UNIVERSITI TEKNOLOGI MARA

CALIBRATION OF OPTICAL BASED SILICONE TACTILE SENSOR BASED ON IMAGE DEFORMATION TECHNIQUE

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ABSTRACT

Tactile sensor is a device which can quantify physical contact by means of measuring touched object characteristics such as hardness, texture, and smoothness. Object profile surface and shape can also be determined. By using tactile sensor, the robot fingers tip, condition monitoring machine and object manipulation task system adopted to the environment by sense of touch. Until today, most of established tactile sensors operate and sense force by transduction method using electrical device such as piezoelectric device, photoelastic device, and resistive device. In this project, an optical tactile sensing technique is proposed. Machine vision system coupled with CCD camera, optical fibrescope and WiT Image Processing Software as well as C Language Compiler will be used. Then optical silicone type tactile sensor is integrated with image processing working principle model to measure optical tactile sensor accuracy and performance. The overall research objective is to develop a computer algorithm for real-time sensorization for optical sensor characterization. In this research, a parameter considered is normal force in z-axis. The forces in y and x-axis as well as tri-axial torques T_x, T_y and T_z are not considered in the research. The characteristics of the tactile sensor will be analysed according to three parameters namely area, perimeter and diameter of the tactile sensor. Based on these three parameters, three different types of algorithm are developed in order to measure experimentally the forces and deformation based on optical information of the tactile sensor. These newly developed algorithms convert unmeasurable image to measureable image using image processing technique. Inspiring by human finger model, a silicon tactile sensor is proposed to low force object gripping and sensorization task. To make sure proposed tactile sensor feasibility, this optical tactile sensor underwent calibration process. To evaluate the performance of the algorithm, this proposed optical tactile sensor compares the results of these three parameters that give a better accuracy with respect to sensitivity value, low hysteresis and high repeatability. The location of the centroid is analysed to determine the stability of the tactile sensor.

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CHAPTER ONE
INTRODUCTION

1.1 RESEARCH BACKGROUND

Tactile sensor as a device or system that can measure several properties of an object or contact event through physical interaction between the sensor and the object[1] such as shape of an object, surface texture, hardness[2], smoothness and moisture content. Most tactile sensor applications are used as processing sensory data, cutaneous sensors, sensing fingers, biomedical sensors, haptic perception, multifingered hands, analysis of sensing devices, probes and whiskers and other incoming new applications. Currently, there are several tactile sensor principles developed in this world which are stated in international journals & proceeding papers. The tactile sensors principles currently developed are piezoelectric principle[3], piezoresistive principle[4], capacitive principle[5], inductive principle, and optical principle. To date, three axis optical based silicone tactile sensor principle was developed by a research team from Japan[6] and a research team from Malaysia[7]. This silicone based optical tactile sensor is equipped with an optical waveguide plate mounted on a robot manipulator. The development was more on robot finger application which usually for human-robot interaction[8]. Basically the optical based silicone tactile sensor force measurement is depending on the image appeared in the frame grabber software which is a monocular CCD camera used to record the images changes. The nature of images changes is due to silicone based tactile sensor deformation [9]. In this project, based on the developed optical based silicone tactile sensor, a set of reference images is recorded to give a direct relationship with the normal force exerted on the tactile sensor dome.