Faculty of Manufacturing Engineering

DEVELOPMENT OF FINGER TYPE TACTILE SENSOR WITH SURFACE ROUGHNESS ANALYSIS

ShafiyahbintiAbd Rashid

Master of Science in Manufacturing Engineering

2018

DEVELOPMENT OF FINGER TYPE TACTILE SENSOR WITH SURFACE ROUGHNESS ANALYSIS

SHAFIYAH BINTI ABD RASHID

A thesis submitted
in the fulfilment of the requirements for the degree of Master of Science
in Manufacturing Engineering

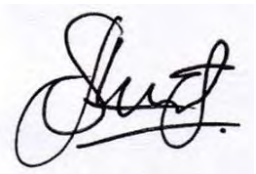
Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2018

DECLARATION

I declare that this thesis entitled "Development of Finger Type Tactile Sensor with Surface Roughness Analysis" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.



Signature : ……...

Name : SHAFIYAH BINTI ABD RASHID

Date : ……...

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 Master of Science in Manufacturing Engineering.

Signature : ……...

Supervisor Name : DR. FAIRUL AZNI BIN JAFAR

Date : ……...

DEDICATION

Gratitude to God Almighty ALLAH S.W.T and His Messenger MUHAMMAD S.A.W that

has given me the perfection for

solving this thesis.

Special thanks to my father and mother,

Abd Rashid B. Yusof and AsmaliaBtJaafar,

also not forgetting all the lecturers, staffs and friends of the

UniversitiTeknikal Malaysia Melaka

involved directly or indirectly,

a lot of help in preparing this thesis.

Only ALLAH S.W.T is able to respond to the

dignityof life helped me deal with this.

ABSTRACT

This research is focused on the development of finger type tactile sensor with surface roughness analysis. Among various human sensations like hearing, sight, taste and smell, touch is a critical co-existing sensation required to interact with surrounding environment. Therefore, it is believed that a good understanding between the touch and surface roughness have potential benefits to the performance of the finger type tactile sensor robot. Even though there is a lot of tactile sensor's type used in robotic application but there is much less on work has been done on load cell. As far as it is concerned, tactile sensor, vison and audio system is very expensive. Therefore, something cheaper which is load cell is used as a replace for other expensive tactile sensor, in order to modelling and develop a finger type tactile sensor. So, a knowledge study regarding on tactile sensor, touch and grasping are investigated in order to proceed the research. Next, the finger type tactile sensor is designed and developed in SolidWorks software for visual- aided all the view of prototype. To achieve the sensory performance and function of the human fingertips, the design of the fingertips sensor mimics the human fingertips in many aspects, including its size and shape. As objects slide across the structure of surface roughness of the finger type tactile sensor, it generates force that measure in ADC (Volt) that are detected by a loadcells inside the holder. By using Graphical User Interface (GUI), data logging for every extracted graph of each experiment is performed. The developed finger type tactile sensor needs to be tested in order to identify the performance capability of the sensor according to the designed function. A set of 3D printed objects with different values of roughness has been prepared as the sample for this test. Then, for performance validation, Experiment 1: Calibration (Mitutoyo Precision Reference Specimen) has been conducted between using manual robot (Z-arm) and auto robot (Comau Robot). Comau Robot has been chosen as the most suitable robot for the rest of the experiments, then the work is extended to Experiment 2 (Test using Needle File) and Experiment 3 (Test using Tile). The experiment results show that the functionality of the finger type tactile sensor has been successfully validated and proven acceptable for all set of experiment.

ABSTRAK

KajianinimemberitumpuankepadaperkembanganPerantiSentuhanBentukjaridengananalisis kekasaranpermukaan. Manusiamempunyaipelbagaideriasepertipendengaran, penglihatan, rasa danbau. Akan tetapi, deriasentuhadalahsangatpentinguntukberinteraksidengankekasaranpermukaansesuatuobjek. Olehitu, dipercayaibahawapemahaman yang baikantarasentuhandankekasaranpermukaanmempunyaipotensi yang tinggidalammeningkatkanprestasiPerantiSentuhanBentukjari. Walaupunterdapatbanyakjenisperantisentuhan yang digunakandalamaplikasirobotiktetapimasihkurang yang menggunakanaplikasiselbeban. Setakatini, perantisentuhan, visondansistem audio sangatmahaldansebagaipelajar, sayatidakmempunyaibanyakwanguntukmembeliperantitersebut. Olehitu, berurusandengankeadaanini, membuatsayamencarisesuatu yang lebihmurahiaituselbebansebagaipenggantiperantisentuhanmahal yang lain, untukmemodelkandanmembangunkanperantijenissentuhanjari. Olehitu, satukajianpengetahuanmengenaiperantisentuhan, sentuhandankonsepgenggamanjari robot disiasatuntukmeneruskanpenyelidikan. Selanjutnya, PerantiSentuhanBentukjaridirekadandibangunkandalamperisianSolidWorkuntukmelihatsemuaprototaip visual. Untukmencapaiprestasidanfungsideriasentuh yang samasepertimanusia, rekabentukperantijariadalahmenirujarimanusiadalambanyakaspek, termasuksaizdanbentuknya. ApabilaobjekmelintasiPerantiSentuhanBentukjari, kuasadijanadandiukurdalam ADC yang dikesanolehselbeban di dalamnya. DenganmenggunakanPerisian GUI, eksperimendijalankanuntukmendapatkan data bagisetiapgraf yang diekstrak. PerantiSentuhanBentukjariseterusnyadiujiuntukmengenalpastiprestasikeupayaannyamengikutfungsi yang dirancang. Satu set bahaneksperimenbercetak 3D denganpelbagainilaikekasarantelahdisediakansebagaisampeluntukujianini. Kemudian, untukpengesahanprestasi, Eksperimen 1: Penentukuran (Specimen RujukanKetepatanMitutoyo) telahdijalankanmenggunakan robot manual (Z-arm) dan robot automatik (Comau Robot). SelepasComao Robot dipilihsebagai robot yang paling sesuaiuntukseluruheksperimen, makaeksperimeniniakanditeruskankeEksperimen 2 (UjianmenggunakanKikirJarum) danEksperimen 3 (UjianmenggunakanJubin). MengikuthasilEksperimen 1 danseterusnya, inimengesahkanbahawabacaanPerantiSentuhanBentukjariadalahberfungsiseperti yang dikehendakidanbolehditerimauntuksemua set eksperimen.

ACKNOWLEDGEMENTS

Alhamdulillah. All my praises to Allah SWT, whom with His willing giving me the strengths and passion to complete this thesis.

First and foremost, I would like to convey my deepest gratitude to my respected supervisor, Dr FairulAzni B Jafar. It is a great honour and pleasure to be able to work with him, who is spending his precious time for giving me ideas in and providing intellectual opinions throughout the learning process. Your kind advice, time, attention and dedication towards realizing this works are greatly appreciated and indebted.

Deepest thanks and appreciation to my friends for their cooperation, encouragement, constructive suggestion and full of support for the report completion, from the beginning till the end. Thanks for the friendship and memories.

Last but not least, special thanks to my family, father and mother who's never give up on me. Thank you for the warm care that provided by them every moment of my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF SYMBOLS

µm	-	Micrometer
˚C	-	Temperature (Celcius)
E	-	Electrode impedances
C	-	Manufacturer's Industrial Group
eC	-	Capasitor
D	-	Reverse Polarity
R	-	Resistor
OSC	-	Oscillator or clocking
µm	-	Micrometer
˚C	-	Temperature (Celcius)