during or after the practice session. It will be wasting time and exhausting to run all over the court to collect the tennis balls.

Example if the rental for the tennis court is RM 10 per hour and training fees for the trainer is RM 50 per hour, and the player train 2 hours per day, it will cost RM 120 per session and RM 840 per week. And if the player spends 40 minutes on each session on collecting the balls and rest, the player will lost RM 280 from the total cost per week just to collect the balls.

By using the Tennis court robot, the player can practice the tennis alone without hiring a trainer which will cost lots of money and saving the time on pick up the tennis balls that scattered around the tennis court. The robot can be controlled remotely and can launch the tennis balls on the desired location and can collect the tennis balls on the court. The robot is designed to be user friendly, it can fit into the car and low cost to produce. This robot could save a lot of cost for each practice session.

1.2 Objective

The Tennis Court Robot is divided to the 3 main sub systems which is tennis balls launcher system, tennis balls collecting system and control system (mechatronic). However, this report and project will only focus on the launcher system for the Tennis Court Robot.

Based on the problem statement, the objectives for this project are focused on the launcher system of the Tennis Court Robot are stated as below:

- Design and develop a Tennis Court Robot.
- Develop a Tennis Court Robot that is low cost and easy to produce.
- Develop a Tennis Court Robot that is easily carry by one person and can fit into the car.
- Develop a functional Tennis Court Robot at the end of project.

1.3 Work Scope

Based on the objective above, the work scopes for this project are stated as below:

- Design the tennis ball launcher system for the Tennis Court robot.
- Analysis the tennis ball launcher system for the Tennis Court robot.
- Fabricate the tennis ball launcher system for the Tennis Court robot.
- Test and evaluate the prototype.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The crocodile logo on LaCoste polo shirt was greatly recognized for the French tennis player from the 1920s name Rene LaCoste. The first hand crank tennis ball machine was created by him and he name it “lance-balle”. LaCoste coach criticized him for overtraining and he is familiar as a perfectionist. He decided to create a ball-throwing machine to keep his threshold because the hardship of the training is too tiring for his partners. Someone from opposite of the court has to operate the machine by using hand crank. (Prescott, 2008).

The first electronic tennis ball machine was then made by Bob McClure fifty years later. By reversing the motor on his vacuum cleaner, McClure and his tennis partner Jerry Sweeten formed the discovery in his garage in Princeton, New Jersey. The tennis ball is propel out of a connected tube by applying pressure from the vacuum is how this machine works. “Little Prince” was name that McClure gave to his invention and Prince Manufacturing Company constructed beginning with the machine fame. (Blessing,2012).

Tennis ball launcher can be easily found on the market either online or offline. Each of them has their own advantages and disadvantages. But basically, the tennis ball launcher must be able to launch the balls to the direction of the player so they can practice to hit the tennis ball consistently. Some of the tennis ball launcher will have the features such as controlled ball rotation, variable projectile angle, injection and feeding speed and many more. The tennis ball launcher usually is human

operated and the most popular tennis ball launcher is mechanical type tennis ball launcher.

The mechanical launcher usually comprised of two spinning rollers or wheels to deliver the tennis balls to the opposite direction of the tennis court. Usually the electrical motor is used to drive these wheels to spin. The velocity of the spinning wheel will affect the initial velocity of the tennis ball. The incoming tennis ball will be squeezed between the small spaces between the wheels under massive speed and pressure before the ball is launch to the targeted area with great speed and pressure. The projectile angle usually can be varied by using the servo motor in the launcher system. By changing the speed of the both spinning wheels, the ball spin can be produced. Top spin can be performed when the upper wheel rotates faster than the lower wheel. The back spin can be performed when the lower rotating wheel is rotates faster than the upper wheel.

2.1 Previous Product Review

2.1.1 Ball-Throwing Device for Tennis Balls

The "Ball-Throwing Device for Tennis Balls" as shown in figure 2.1.1.1 was invented by Werner Salansky and registered under United States Patent (Patent Number: 5,107,820) on 28 April 1992. It is a machine that designed to launch the tennis balls. The tennis balls in the ball magazine are directed one by one to the launcher system via the feed system. The speed, spin and direction of each balls that launch by the ball launcher system is controlled by the preprogramed firing setting. By refer to the figure below, the number 2 shows the magazine of the tennis balls. The ball launcher system (3) is linked to the balls magazine (2) via feed line that similar to the hose (4). The tennis balls from (2) to the launcher system (3) are guide by the rotating driver rotor (6). Only one tennis ball can fall between the arm (7) of the rotor. The ball then is directed one by one to the opening (8) which is connected to the hose (4). An electric motor is used to drive rotor (6) and support by shaft (9).

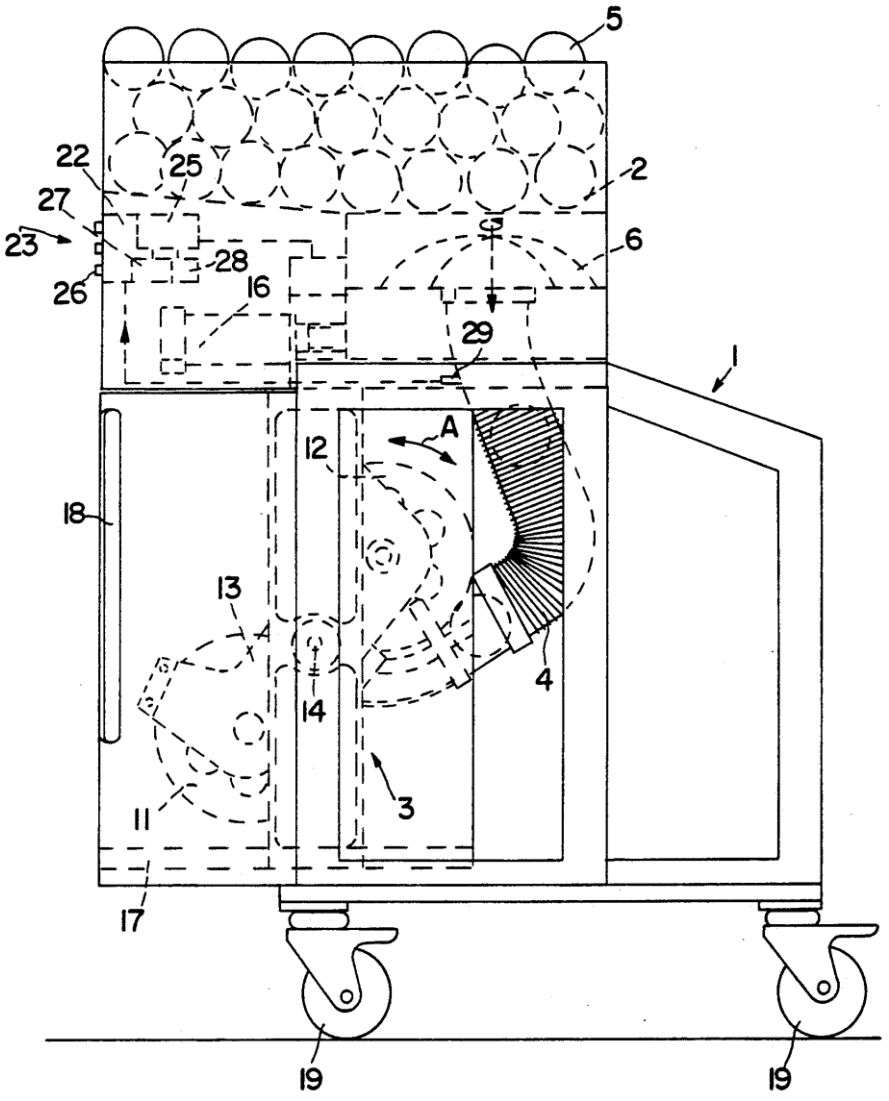

FIG.1

Figure 2.1.1.1 shows the side view of the Ball-Throwing Device for Tennis Balls. (source: https://patentimages.storage.googleapis.com/pages/US5107820-1.png)