



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN, ANALYSIS AND DEVELOPMENT OF FRAME, BODY
AND MECHATRONIC SYSTEM 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) with Honours.

by

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DECLARATION

I hereby, declared this report entitled “Design Analysis and Development of Frame, Body and Mechatronic System for a Tennis Court Robot” is the result of my own research except as cited in references.

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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 Mechanical Engineering Technology (Automotive) with Honours. The member of supervisor is as follow:

.....

(HERDY RUSNANDI)

ABSTRACT

Tennis is a sport where two or more players are needed to play it. The problems arise when they does not have partner to play with. Not only that, scatters tennis balls around the court is a very tedious job to do. Tennis court robot was designed as a common platform for tennis ball collector and launcher system. This product has three major parts; launcher system, collector system and the mechatronic and drive system. This report will focus on the mechatronic and drive system. The method to develop this project start from problem definition, conceptual design, design evaluation followed by design selection. This robot uses Arduino as the controller and power window motor as a drive system. The prototype of tennis court robot has been tested, it has average speed around 5km/h and can be controlled remotely.

ABSTRAK

Tenis adalah sukan yang memerlukan dua atau lebih pemain. Masalah timbul apabila pemain tidak mempunyai pasangan untuk bermain tenis. Bukan itu sahaja, aktiviti mengutip bola yang berselerak di serata gelanggan adalah sangat menyusahkan. Robot tenis direka sebagai satu dasar untuk sistem pemungut dan pelancar bola. Produk ini mempunyai tiga bahagian utama; system pelancar, system pemungut dan system mekatronik dan pemacu. Laporan ini memberi tumpuan kepada sistem mekatronik dan pemacu. Cara untuk menghasilkan projek ini bermula dengan definisi masalah, konsep rekaan, evaluasi rekaan dan pemilihan rekaan. Robot ini menggunakan Arduino sebagai kontroler dan motor tingkap kuasa digunakan dalam sistem pemacu. Prototaip robot tenis telah diuji, ia mempunyai purata kelajuan sebanyak 5km/h dan juga boleh dikawal dengan menggunakan alat kawalan jauh.

DEDICATIONS

For my supervisor.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

DC	-	Direct Current
IDE	-	Integrated Development Environment
LCD	-	Liquid-crystal display
NMOS	-	N-type Metal Oxide Semiconductor
PWM	-	Pulse Width Modulation
RC	-	Remote Control
RM	-	Ringgit Malaysia
USB	-	Universal Serial Bus
τ	-	Shear Stress
π	-	pi
T	-	Torque

CHAPTER 1

INTRODUCTION

1.0 Background

Tennis is a common sport in today's society. It can be play in international level or for exercise purpose. Moreover, tennis is a universal sport that can be played regardless any gender or age.

Tennis is also a sport where two or more players are needed to play it. Thus, to practice one player needs at least one partner to play with. The problem arises when a player do not have any partner or coach to play with. Time constraint between players or player with coach can lead to this problem.

After practicing, there will be a lot of balls scattered around the court. It is a very tedious job to do and time consuming to pick up all the balls one by one especially after tired of training.

There are so many different kind of tennis machines exist in the market. Still, the problems are yet to be solved. Player needs to buy two different machines to overcome these two problems. This can be costly especially for a player who plays tennis for fun.

This is why a new machine should be designed to solve these two problems just by using one platform. It should be able to assist player to practice as well as to pick up the balls.

The goal of this project is to develop a tennis court robot that has two functions; tennis ball launcher and as a tennis ball collector. This report will be focused on the driver and mechatronic system.

1.1 Problem Statement

People become successful through a repetition, they train repeatedly to be better in what they are doing. They will train as much as they can to enhance their skills and it will require a lot of costs and time. Many hands are needed to help the player such as coach or partner. It is also a very tiring to pick up all the tennis balls that are scattered all over the court. Tennis court robot could help in training and save the time. There are many tennis machines exist in the market already. However, there are few machines that combine two functions in one platform. To buy each machine for each function can be expensive for the beginner player. Thus, a cheaper tennis court robot is needed to solve these problems.

1.2 Objective

This project has three main systems which are the launcher system, collector system and the mechatronic and drive system. This report will focus on the mechatronic and drive system while the other two systems were conducted by two other students. The objectives of this project are:

- a) To design and analysis a tennis court robot
- b) To develop a low cost tennis court robot

1.3 Scope

This project will be done according to the scopes provided. The scopes are listed as below:

- a) Design, analyze and fabricate platform for tennis court robot
- b) Develop the mechatronic system for tennis court robot
- c) Test the tennis court robot prototype

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Literature review is an evaluation or analysis of previous study. The main purpose of literature review is to summaries what already been done in the previous study.

This chapter will provide literatures that are related to the previous product or similar product that are already in the market. Other than that, it will also review about theoretical background about the system or material that will be used in this study.

2.1 Product Review

2.1.1 Boomer

David 'Dave' Jordan has invented tennis machine called Boomer as shown in figure 2.1. He began to design the concept since 2001 with an aim to coach and lead players regardless their age or level. Boomer not only can be used as opponent in the training session but also can give feedback on the player's skills such as the swing of the players. It act as a coach since it can 'talk' and give feedback directly to the player (Murphy & Gibson, 2012).



Figure 2.1: Boomer Tennis Machine

(Source: <<http://www.tennis.com/gear/2012/11/question-day-rallying-machine/45524/>> 20/5/2017)

It took five years to build Boomer. Boomer stays in the center of the court at the baseline and uses one camera that is placed on a wall above the Boomer. This camera will give information to Boomer through computer. The computer will then give command to the actuator, which is Boomer, on when and the speed of the ball and tell the player on how to counter the ball. Not only that, it also record the score as the software able to track the ball. The idea of Boomer rise when the inventor has to play alone and when he feels like the available tennis machines are limited as the function are not vary. He also wants a machine that can give him feedback. Boomer able to launch ball in many different angles, speeds and spins. The price for Boomer is around RM60000. The price is too high for a player to buy on their own, which is why Boomer usually available at tennis sport center or tennis club (Hartt, 2003).

2.1.2 BallBot

The purpose of BallBot robot is to pick up all the balls that are scatter around the court. BallBot as shown in figure 2.2 is an autonomous robot that has a microcontroller to detect any objects that are similar to tennis ball by using a camera that attached on it. By using the coordinate of the net, it uses it roaming around the court. When it can no longer detects any tennis balls or if the storage is full, it will pour it in a pile out of the court. It uses a rover as a body. It also uses sensor to detect the tennis ball and also to avoid form being tangled in the tennis net, as it is an autonomous robot. The programming will be use to directs the BallBot movement (Ford, 1999).



Figure 2.2: BallBot

(Source: <<http://www.seattlerobotics.org/encoder/aug99/ballbot.html>>

20/3/2017)