UNIVERSITI TEKNIKAL MALAYSIA MELAKA

RADIO FREQUENCY CONTROLLED STAIRS CLIMBING ROBOT

Thesis submitted in accordance with the partial requirements of the
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Bachelor of Manufacturing Engineering (Robotics and Automation)

By

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APPROVAL

This PSM submitted to the senate of UTeM and has been as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotic and Automation). The members of the supervisory committee are as follow:

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DEDICATION

To my mother and father, thank you for your undying love and support. To all my lectures and friend, thank you for your support.

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ABSTRACT

This report presents the study on a stairs climbing robot which will be manually controlled using radio frequency (RF). RF control implements the use of wireless technology to propagate data. This report includes the process flow of the project, literature review, the development of the robot, and the tests conducted on the stairs climbing robot. In integrating the controller with the robot, a radio frequency control circuit is modified to fix it with the robot structure and mechanical system. As the robot is developed, it has been tested on three different tasks including a stairs-climbing task. Generally, the structure of the stairs climbing robot is developed mainly from the aluminium L bars. Two power window motors are used as the robot's source of movement. The motors are attached to two wheels through two shafts. The robot has four "legs" attached to each of the two wheels that are developed from aluminium L bars. This is purposely to make the stairs climbing robot 'catch' the stairs in order to climb the stairs. Furthermore, the RF control system is developed by modifying the normal RF control circuit from a normal RF control toy. As for the result of this project, two out of three of the objectives which are to modify a RF circuit and integrate to the robot mechanical system, and to ensure that the robot able to receive and send command signal between the robot and the controller by using the RF signal has successfully been achieved. For the stairs climbing task which implies to the first objective of this project that is to design and develop a robot that has capability to climb stairs, the robot managed to climb the stairs after 20 times of tries.

ABSTRAK

Buku laporan ini mengandungi kajian mengenai robot yang dibina untuk menaiki tangga dan dikawal secara manual menggunakan frekuensi radio (RF). Kawalan secara RF merupakan penggunaan teknologi tanpa wayar dalam penghantaran data. Buku laporan ini juga merangkumi aliran process projek, ulasan artikel, pembinaan robot, dan ujian-ujian yang telah dijalankan terhadap robot tersebut. Dalam menyepadukan sistem kawalan terhadap robot tersebut, litar kawalan RF diubahsuai supaya dapat disepadukan bersama struktur robot dan sistem mekanikal robot. Setelah robot siap dibina, robot tersebut telah diuji dengan tiga ujian yang berbeza dimana salah satunya termasuk ujian menaiki tangga. Secara amnya, struktur robot dibina dengan menggunakan kepingan aluminium berbentuk L. Dua motor (yang digunakan pada sistem tingkap automatik kenderaan) digunakan sebagai sumber pergerakan untuk robot tersebut di mana, dua motor tersebut disambungkan pada dua tayar dengan menggunakan dua syaf. Pada setiap tayar tersebut terdapat 4 “kaki” yang diperbuat daripada kepingan aluminium berbentuk L yang bertujuan membolehkan robot tersebut ‘menangkap’ anak tangga dalam mencapai salah satu objektif projek ini iaitu menghasilkan robot yang boleh menaiki tangga dengan menggunakan kawalan RF. Disamping itu, sistem kawalan RF dibina dengan mengubahsuai litar kawalan RF yang diambil dari alat permainan kawalan jauh yang menggunakan RF. Projek ini berjaya mencapai sepenuhnya dua daripada tiga objektifnya iaitu mengubahsuai litar RF dan menyepadukannya bersama struktur dan sistem mekanikal robot, dan memastikan bahawa robot tersebut boleh dikawal menggunakan alat kawalan dengan menggunakan RF. Bagi ujian menaiki tangga yang mana ianya berkait dengan objektif pertama projek ini iaitu mereka dan membina sebuah robot yang boleh menaiki tangga, tobot tersebut berjaya menaiki tangga setelah sebanyak 20 percubaan dijalankan.

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CHAPTER 1
INTRODUCTION

1.1 Background

Robot had come to human life for the past almost 90 years ago. Robot once was created with the purpose as a human assistant tool. But nowadays, people create robot for many reasons and purposes. Other than as human assistant tools, people make robots for hobby, entertainment, and personal use. Some people think or sense a robot is just about wires and wheels but several just think over the limit. Math rules physics, and physics rules robots. The laws of physics and math are evident in everyday life. Throughout the history of science and technology, the path to great discoveries has almost started with the observation of simple events. Newton's apple, Einstein's empty room in space, and Shannon's word games are clear examples.

Making a vehicle that can autonomously drive around, both indoors and out seems, at first, like a simple thing. Build a chassis, add drive wheels, steering wheels, a power source (usually batteries), some control code that includes some navigation and obstacle avoidance routines or some other way to control it, throw some bump sensors on it, and there it go, a robot. Unfortunately, soon after these first attempts, the designer will find the robot getting stuck on what seem to be innocuous objects or bumps, held captive under a chair or fallen tree trunk, incapable of doing anything useful, or with a manipulator that crushes every beer can it tries to pick up. Knowledge of the mechanics of sensors, manipulators, and the concept of mobility will help reduce these problems.

1.2 Objectives

The main aim of this project is to design and develop a stair climbing manual control robot in which control by using radio frequency (RF) signal. With the RF control, the movement of the robot can be much easier and not too limited because it is not attach to a wire. The objectives of this project are as follow:

1. To design and develop a robot that has capability to climb stairs and control by a remote control that using RF as the command transmission between the robot and the controller.
2. To modify a RF circuit from a normal control car toy and integrate to the robot mechanical system.
3. Able to receive and send command signal between the robot and the controller by using the RF signal.

For future development of this project, this kind of robot can be develop or modify so that it can help human on carry heavy baggage through stairs.

1.3 Scope

In this project, the literature research will cover about the wireless communication system such as radio frequency (RF), infra red, and microwave. Each type of the wireless communication has its own advantages and disadvantages. Furthermore, this project will cover on the types of motors, materials, and mechanical parts such as chains, wheels, and gears in making the robot. Other than types of robots, the movement style of robots also will be covered. Therefore, the research will the decided the design and movement style of this stair climbing robot. Moreover, some analysis on different materials for robot structure also will be covered in this project in order to build the robot.

In this report of the project which consist 6 chapters, Chapter 1 discuss generally about the background of this project. The objectives of the project also are stated and elaborate in Chapter 1. Furthermore, the scope and the problems statement of the project also discussed. The Gantt chart is provided in this Chapter 1.

Chapter 2 in this project report discusses all the literature research and the information obtained. Generally, in Chapter 2 consists discussion about particular aspects such as introduction to robots; history of robot, types of robot, properties of typical robots, and application of robots. Furthermore, wireless remote control system; wireless transmission. Moreover, components of stair climbing manual control robot, such as joypad, dc motor, wheels, chain, and other mechanical parts. Structure, which includes aluminium and acrylic also, be discussed in Chapter 2. Last but not least, there is previous research that related to this project done by other provided and discussed in this chapter.

Chapter 3, that is methodology, generally explain on how this project will be implement, project planning, and the process flow of the project. With the flow chart provided, particular process flow and methodology which consists robot structure, design, mechanical system, and radio frequency control circuit in the project will be briefly discussed.

However, for PSM 1, the project report only covers until Chapter 3. Further investigations and researches will be continued in the second task of PSM, PSM 2.

1.4 Problem Statement

In order to design a stairs climbing robot, one of the aspects that need to concern about is the movement method of the robot. There are many methods that can be attached to a robot so that it be able to move through stairs such as robot legs, rubber wheels, chain-wheels, blocks or else. All this depends on the condition of the stairs, the cost of the materials, movement style of the robot and the speed movement of the robot.

In the other hand, in order to modify a circuit for the controller and for the robot so that the controller be able to send command by RF signal and for the robot to receive command from the RF signal, the method on how to modify the circuit with the transmitter and receiver of RF signal attach to it, will be need to studied. Besides, type RF transmitter and receiver and power supply use in the circuit will put in consideration depends on the circuit system, cost of the equipments, and the robot needs itself.

Furthermore, suitable types and quantity of motors to be used for the robot such as power widow motor, servo motor, or stepper motor, will depend on the design of the robot, speed movement of the robot, the power and torque of motors the robot need and the cost of the motors.

In developing and fabricating the robot, it will consider the materials use depend on the size of the robot, the shape or design of the robot, the cost of materials, and the ability to fabricate with the materials in order to developing the robot.

Other than aspects mentioned above, there are particular parts and aspects that need to learned and studied in developing the robot such as types of gears to be used, types of wheels to be used, materials to be used for the robot structure, chains, wireless remote control system, and mechanical system of the robot.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction to Robots

The field of robotics is very interesting to anyone that curious about how living things or organisms (including people) interact with the real world. Robotics is a very comprehensive, applications-oriented field of study. A complete understanding of robotics involves many different technical areas such as electrical principles, electronic devices, digital principles, electromechanical fundamentals, basic programming techniques, hydraulics, pneumatics, and basic manufacturing process. Generally, robots had been created for certain purposes or agency. A robot has artificial intelligence programmed which running by its own or control by a controller.

A robot is not necessarily only in form of physical appearance that is touchable, but also in virtual form. Sometimes software also can be called a robot. Specifically, the definition of a robot that stated by Robot Institute of America as “A reprogrammable and multifunctional manipulator, device for the transport of materials, parts, tools or specialised system with varied and programmed movement, with the aim of carrying out varied tasks” [1]. But, this definition is far from perfect and needs additional definitions to completely define a robot.

2.1.1 History of Robot

The research about robot actually had started from 12th century consider about the high level of achievement of watchmakers whom made clockwork robots called automaton. These automatons are be able to write separate sentences, draw different pictures, play musical instruments, and perform simple tasks such as perform magic show on a stage as shown in Figure 2.1. The automatons are examples of the true robots as they were programmable via a system of interchangeable cams. As the time flows, the coming of industrial age, with its heavy use of machines, had a big culture impact.

The sense that the technology was running away by itself was felt during this time and people felt that it is unwise to develop a high functioning mechanical human with no emotions no humanoid behaviors in it. Therefore, as the idea was there, in the year 1920, a Czechoslovakian name Karel Capek introduced the word 'robota' in the play of R.U.R – Rossum's Universal Robot; human-like mechanical creature produced by Rossum's factory as shown in Figure 2.2. The word robot eventually comes from the Czech word, 'robota', which means labour [2]. In this case, it means about a very long lasting labour. From the play, it certainly defines the stereotype of a modern age robots.

And in early 1930, a programmable humanoid robot named Electro was invented by Westinghouse Electric Corporation [1]. Thus, in 1942, came the Three Laws of Robotics which are designed to protect human from robots. The Three Laws of Robotics are stated as follow; first, a robot may not injure a human being, or, through inaction allow a human being to come to harm, Second, a robot must obey the orders given to it by human beings, except where such orders conflict with the First Law, and Third, a robot must protect its own existence as long such protection does not conflict with the First and Second Laws [2].

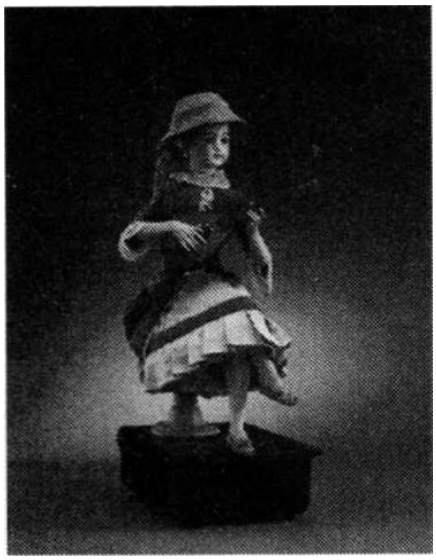

Figure 2.1: An automaton that plays a mandolin, circa 1890 [2].

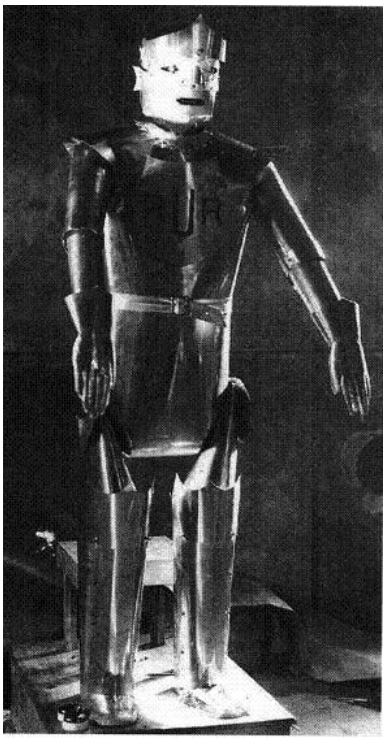

Figure 2.2: An English robot built for a production of ‘R.U.R’ [2].

2.1.2 Types of Robots

Basically, there are two types of robots that widely use in human daily life which are industrial robot and mobile robot. Of course, there are major differences between these two types of robot.

2.1.2.1 Industrial Robot

From the word ‘industrial’ itself tells that industrial robots are robots that widely use for industries that can easily found in many factories. There are commonly seen as robotic arms. Use of these robots is to improve the quality and productivity of the industry productions. Generally, different robot conveys different tasks such as welding, painting, ironing, assembly, pick and place, packaging and palletizing, product inspection, and testing the products, that accomplished with high endurance, speed, and precision [5]. Industrial robot usually consists of a jointed-arm (multi-linked manipulator) and gripper assembly or end effector that is attached to a fixed surface as shown in Figure 2.3. There are many types of industrial robot such as articulated robot, Cartesian coordinate robot, Delta robot, gantry robot, liquid handling robot, parallel manipulator robot, serial manipulator robot, and SCARA robot [6].

Figure 2.3: KUKA Robot, an example of an industrial robot [12].