UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF FOOT SOLE PRESSURE PADS FOR REHABILITATION PURPOSES

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industry Automation & Robotics) with Honours.

by

RAHMAN BIN RANULFO@MOHAMMAD BUDI

B071710645

970421-12-5977

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: DEVELOPMENT OF FOOT SOLE PRESSURE PADS FOR REHABILITATION PURPOSES

Sesi Pengajian: 2020

Saya **Rahman Bin Ranulfo@Mohammad Budi** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

Rahman Bin Ranulfo@Mohammad Budi

Alamat Tetap: No 23 Jln Nikmat 25/47

Tmn Sri Muda, Seksyen 25 40400 Shah

Alam, Selangor.

X

X

X

Tarikh:20/1/2021

Disahkan oleh penyelia:

.....

Ts. Dr Aliza Binti Che Amran

Cop Rasmi Penyelia

TS DR ALIZA BINTI CHE AMRAN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik,
Fakulti Teknologi Kejuruteraan
Elektrik dan Elektronik,
UTeM

Tarikh:20/1/2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled DEVELOPMENT OF FOOT SOLE PRESSURE PADS FOR REHABILITATION PURPOSES is the results of my research except as cited in references.

Signature:

Author : Rahman Bin Ranulfo@Mohammad Budi

Date: 20/1/2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industry Automation & Robotics) with Honours. The member of the supervisory is as follow:

Signature: .....

Supervisor: Ts. Dr Aliza Binti Che Amran

TS DR ALIZA BINTI CHE AMRAN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik,
Fakulti Teknologi Kejuruteraan
Elektrik dan Elektronik,
UTeM

Signature: .....

ABSTRAK

Foot Plantar Pressure adalah daya geseran yang wujud antara kaki dan permukaan sokongan semasa operasi lokomotif biasa. Maklumat berdasarkan tekanan penting dalam penyelidikan gaya berjalan dan postur untuk mendiagnosis masalah anggota badan yang lebih rendah, reka bentuk kasut, biomekanik sukan, pencegahan kecederaan dan aplikasi lain. Dalam laporan ini, Arduino Nano yang dilengkapi dengan *Force Sensing Resistors* (FSR) sedang dikembangkan untuk mengukur tekanan plantar. Sensor tanpa wayar telah menunjukkan ketepatan dan kecekapan tinggi ketika mengira kepekatan tekanan tinggi di bawah kaki dalam masa nyata. Projek ini akan menggunakan *Internet of Things* (IoT) seperti firebase sebagai pangkalan data awan, di mana rekod pesakit disimpan dalam pangkalan data, yang membolehkan doktor dan kakitangan perubatan yang lain dapat mengakses maklumat pesakit. Thunkable adalah aplikasi mudah alih yang digunakan untuk pemantauan sebenar untuk penggunaan pesakit untuk memeriksa pengukuran tekanannya secara langsung dengan doktor. Data dari aplikasi mudah alih Thunkable akan disimpan di telefon pintar dan akan dihantar dan disimpan di pangkalan data awan. Keuntungan utama firebase adalah data pesakit tidak akan hilang malah data pesakit di dalam komputer riba telah dihapus atau hilang. Untuk aplikasi mudah alih Thunkable, kelebihannya ialah pesakit dapat mengakses maklumat perubatannya dalam masa nyata. Tujuan utama projek ini adalah untuk mengembangkan tekanan kaki bawah untuk lebih maju seperti menggunakan *Internet of Things* (IoT).

ABSTRACT

Foot Plantar Pressure is the friction force that exists between the foot and the support surface during normal locomotive operations. Pressure-based information is important in gait and posture research to diagnose lower limb problems, shoe design, sports biomechanics, injury prevention and other applications. In this report, an Arduino Nano equipped with Force Sensing Resistors (FSR) is being developed to measure plantar pressure. This project will use the Internet of Things (IoT) like firebase as a cloud database, where the where patient records are saved in a database, allowing doctors and the rest of the medical staff to have access to patient information. Thunkable is the mobile apps that use for real monitoring for the patient use to check his/her pressure measurement in real-time with the doctor. The data from the Thunkable mobile apps will be saved in the smartphone and will be sent and saved in the cloud database. The main advantage of the firebase is the patient data will not be lost even the patient data in the laptop storage ar been deleted or lost. For Thunkable mobile apps, the advantage is the patient can access his/her medical information in real-time. The main purposes for this project are to develop the foot plantar pressure for more advance like using Internet of Things (IoT).

DEDICATION

I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. To my beloved parents Mani Binti Dahlan and Ranulfo@Mohammad Budi who been encouraging me all the way, and whose encouragement has made sure I give it all I need to finish what I have started. Thank you very much and my love for my family can never be quantified. May Allah bless us.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to thank my family especially my beloved parents Mani Binti Dahlan and Ranulfo for their endless support, love, prayers and help me in financial to complete this project.

My sincere gratitude goes to my supervisor, Ts. Dr Aliza Binti Che Amran as a senior lecturer of Faculty of Electrical and Electronic Engineering Technology, University Teknikal Malaysia Melaka (UTeM) for giving me the opportunity to do the project and providing invaluable guidance throughout this project. She ha taught me the methodology to carry out the project and to present the research works as clearly as possible. I am grateful for what she has offered me. Also, I would like to appreciate the University Teknikal Malaysia Melaka (UTeM) for providing the project platform and financial assistance.

Finally, I would thank all my friends that provided me with the assistance, support and always inspire me to complete my project. My special thanks go to my beloved housemate who always gives me motivation and always help me during when I need some motivation to complete this project.

TABLE OF CONTENTS

LIST OF TABLES

TABLE **TITLE** **PAGE**

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOLS

D, d	-	Diameter
F	-	Force
g	-	Gravity = 9.81 m/s
I	-	Moment of inertia
1	-	Length
m	-	Mass
N	-	Rotational velocity
P	-	Pressure
Q	-	Volumetric flowrate
r	-	Radius
T	-	Torque
Re	-	Reynold number
V	-	Velocity
w	-	Angular velocity
x	-	Displacement
z	-	Height
q	-	Angle

LIST OF ABBREVIATIONS

PCA	Principal Component Analysis

LIST OF PUBLICATIONS

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will explain the project background, problem statement, objective, scope of research and the thesis outline.

1.2 Backgrounds

In this modern world, biomedical and sport-related fields of research such as ergonomic shoe design, sports performance analysis and injury prevention, improvement in balance function, physical therapy, recovery training systems, and disease diagnosis, plantar foot pressure monitoring devices are gaining interest. Much valuable biometric information relevant to human health is provided by measuring the distribution of plantar foot pressure during everyday activities. Application of this knowledge helps us create personal-optimized shoes, boost sports performance, track patient recovery and even early detection of diabetic foot ulceration. There are two main types of tools used for this analysis and measurement. They are broadly categorized as platform method or pads system and in-shoe systems.

In general, the platform method or pads system is more accurate than in-shoe systems. Still, pads system nowadays is using a wired system to collect and save the data. Incoming sensor measurements are processed and stored only for offline analysis on a

laptop or computer memory. However, data losses always occur because it's only stored in one system or offline systems.

Common the data losses are due to the laptop or computer memory problem. Hence, by using the Internet of Things (IoT) or in medical and healthcare application is called the Internet of Medical Things (IoMT) which is applied to medical and health-related purposes, research and surveillance data collection and analysis. All patient records are kept in a database that is easier for doctors and the rest of the medical staff to access patient information, and the patient to be able to access it on the smartphone.

1.3 Problem Statement

Nowadays, we can look around there are many people either young or old that have a foot problem that eventually causes back pain. When people walk, he or she put the force on each of them like five times you're their body weight. If the foot does not adequately absorb that shock or redistribute it, problems can develop elsewhere. While you may not think that the cause of your back pain could be a small, almost unnoticeable, problem in your foot, it might very well be. This is because all our bodies are founded on our feet. When they are just marginally off, you can sense a ripple effect in the body. Small deviance in our feet from the norm could change the way we walk, or move our hips, back, arms, and shoulders. These small changes can irritate or overwork certain parts of the body, such as the muscles and tendons in our lower back, and lead to pain over time.

For this project, the problem faced was the inability to detect the pressure difference that might occur between the two-foot sole, left and right. When someone has

a problem with his or her body that relates with back pain or slipped disc, there will be a pressure difference between the two feet, however, they cannot detect or realize that during walking or other activities. This is where the problem comes in. If a person cannot detect that he or she is having a leg or walking problem, he or she will continue to walk in that pattern, even though that walking pattern is not good and bad for their body posture. If the leg or walking problem becomes worse, that problem could turn into a bigger problem for example critical slipped disc diseases that usually ends up with open surgeries to remove the compression and cause some nerves not functioning well anymore.

For professional athletes that do a workout program that uses gym equipment that makes a force to the foot sole like squat exercise which is there is more pressure on the foot soles. That is because people walk two legs straight. The legs and feet, including gait and posture, play a significant role in the general health of humans. The diagnosis of orthopaedic but also other related disorders is therefore of paramount importance as soon as possible. So, by developing the foot pressure pads, it will overcome the problem by detecting the pressure or force between right foot and left foot to prevent illness that causes from the foot.

1.4 Objectives

The main aims of this project consist of:

- To design foot sole pressure pads for rehabilitation purposes or sports purposes.
- To build or develop the foot sole pressure pads that will be monitored by real-time using the Internet of things (IoT).
- To test the effectiveness of the pads in pressure measurement.

1.5 Scope of Research

This project needs pressure sensor pads to detect the foot pressure under the human foot sole. The project will use a force sensing resistor that connects to the NodeMCU ESP32. This device can monitor the pressure of the human foot sole that will be placed at a certain area of the human foot's sole. It will generate by using a 9V battery or just connect the Arduino to the laptop or computer. NodeMCU ESP32 will connect the project to the laptop or smartphone.