



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

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

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

by

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## **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 Engineering Technology Automotive with Honours. The member of the supervisory is as follow:

.....  
HERDY RUSNANDI

## ABSTRAK

Terdapat banyak bola yang berselerak di seluruh gelanggang tenis semasa sesi latihan. Pergerakan di sekitar gelanggang tenis untuk mengumpul tenis yang berselerak satu demi satu merupakan pembaziran tenaga. Robot pengutip bola tenis dicipta bertujuan untuk membantu pemain untuk mengumpul bola tenis di gelanggang tenis dengan cekap. Bagi menghasilkan satu robot pengutip bola tenis yang boleh berfungsi, kami telah mengeluarkan 4 reka bentuk konseptual. Selepas pemilihan reka bentuk, reka bentuk yang dipilih turut dilukis dalam Catia dalam ukuran yang betul. Selain itu, beberapa kerja fabrikasi seperti “milling”, “turning”, “welding”, dan proses “cutting” untuk menghasilkan bahagian-bahagian pengutip bola tenis dilakukan sebelum kerja-kerja kemas. Satu prototaip berfungsi yang direka mesti dapat mengumpul bola tenis. Setelah robot pengutip tenis siap dihasilkan, analisis harus dilakukan seperti analisis kekuatan. Robot pengutip bola tennis boleh menyimpan maksimum 95 bola tenis. Selain itu, ia juga mampu mengutip bola tennis tanpa henti sekitar 45 hingga 50 minit. Dalam masa satu minit, robot pengutip bola tennis dengan kelajuan “belt conveyor” 2.7 saat per meter untuk mengumpul purata 21 bola tenis lebih daripada 18 bola tenis yang mengutip dengan menggunakan tangan.

## **ABSTRACT**

There are many balls are scattered all over the tennis court during the practice session. It is a waste of energy to move around the tennis court to collect scattered tennis balls one by one. The tennis ball collector robot was developed to assist player to collect the tennis ball in the court more effectively. To fabricate a functional tennis ball collector robot, initially it came out with four conceptual designs. After design selection, the final design using Catia with dimensions was generated. Fabrication processes such as milling, turning, welding, and cutting are conducted to produce prototype. The prototype should function to collect the tennis balls. Next, analysis such as strength analysis must be carried out at the critical part. Tennis ball collector robot can store maximum 95 of tennis ball. Moreover, tennis ball collector robot able to collect the tennis ball without stop around 45 to 50 minutes. Within one minutes, tennis ball collector robot with belt conveyor speed 2.7 second per meter to collect average 21 tennis balls more than 18 tennis balls picking by hand.

## **DEDICATION**

This report I specially dedicated to my beloved family and also to my supervisor, Mr Herdy Rusnandi and my friends for endless support and encouragement to finish my report.



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## LIST OF ABBREVIATIONS

%	–	Percentage
±	–	Plus-minus sign
$\omega$	–	Angular Velocity
$d$	–	Major Diameter
$d_c$	–	Minor Diameter
$N$	–	Motor Speed
$n$	–	number of teeth
$f$	–	Coefficient of friction
$\mu_s$	–	Coefficient of friction
$v$	–	Velocity
$\alpha$	–	Angle
$\eta$	–	Efficiency
$t$	–	Torque
$T$	–	Tension belt
Ah	–	Ampere hour
cm	–	Centimeter
DC	–	Direct current
F	–	Force
GI	–	Galvanized Iron
km/h	–	Kilometer/hour
kg	–	Kilogram
mAh	–	milliamp Hour



mm	–	Milimeter
MPa	–	Megapascal
N	–	Newton
Nm	–	Newton meter
RPM	–	Round Per Minutes
V	–	Volt
W	–	Watt

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Tennis is a sport that originated in England around the 19<sup>th</sup>. Nowadays, tennis is a very popular sport in every country and it has been quite popular among people of all ages. Tennis can be played by two people (called ‘playing singles’) or four people (called ‘doubles’). Players use racquets to hit a ball over a net into the other side of the court.

Tennis also as one of important sporting event which has gained popularity in recent years. Correspondingly, coaching or training sessions have increased where the feedback received from majority of tennis trainer is trainee difficult to conduct their training alone. Normally tennis sport need two players to conduct the game, it is impossible for a single player to play or having their private practice alone.

In tennis, there are a variety of types of shots (ways of hitting the ball) which can be categorized in various ways. The serve is the opening shot of a point. There are different type of ball hitting during warming up for match or practice within 10 minutes, for example top spin forehand and backhand. However, the best partner or coach is always not available when on tennis court training. It appears to be a lot of

troubles when a lone player would like to carry out training and the person has no partner.

Furthermore, when practice together with trainer in tennis court, the trainer usually proactive to hit the ball. Normally for tennis beginner is needed many balls to standby instead of collect the tennis ball one by one every nine to ten servicing. There are many balls are scattered all over the court during the practice session. It is a wastage of energy to move around the tennis court to collecting scattered tennis one by one.

Both collecting and servicing the tennis ball are tedious job as a tennis player to face this problem instead to spend the time in training. Insufficient resting time for tennis players which results in more energy exhaustion and unsatisfactory performance of the tennis players during training sessions. However, there is existing machine in market but there cannot solve these problem in same unit of machine. The launcher and collector are separately design independently and sell in the market currently are every expensive depend on the different specification.

With strong reason to overcome the problems that mentioned in the previous section, we are going to combine these two different function of machine into one unit or know as tennis court robot. The robot is proposed to be used as a training assistant which functions as a ball collector and also ball launcher which it can be controlled remotely that they preferred. The robot should be low cost product and easy to fabricate. On other hand, the size of robot are able to be easily carried or moved, and can be fit into the car.

## **1.2 Problem Statement**

Ball sport training generally requires a partner of the same skill level. Tennis is a sport that requires at least two players. An average tennis match in the men's

singles category at the U.S. Open in 2014 was two hours and 44 minutes, often with little more than 10 minutes of rest in between sets. The need to train for such endurance matches becomes difficult without a partner of adequate skill.

There are two problems encountered by the players is difficult to conduct training alone, waste of energy to move around the tennis court for collecting balls. The problem appears to when a player would like to carry out the training and the person has no partner or coach to serve the balls. The project idea is generated to design and develop a robot to replace the training assistant or second player with robot when time to warming up.

In marketing, the ball collector and launcher machine are too much however both function are not exist in one machine. The price for singer function tennis ball collector and launcher are not user friendly and quite expensive. The single function machine cause a lot of money and not worth if rent for few hours used in training session. In long terms consideration, the fees to take a coach and money to spend in renting the court are higher than to buy a machine that might solve the problems.

To overcome the problem, the tennis court robot is easily to set by player with controlled remotely that they preferred in ball launching and collecting tennis balls in the court. The robot is programmed to only perform its task when the specific modes of operation are activated by the user for ball launching system. Besides that, tennis balls collecting task will perform when the robot is controlled by the user.

The objective of this project is to design and develop a tennis court robot. The robot should be low cost product and easy to fabricate. On other hand, the size of robot are able to be easily carried or moved, and can be fit into a trunk of a car.

### **1.3 Objective**

This project is a group project and consist of 3 main parts, there are tennis ball collector robot, tennis ball launcher robot and base drive for tennis ball robot. In this project is focus on design, analysis and development of tennis ball collector robot part only. Based on the problem statement, the objectives for this project 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 easily carry by one person and can fit into the car.
- Develop a functional Tennis Court Robot at the end of project.

### **1.4 Work Scope**

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

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

## CHAPTER 2

### LITERATURE REVIEW

#### 2.0 History

The tennis ball machine are famous in recent years. There are two different function of machine had been used in tennis court such as tennis ball launcher machine and tennis ball collector machine.

In 1970s, Bob Mclure created a ball launcher machine by reversing the vacuum motor to build up compress air use to throw the tennis ball out from the launch tube, and the successful of this project was named as “little Prince”. The ball launcher machine have a strong enough battery to support the machine after few times of upgrading.

In 1967, IFI Claims Patent Services show that the tennis ball pick-up and collecting machine has been patterned. A conventional hand-pushed lawn mower, including side frames, helix reel assembly, wheels, roller, cutter bar, and handle, is modified by removing the cutter bar and replacing it by a tennis ball guide plate ([Offner Maximilian](#), 1967). After the tennis ball collector machine has been invented, the sport of tennis are greatly increased popularity.

Based on journal prepare by Ryan Collier (2009), the autonomous tennis ball collector machine has been invented. The ball collector machine can function detect the ball by using camera, and automatically move around the tennis court. The sensor are attached to avoid the collision. The small DC electric motor is used to move the collector machine with small voltage consume.

## **2.1 Previous Product Review**

When practice together with trainer in tennis court, the trainer usually proactive to hit the ball. After the balls are finished, the player have to pick up the balls to continue the training, wasting money to hire the trainer and tennis court rental. In order to improve this task, various types of balls collector are invented to assist player to collect the balls quickly. There are many types of custom made balls collector available in market today.

### **2.1.1 Tennis Ball Pick Up and Collecting Machine.**

The tennis ball pick up and collecting machine in **figure 2.1** has been verified in United State Patent Office on the date patented 23 December, 1969. A conventional hand-pushed lawn mower is modified to become a tennis ball collector machine used to collect the scattered balls in tennis court. To fulfil certain important criteria in building machine, a machine should not require electricity for its operation, highly efficient and with a reasonable price.

The machine not require any special skill, it's move when we push forward. The machine have a rotatable helix reel assembly and including a plurality of helical blades. The rotating wheel is moving on the floor and it connected to the roller together to move along the surface on which tennis balls are lying. The tennis ball then will struck one of the rotating helical blades and

the tennis ball will drop into the storage when it hit the surface behind the helix reel assembly.

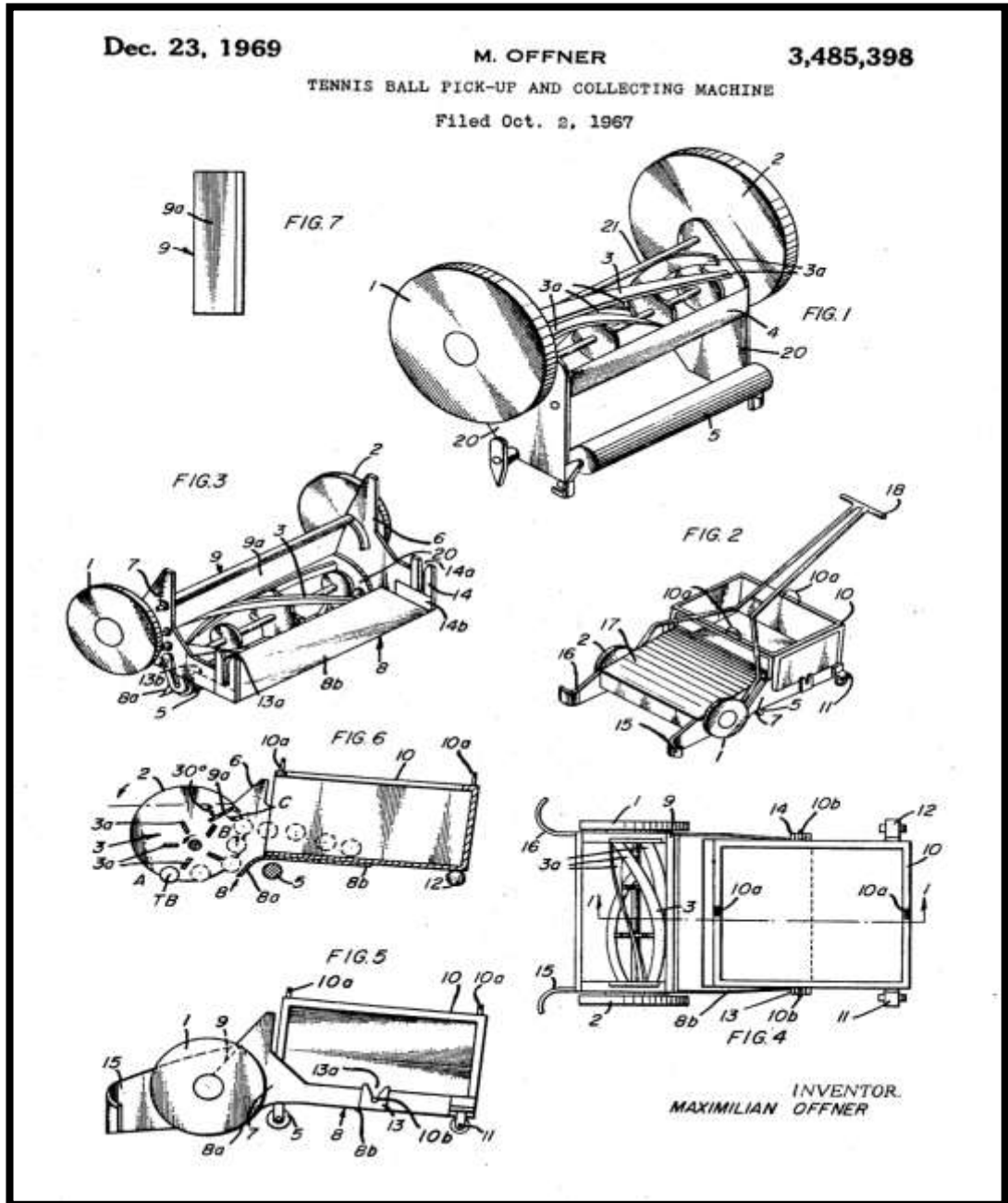


Figure 2.1: Tennis ball pick up and collecting machine.  
 ( Collier, R. & Haldenby, P., 2009. Design Report Autonomous Tennis Ball  
 Collector. , (20201838), pp.1–30. )