UNIVERSITI TEKNOLOGI MARA

TACTILE SENSING FINGERS DEVICE USING QUANTUM TUNNELING COMPOSITE (QTC) PILLS

NUR IZZAH LINA BINTI AZAMAN

Thesis submitted in fullfillment
of the requirements for the degree of
Master of Science
(Mechanical Engineering)

Faculty of Mechanical Engineering

March 2018

ABSTRACT

This study investigated the potential of new material namely Quantum Tunneling Composite (QTC) pills as a tactile sensor. The properties and potential of QTC pill motivate this study. The purposed of this study is to develop a new tactile finger device to increase muscle strength and functional ability of the hands. This is due to the health problems involving the hand such as due to stroke, Parkinson, and carpal tunnel syndrome. These problems cause difficulties for hand to remain stable when grasping objects. In this research, three main objectives were highlighted. The first objective is to characterize the nature of QTC pill as a tactile sensing application. The second objective is to design and develop a tactile finger device using QTC pills for tactile sensor application and the third objective is to evaluate the performance of QTC pill as tactile sensing for the device. There are only two parameters which were considered in developing tactile finger device. These parameters are force and different shapes of the object. The piezoresistive experimental test was performed to determine material resistivity characteristics. Then, grasping and gripping experiments were carried out to evaluate the suitability of QTC pill as a tactile sensor for the fingertip device. The results showed the unique electrical behavior occurred when the graph of force vs. resistance was plotted and the exponential curve was obtained. In no compression, the QTC pill act as an insulator but in the highest compression, it acts as a conductor. This is due to no electron can pass through this material without compression. This proved that QTC pill has very high resistivity. Then, the result was supported by graph current vs. voltage. At very low voltage, the electrons exhibit very little energy to tunnel through the insulating material barrier. In addition, the Concept 3 was chosen as a prototype tactile finger device. Then, the prototype used to evaluate the three types of different gripping touches which are; no gripping touch, light gripping touch, and a heavy gripping touch of objects. The data obtained show that the sensitivity of the tactile sensor varies from the range as small as 0.098N. This is in-line with the theory that the higher the resistant, the more difficult for the electron to flow in QTC pill. As the final analysis of data was displayed on LabVIEW, the experiment of heavy touch shows the highest data as 7.123N. This data is obtained by index finger interaction between the shapes of pyramid object. The overall data collected has proven that the value of QTC sensor will increase if the amount of the force gripping is increased. As a conclusion, it can be said the QTC Pills are suitable tactile sensor for developing fingers device. Furthermore, in future, it can be applied in medical technology to help the weakness hand patients to improve their quality of life.

ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my MSc and for completing this long and challenging journey successfully.

I would like to express my gratitude to my primary supervisor, Prof. Ir. Dr. Hj. Muhammad Azmi bin Ayub, for his valuable advice, encouragement, and supervision throughout this research study. I also would like to thank Mrs. Ahsana Aqilah binti Ahmad as my second supervisor for her guidance, valuable advice and encouraging me in completing my MSc.

My appreciation goes to the staff Centre of Mechatronic UiTM, Mrs. Fazlin Suhaina, who provided the facilities and assistance during the experimental work.

Lastly, my thousand appreciation goes to my beloved parents, Mr. Azaman bin Mat Ali and Mrs. Masitah binti Yusuf and my lovely fiancé, Mr. Tuan Idruss Tarmizi bin Tuan Roslan. Without their outstanding moral support in everything I do, I would not reach this phase. This piece of victory is dedicated to them.

Finally, a big thank you to my colleagues who helped me with everything until the project was completed. Alhamdulillah.

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Introduction Background

The human hand is a great invention and unable to be replicated by human beings. Its definition as according to H. Gray expressed that hand is a part of the body at the end arm which included fingers and thumb. Normal humans have five fingers which are a thumb, index finger, middle finger, ring finger and little finger [1, 2]. Human beings use the hand to grasp, hold, and manipulate objects. For instance, they use the hand to perform precise actions or heavy labour. This is due to the hand able to feel whether something is rough or smooth, hot or cold, and sharp or blunt [3]. Furthermore, it is also used to identify surface texture, weight, shape, size and thermal properties [4] of the object. Therefore, this upper limb is important to human beings in their daily life and should always be in a good and healthy.

However, a human can suffer serious health problem involving the hand such as stroke, Parkinson, carpal tunnel syndrome and others. These health problems caused nerve injury where the hand is overstretched, crushed or burned. Symptoms include numbness and difficulty moving will affect in that area. Additionally, a human hand movement, skeleton and muscles are nothing without the tactile sensing involvement. R. L. Klatzky has described that a person with numb hands has difficulties to remain stable when grasping objects [5]. Following a stroke, damage to the brain will change how the nervous system works. Damaged nerve tissue may not repair itself. Therefore, in order to remain healthy, the rehabilitation needed to train and recover the damage nervous system between the brains. Thus, the tactile sensor is important in creating an intelligent device for rehabilitation treatment that relates to the hand. For that reason, it is crucial to study the anatomy of the human hand and movements to have a better understanding of human tactile sensing and a stable grasp.

Physiotherapy is one way to recover these illnesses. Physiotherapy provides the necessary physical foundation where the function and survival of the weak hands can be reinvented. Advances in technology nowadays enable the creation of a variable tactile device to help the patients. For instance, the devices being developed to