DESIGN AND DEVELOPMENT OF A MECHANISM TO DETERMINE WHEELER SELF-PROPELLING FOR REHABILITATION

OOI ZHU OON

This Report Is Submitted In Partial Fulfillment Of Requirements For The Bachelor Degree of Electronic Engineering (Industrial Electronics)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer

University Teknikal Malaysia Melaka

June 2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : DESIGN AND DEVELOPMENT OF A MECHANISM TO DETERMINE WHEELER SELF-PROPELLING FOR REHABILITATION

Sesi Pengajian : 1 6 / 1 7

Saya OOI ZHU OON
(HURUF BESAR)

mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√):

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☒	**TIDAK TERHAD**	

(TANDATANGAN PENULIS)

Tarikh: 30/5/2017

Disahkan oleh

PROF. MADYA DR. LOK SWEE LEONG
Profesor Madya
Fakulti Kejuruteraan Elektronik Dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka (UTeM)
Hang Tuah Jaya
76100 Durian Tunggal, Melaka

(COP RASMI)

Tarikh: 30/5/2017

"I hereby declare that the work in this project is my own expect for summaries and quotation which have been duly acknowledge."

Signature : 

Author : OOI ZHU OON

Date : 30/5/2017

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor in Electronic Engineering (industrial Electronic) with Honour."

Signature :

Supervisor's Name: PM Dr Kok Swee Leong

Date : 30th May 2017

DEDICATION

To my parents,

Ooi Eng Moh and Yeoh Bee Fong

For raising me become who I am today.

ACKNOWLEDGEMENT

First of all, I would like to express my appreciation to my supervisor, P.M. Dr. Kok Swee Leong and Dr. Lim Kim Chuan for the opportunity to do the final year project under both of their supervision. I would like to express my gratitude to them for guiding me throughout the whole semester for this project. They have given me a lot of ideas and thank to their supervision, I have gain a lot of additional knowledge throughout the whole project.

Then, I would like to thank my friends for supporting me throughout the entire semester for the purpose of completing the project. They have helped me by becoming my test subjects that is important to complete the project. Besides that, they have coped up to my selfish request till the end without any complain

Last but not least, I would like to thank my family for their encouragement during the time for me to complete the project. They have not only given me their encouragement but also support me through the end. If not for their support and encouragement, I would have long given up to complete the project due to hardship encountered.

ABSTRACT

The life of many limbs disabled patients as a result of illness and accident can be improved using physiotherapy. These patients need to undergo rehabilitation and supervise by physiotherapists. One of the activities of rehabilitation is self-propelling in a wheelchair by the patients. This is to monitor their physical and mental stability. As the number of these patients are gradually increasing and outnumbering physiotherapist from day to day, therefore an electronic monitoring system is needed. However, to determine the self-propelling action by the patients themselves on wheelchair is a challenge due to many factors which include many possibilities of movements. In this project, a monitoring system is being proposed using an accelerometer and integrated with an optical sensor to detect movement while measure the distance travelling by the patient on their own in order to accurately report to physiotherapist for following up with the progress of the rehabilitation of the patient and make a more accurate assessment on them. From the experiment, when accelerometer is attached on the upper chest of the subject, it shows a self-propelling action produce signals with maximum magnitude at the range of 0-5Hz compared to non self-propelling which have a lower maximum magnitude at the range of 5-20Hz. Then, when the accelerometer is attached to the lower chest of the subject, it shows a self-propelling action produce signals with maximum magnitude at the range of 0-5Hz, similar to the result when accelerometer is attached to the upper chest of subject. Meanwhile, the non self-propelling action when accelerometer is attached to the lower chest of subject produces a minimum magnitude of 5-15Hz.

ABSTRAK

Kehidupan pesakit kurang upaya akibat daripada penyakit dan kemalangan boleh diperbaiki jika mengikuti fisioterapi. Pesakit perlu menjalani pemulihan dan penyeliaan oleh ahli fisioterapi. Salah satu aktiviti pemulihan fisioterapi adalah menggerakkan kerusi roda tanpa bantuan orang lain. Ini adalah untuk memantau kestabilan fizikal dan mental mereka. Bilangan pesakit-pesakit kurang upaya ini yang beransur-ansur meningkat dari hari ke hari telah mengatasi bilangan ahli fisioterapi dan oleh sebab itu sistem pemantauan elektronik diperlukan untuk membantu ahli fisioterapi. Walaubagaimanapun, untuk menentukan sama ada pesakit itu sendiri melonjakkan kerusi roda adalah satu cabaran kerana banyak faktor termasuk banyak kemungkinan pergerakan. Dalam projek ini, satu sistem pemantauan telah dicadangkan dengan menggunakan pecutan bersepadu dengan sensor optik untuk mengesan pergerakan manakala mengukur perjalanan jarak oleh pesakit sendiri untuk melaporkan dengan tepat kepada ahli fisioterapi demi mengikuti perkembangan kemajuan pemulihan pesakit dan membuat penilaian yang lebih tepat kepada mereka. Dari eksperimen, apabila pecutan dilampirkan di atas dada subjek, ditunjukkan bahawa isyarat hasil tindakan sendiri menggerakkan kerusi roda adalah magnitud maksimum pada julat 0-5Hz berbanding bukan pergerakan sendiri yang mempunyai magnitud maksimum yang lebih rendah pada jarak yang daripada 5-20Hz. Kemudian, apabila pecutan melekat pada bawah dada ini, ditunjukkan bahawa isyarat hasil tindakan sendiri menggerakkan kerusi roda adalah magnitud maksimum pada julat 0-5Hz, sama dengan nilai hasil apabila pecutan melekat pada atas dada subjek. Sementara itu, tindakan bukan lonjakkan sendiri apabila pecutan melekat pada bawah dada yang lebih rendah tertakluk menghasilkan magnitud minimum 5-15Hz.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

CHAPTER I

INTRODUCTION

This chapter contain the introduction of the whole project. It includes the project description that explain why this project is done, how the project is designed and the impact of this project to consumer. Then, the objective is explained based on the problem statement and finally the scope of project is stated.

1.1 Introduction

Looking forward into the future of financial crisis where inflation is happening everywhere across the globe, those who can afford an electronic automated wheelchair will be a dream that is impossible to achieve to patients who come from a low and middle income family. Thus, it is important for a rehabilitation centre to have a mechanism that can determine the self-propelling action of a wheeler on a wheelchair for it is the only institution that is able to train patient who have become wheeler to become an expert in rolling a wheelchair so that patient will not have to rely too much on an electronic powered wheelchair for mobility. As patients who become wheelers are increasing day by day, the number of physiotherapist is coming to a standstill. This makes a monitoring system a much more important tools to a physiotherapist to ensure that wheelers get an adequate amount of training for when they are done with the rehabilitation session, a manual

wheelchair will not become a hindrance to these wheeler when they are going through with their daily life. A mechanism to determine wheeler self-propelling for rehabilitation will be done for the use of physiotherapist that contribute to an accurate assessment in patient that are undergoing physiotherapy. An accelerometer is used to collect signal data from motion of wheeler on the wheelchair. The data is processed to recognize whether the wheeler is self-propelling on the wheelchair or there is someone pushing the wheelchair from behind. An optical sensor is used to measure distance travelled by wheeler through self-propelling. Through the assistance of the data from the system regarding the capability of patient who can self-propel to a further distance, physiotherapist will be able to make more accurate assessment on patient. Thus, he/she can give more attention to patient with weak physical and mental capability.

1.2 Problem Statement

It is difficult to determine the person on the wheelchair is pushing the wheelchair on his own or someone pushing the wheelchair. There are many mechanism that can be used to determine whether or not the person sitting on the wheelchair is rolling the wheelchair on his own. However, it is difficult to find a mechanism that can accurately determine

All activities will involve some kind of movement and so, motion will be induced from these activities. Different activity will give different motion signal to sensor. For an example, running will give a higher acceleration data while sitting still will give up to no motion data.

Using one sensor is not enough to determine the motion induced when wheeler is rolling wheelchair on his own. As wheelchair rolling action is done from a very complex body movement, the motion signal harvest from the movement will give out a complicated motion signal data.

1.3 Objective

a) To analyze sensors signal so that a system to detect the rolling action induced by the wheeler himself can be designed.
b) To derive algorithm that can recognize the body motion of wheelers rolling a wheelchair based on signal from sensors.
c) To develop a wheeler self-propelling rolling recognition system that can calculate the distance travelled through self-propelling a wheelchair for the purpose of rehabilitating wheelers on the effort of rolling the wheelchair.

1.4 Scope of work

The aim of this project is to design a sensor based system that can correctly determine the rolling action induced by the wheeler when he/she is rolling the wheelchair himself rather than someone pushing the wheelchair. An algorithm will be derived to determine the rolling action for the system by recognising body motion of wheeler when rolling the wheelchair. However, the algorithms will only be measuring body motion of wheeler sitting on the wheelchair. Then, when wheelers are rolling the wheelchair, the distance which wheeler has rolled or travelled will be displayed but if there is someone who helped wheelers to roll the wheelchair, the distance will not be recorded and displayed.

The equipment used to build the system are Arduino101 microcontroller, accelerometer and optical sensor. Accelerometer will be used to measure body motion of wheeler. Data obtained from accelerometer will be processed with the NanoCurie processor to determine the self-propelling action of wheeler on wheelchair in forward propulsion as inclination propulsion of wheelchair is not included because of sensor limitation. Optical sensor will measure distance travelled by the wheelchair when wheeler rolls wheelchair on their own. The display used to display distance travelled by wheeler through self-propulsion will be a HTML interface where the data is pushed from the server in Microsoft Azure. As IOT is not included in this project, the server and interface used is

done by others that takes part in the project. The test subject that will be testing the functionality and accuracy of the system in the end will be aged between 18 to 30 years old. They will not be disable as a doctor's approval will be needed for acquiring a patient or subject who are disable. The system prototype will be installed on a wheelchair with 44cm length x 43cm width x 87cm height. Thus the system prototype will not be larger than 44cm length x 44cm height in size. A good lighting environment is needed for the optical sensor to function. So, the optical sensor can only be used outdoor from 8.00a.m. until 5.00p.m. or indoor with a good lighting condition.

Signals are processed using MATLAB software. Data is collected through the use of Node.js. During the design of experiment, a HTML local host is created to display the collected data in the form of graph where Node.js is used to push data to the local host. Data is logged in a text file to be processed. The hardware produced can only be used in lab. The complete system is shown in the block diagram in Figure 1.1 below.

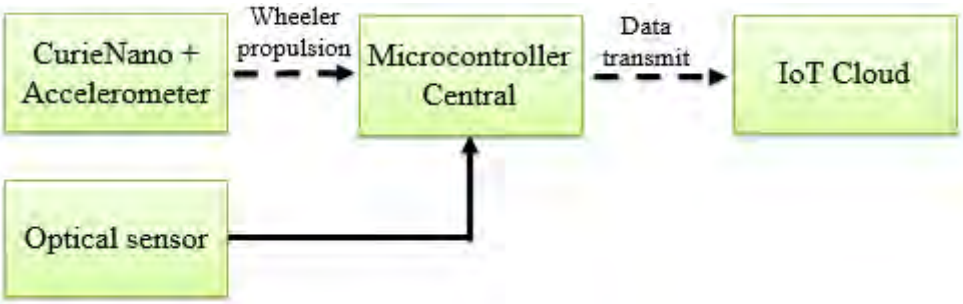

Figure 1.1 Block diagram of the complete system

1.5 Chapter Conclusion

This chapter has discussed about how the system is built. The problem statement has clearly explained the current technological problem that is faced in the project. Then, the objective is clearly listed out. Finally, the scope of work has thoroughly discussed the equipment used, limitation and how the system will function.

CHAPTER II

LITERATURE REVIEW

This chapter discusses about the background study made for this project. The study includes some solution some people used to solve the problem from the problem statement at the moment, number of disables that are registered in Malaysia and some explanation about rehabilitation program. Then various study is done on sensors used in the project as well as technique used by other researcher to solve the problem faced in the project which is the motion recognition problem. The techniques that had been done are compared and serve as a reference to derive an algorithm for the project.

2.1 Background Study

The mechanism used to determine wheeler self-propeller will be sensor based motion recognition application. There are many technique for capturing human body motion. In the past, body motion is captured using camera based optical motion tracking system. However, as camera based optical motion tracking has too many constrained such as lighting condition of environment, interference from another and calibration volume of camera for specific experiment cause inefficiency[1]. Nowadays, the use of inertial measurement units (IMUs) such as the accelerometer and gyroscope serve as an alternative to the optical motion sensing technique as they can measure motion in more

than 1 axis simultaneously[18]. Besides that, IMUs are not susceptible to lighting condition and interference which are very suitable and useful in many environment. These sensors are able to take measurement over the performing activities without interference with any motor gestures from the subjects and additionally, they are low in cost [1][16].

Wheeler refer to people who have to rely on wheelchair to move. For wheelers, wheelchair is the primary equipment used to commute from one place to another. They are usually disabled persons who lose the ability to move due to factors such as accidents, infections to the spine and stroke[2]. According to World Health Organization, there are more than 1 billion people that live disability in the world[3]. In Malaysia alone, there are more than 300000 disables registered. Figure 2.1 shows a chart indicating the total number of disabilities registered in Malaysia by the Department of Social Welfare Malaysia. However, not all disables use wheelchair. Only patients with certain illness or disability will have to rely on a wheelchair to move. The most significant wheelers are the spinal cord injury (SCI) patients as wheelchair is the most important tools for SCI patients to be mobile in social life[4]. SCI is a damage to the spinal cord that results in disruption signal between the brain and body causing a paralysis on the lower part of the body[19]. While there is also amputated patient, people who have lost their limbs in an accident or illness. This makes the patient to have difficulty to move around. So, they need to rely on a wheelchair for movement[19]. Not only SCI and amputated patients, there are stroke patients, bedridden patients and many more who will need a wheelchair to move and thus, they are called wheelers.

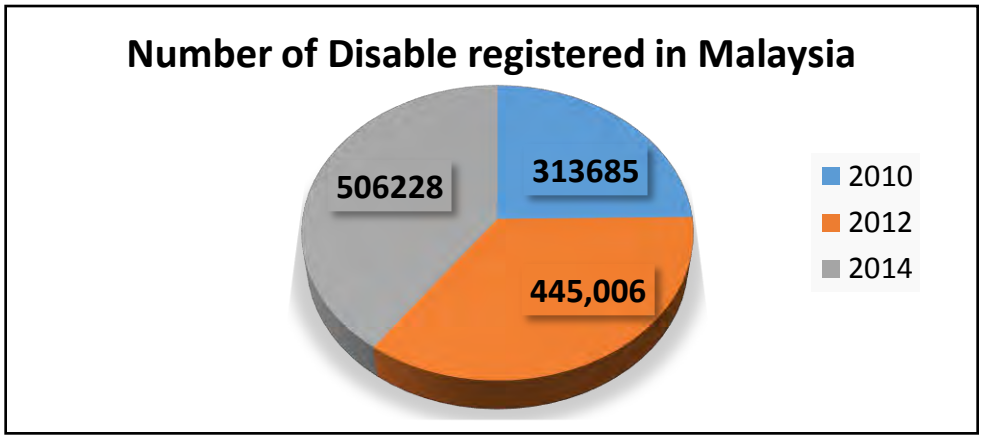

Figure 2.1 The chart of number of disable registered in Malaysia[3]

Rehabilitation are programs prepared to help people whose body have lost the ability to function properly because of bedridden for too long, an injury, a stroke, surgery or lost function in limbs[5]. These programs include pulmonary rehabilitation program for people who have long term poor airflow and prolonged bed rest rehabilitation for people who become weak after a long bed rest which are caused by severe injury or after a surgery[5]. Physical therapy, occupational therapy, inflammation treatment, pain treatment and training to compensate for lost limb are the typical focus of rehabilitation. The treatment will usually be a one on one training that last for many weeks and record based. Rehab program not only prepares wheeler to be mobile in daily life with wheelchair but also both mentally and physically ready to go back home, returning to the community, and ready for the workplace. Seamlessly connecting all the stack holders such as wheeler, family members, therapist, social worker, and the management of the rehabilitation centre will not only help to streamline the care processes but also improve the patient care both quantitatively and qualitatively. Rehabilitation is not limited by age groups even though the type, level, and goals are different for everyone.[5]

2.2 Motion Recognition

Motion represent the language of a human being. It can even be a second language of human beings besides speech. One is able to predict what is a person is doing or trying to do based on the motion given out from the other party. By recognizing a motion, a person's activity and behavior can be known beforehand as human motion is able to provide a lot of information. One of the most notable example is that mute people is able to communicate using hand gesture, a kind of hand motion. Motion recognition is important in human activity analysis. Different activity gives a different motion pattern or signal. Many application can be brought by being able to recognize these motion pattern and signal[15][17]. As such, various technique has been developed to be able recognize the pattern of motion signal over the years such as neural network and deep learning[20]. For an example, there is the use of the 3-D Virtual Link Segment Model technique to