ANKLE REHABILITATION SYSTEM FOR SPRAIN ANKLE PATIENT'S

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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This report is submitted in partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

Faculty of Electronic and Computer Engineering
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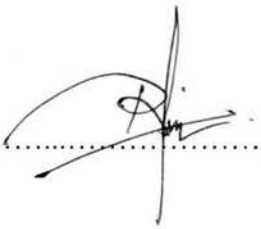
Signature : 

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APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature :

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DEDICATION

Dedicated to my beloved family, father, and mother Azizi Bin Osman & Halizah Binti Ramthan.

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ABSTRACT

An ankle injury can happen to almost everybody especially to active people who are vulnerable to ankle sprain injuries. The ankle rehabilitation is to regain full function without limitations and strength of ankle joint under therapist exercise. Currently, patients mainly perform ankle exercise by manual therapy and can cause loose interest for them to continue the exercise. The purpose of this project is to design an ankle rehabilitation system training which will guide the ankle joint of the subject to follow the desired angle trajectory accurately as a standard of normal people. The robotic platform is user-friendly which can execute ankle with 3 Degrees of Freedom (DOF) via internet connectivity by using servo motor as the actuator and three modes of exercise at a different speed. As the analysis in this system, gyro meter was put on the platform to display the maximum point angle of patient's feedback can achieve in order to increase muscle force and joint stability. The force ability given by each subject almost 55% until 100% able to achieve the actual range angle even different torque of stiffness for the servo motor has given with different power supply current which is 2 Ampere and 3 Ampere.

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ABSTRAK

Cedera pergelangan kaki boleh berlaku kepada hampir semua orang terutama kepada mereka yang aktif mudah terdedah kepada kecederaan pergelangan kaki. Pemulihan pergelangan kaki adalah untuk mendapatkan kembali fungsi sepenuhnya tanpa batasan dan kekuatan pergelangan kaki di bawah latihan terapi. Pada masa kini, pesakit melakukan latihan pergelangan kaki melalui terapi manual dan boleh menyebabkan mereka kurang minat untuk meneruskan latihan. Tujuan projek ini adalah untuk merekabentuk sistem pemulihan pergelangan kaki untuk latihan yang akan membimbing sendi pergelangan kaki subjek mengikut jejak sudut yang dikehendaki dengan tepat seperti orang biasa. Platform robot boleh melaksanakan pergelangan kaki dengan 3 darjah kebebasan melalui sambungan internet dengan menggunakan motor servo sebagai penggerak dan mempunyai tiga mod latihan yang berbeza kelajuan. Sebagai analisis dalam sistem ini, gyro meter diletakkan di atas platform untuk paparan sudut titik maksimum maklum balas pesakit boleh dicapai bagi meningkatkan daya otot dan kestabilan sendi. Keupayaan daya yang diberikan oleh setiap subjek hampir 55% sehingga 100% dapat mencapai sudut jarak sebenar walaupun tork kekerasan yang berbeza untuk motor servo telah diberikan dengan bekalan kuasa arus yang berbeza iaitu 2 Ampere dan 3 Ampere.

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LIST OF SYMBOLS AND ABBREVIATIONS

DOF	:	Degree of Freedom
IoT	:	Internet of Things
GUI	:	Graphical User Interface
PCB	:	Printed Circuit Board
ROM	:	Range of Movement
ARES	:	Advance Routing and Editing Software
PWM	:	Pulse Width Modulation
LCD	:	Liquid Crystal Display

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CHAPTER 1

INTRODUCTION

This chapter will be briefly explained the introduction, problem statement, objective, scope and also the thesis outline.

1.1 Introduction

Figure 1.1 depicts the model of ankle structure for patients to do rehabilitation exercises such as inversion/eversion (x-axis) movements, dorsiflexion/plantarflexion (y-axis) movements and Adduction/Abduction (z-axis) movements. First Rehabilitation is the mainstay treatment for patients who suffer from ankle injuries whether they actually aware or doesn't aware that they have it. Almost everybody especially to active people who are vulnerable to ankle sprain injuries because of side-to-side motion from internal rotation of the ankle joint [1]. One of the most common acute injuries that athletes suffered is an ankle sprain

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[2][3]. This injury happens, when the ankle bends more than normal and affects or damages the ligament [4]. For the worst situation, the ligament can stretch or tear. Normally, the ligament needs six weeks to heal although the rates of everyone to recover are different and depend on ankle sprain level [5].

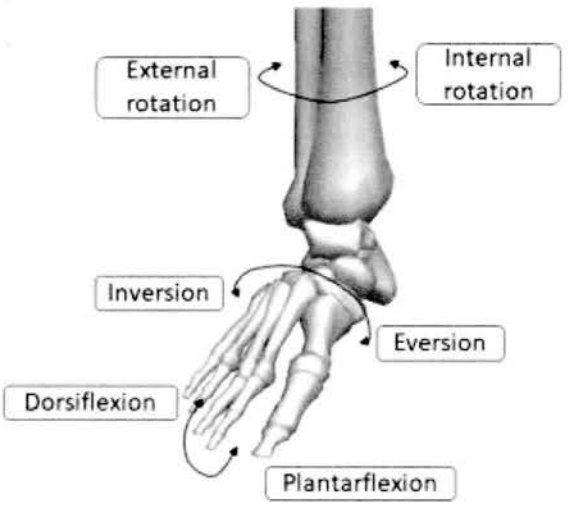

Figure 1.1 Model of Ankle Structure.

The purpose of rehabilitation is to regain full function strength of ankle joint under therapist exercise [6]. Usually, rehabilitation exercise conducted by a nurse or doctor at the hospital or health center. The portable prototype design of ankle rehabilitation will help to solve the problem by doing the exercise anywhere without trouble. The ankle rehabilitation device can be used as the alternative treatment in the medical field for future development.

1.2 Problem Statement

Currently, robot users input instructions to the control system via mouse and keyboard [7]. Robot-assisted system for the ankle rehabilitation system is being thought to be better than manual therapy [8]. A touch panel, integrated into the control architecture, will enable robot user to easily enter the parameters and

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instructions. Most ankle rehabilitation system doesn't connect to smart devices easily but still using a computer or any other operating system to control. So the Arduino set will be used to design an embedded system between the ankle rehabilitation device and to a smart device. Individual who in need of ankle rehabilitation exercise that is critical to ensure that the ankle recovers the injury by manually. Usually, an ankle rehabilitation system manually can make the user lose interest [9]. The develop connection between the ankle rehabilitation system with an Android device can reduce or make the user more interesting. Besides that, the patient can make the ankle rehabilitation exercise on their own to move ankle as it rotates to the position that needed to be controlled by a smartphone device. This will be more comfortable for the patient to do the exercise it anywhere and the device can be used for a longer time. Rehabilitation Centre collects data manually by using their instinct and knowledge study to determine the patient's angle with giving points marks. With the Graphical User Interface (GUI) that has been created, it helps the Rehabilitation Centre to save the data of patient's every day with many sessions. This will help the doctor collect the data more accurately. Furthermore, this project can give different torque stiffness of servo motor that able to know from the angle achieved by the patients. This torque stiffness is important to improve the force given by patients to recover and gain stability [10].

1.3 Project Objectives

The objectives of this project are:

i. To design a prototype of ankle rehabilitation system using Servo Motor wirelessly.

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ii. To develop connections via the Internet of Thing (IoT) connectivity between the ankle rehabilitation system prototype with an Android device.

iii. To analyze the performance of the system based on the patient's feedback in order to increase muscle force and joint stability.

1.4 Project Scope

The project scopes of this project are to design a control system using servo motor and Arduino platform with Internet (IoT) connectivity. The completed prototype of ankle rehabilitation system will be connected to smartphones using Blynk Software via internet (IoT) connectivity. The prototype can use the phone's interface 3-Degree of Freedom (DOF) to control and move ankle to the 3 step angles which can execute ankle inversion/eversion rotation (x-axis), dorsiflexion/plantarflexion rotation (y-axis) and internal/external rotation (z-axis). The leg length and width of the person that suitable for this project analysis is between 23cm until 29.5cm

1.5 Research Methodology

This project begins with research of the proposed title. The results of the research are discussed and the title of this project was accepted. The background of this project is studied and was explored as stated in the literature review.

Next step is to design a prototype which the project was divided into two parts, hardware of an ankle rehabilitation and software using Arduino programming to moves the ankle rehabilitation into angle position by the Internet (IoT)

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connectivity. The troubleshooting took part in combining the hardware and the software.

In this research, the best criteria for ankle rehabilitation will be chosen and the management is needed to get the positive output result that needed by patients. The scope will be studying about the Degree of Freedom, actuator, connectivity interface and also analysis system of this project. The methodology for doing this project will be discussing detail in methodology part. Then, selection will be chosen the best criteria for the design parameter to get the result that we need. Figure 1.2 shows the main focus part that needs to study and consider in order building an ankle rehabilitation platform for analysis proses and marketability. This K-Chart is a tool for systematically organizing research for scope study, methodology, result, and timelines.

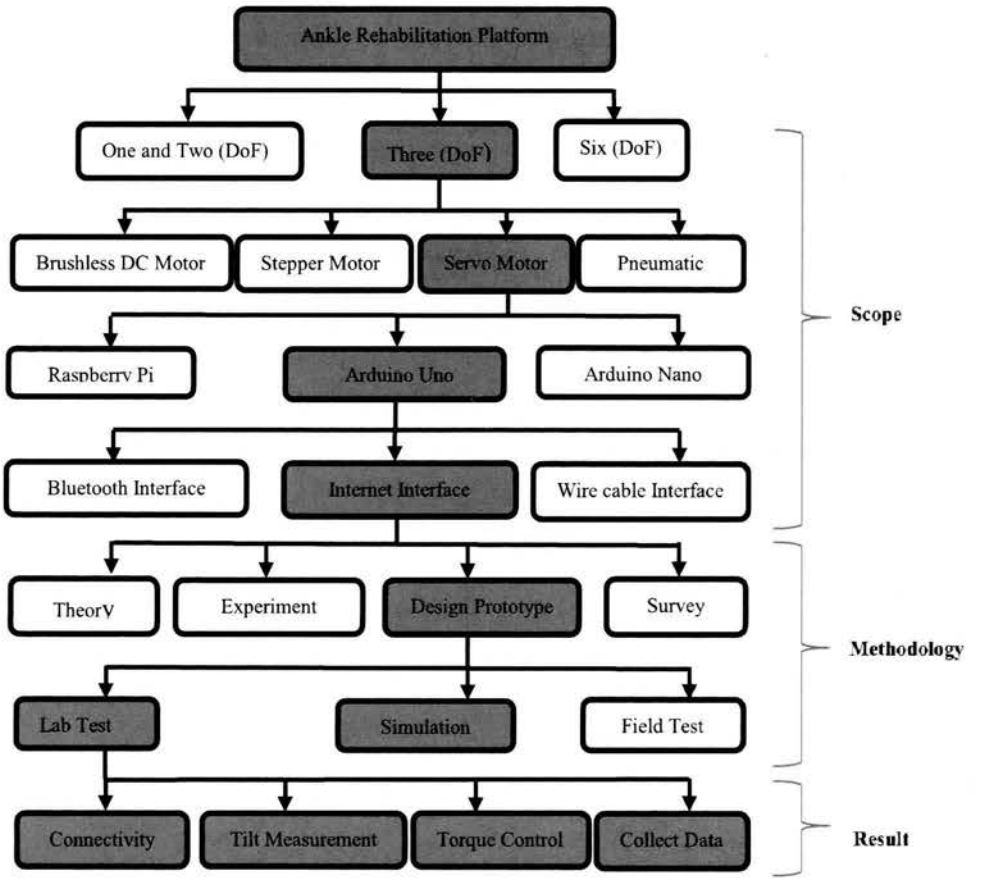

Figure 1.2 Ankle Rehabilitation System for Sprain Ankle Patient's

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