



Faculty of Manufacturing Engineering

**DEVELOPMENT OF FINGER TYPE TACTILE SENSOR WITH
SURFACE ROUGHNESS ANALYSIS**

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**DEVELOPMENT OF FINGER TYPE TACTILE SENSOR WITH SURFACE
ROUGHNESS ANALYSIS**

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

Faculty of Manufacturing Engineering

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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.



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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,

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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, vision 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

Kajian ini memberitumpuan kepada perkembangan Peranti Sentuhan Bentuk Jari dengan analisis kekasaran permukaan. Manusia mempunyai pelbagai deria seperti pendengaran, penglihatan, rasa dan bau. Akan tetapi, deria sentuhan adalah sangat penting untuk berinteraksi dengan kekasaran permukaan sesuatu objek. Oleh itu, dipercayai bahawa pemahaman yang baik tentang deria sentuhan dan kekasaran permukaan mempunyai potensi yang tinggi dalam meningkatkan prestasi Peranti Sentuhan Bentuk Jari. Walaupun terdapat banyak jenis peranti sentuhan yang digunakan dalam aplikasi robotik tetapi masih kurang yang menggunakan aplikasi sel beban. Setakat ini, peranti sentuhan, vison dan sistem audio sangat mahal dan sebagai pelajar, saya tidak mempunyai banyak wang untuk membeli peranti tersebut. Oleh itu, berurusan dengan keadaan ini, membuat saya mencari sesuatu yang lebih murah iaitu sel beban sebagai pengganti peranti sentuhan mahal yang lain, untuk memodelkan dan membangunkan peranti jenis sentuhan jari. Oleh itu, satu kajian pengetahuan mengenai peranti sentuhan, sentuhan dan konsep genggam jari robot diasaskan untuk meneruskan penyelidikan. Selanjutnya, Peranti Sentuhan Bentuk Jari direka dan dibangunkan dalam perisian Solid Work untuk melihat semua prototaip visual. Untuk mencapai prestasi dan fungsinya deria sentuh yang sama seperti manusia, reka bentuk peranti jari adalah meniru jari manusia dalam banyak aspek, termasuk saiz dan bentuknya. Apabila objek melintasi Peranti Sentuhan Bentuk Jari, kuasa dijanadandiukur dalam ADC yang dikesan oleh sel beban di dalamnya. Dengan menggunakan Perisian GUI, eksperimen dijalankan untuk mendapatkan data bagi setiap graf yang diekstrak. Peranti Sentuhan Bentuk Jari seterusnya diuji untuk mengenalpasti prestasi keupayaannya mengikut fungsi yang dirancang. Satu set bahan eksperimen bercetak 3D dengan pelbagai nilai kekasaran telah disediakan sebagai sampel untuk ujian ini. Kemudian, untuk pengesahan prestasi, Eksperimen 1: Penentuan (Specimen Rujukan Ketepatan Mitutoyo) telah dijalankan menggunakan robot manual (Z-arm) dan robot automatik (Comau Robot). Selepas Comau Robot dipilih sebagai robot yang paling sesuai untuk seluruh eksperimen, maka eksperimen ini akan diteruskan ke Eksperimen 2 (Ujian menggunakan Kikir Jarum) dan Eksperimen 3 (Ujian menggunakan Jubin). Mengikut hasil Eksperimen 1 dan seterusnya, ini mengesahkan bahawa bacaan Peranti Sentuhan Bentuk Jari adalah berfungsi seperti yang dikehendaki dan boleh diterima untuk semua set eksperimen.

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LIST OF SYMBOLS

μm	-	Micrometer
$^{\circ}\text{C}$	-	Temperature (Celcius)
E	-	Electrode impedances
C	-	Manufacturer's Industrial Group
eC	-	Capasitor
D	-	Reverse Polarity
R	-	Resistor
OSC	-	Oscillator or clocking
μm	-	Micrometer
$^{\circ}\text{C}$	-	Temperature (Celcius)