UNIVERSITI TEKNOLOGI MARA

SPEED-UP ROBUST FEATURES BASED 3D OBJECT RECOGNITION FOR GRASPING BY THREE FINGERED ROBOT HAND

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ABSTRACT

The ability to manipulate objects is one of the important requirements for industrial robots. Robot that exhibits human-like abilities needs the application of multiple sensors to recognise objects or environment for their tasks. In previous work, a 7-Degree Of Freedom (DOF) three fingered robot hand had been developed for a grasping task. The reference position of the robot hand however was programmed based on predetermined motor positions of the joints for grasping two different shapes of object. The work showed successful grasping by the robot but was unable to generate the motor position on its own since no external sensor was used to recognise the position of the targeted object, hence it is not fully automated. Thus, vision as one of the sensors that can provide rich information was adopted to the robot system where two object image processing methods which are the Speed-Up Robust Features (SURF) and Scale Invariant Feature Transform (SIFT) algorithms were investigated for 2D image recognition of target object in a cluttered environment. Both methods are compared based on the detection performance on several orientations of object in real scene. The information from the method with less detection error is later selected to calculate the object position. Next, the 3D position and grasping points of target object was determined by combining the recognised positions from two 2D SURF images and the triangulation method .The identified object grasping points were then converted to robot space using the robot's transformation equation derived based on the locations and orientation of robot and camera in the 3D workplace. The proposed method was verified through real-time grasping experiments where the target object was displaced for several positions along the x-axis and y-axis directions. Meanwhile, the strength of the gripping force is measured by comparing the result of motor position angle with the voltage from a force sensor attached at each of the robot finger tips. The result proved that the capability of the SURF algorithm to be better in recognising 100% of the target object without fail for nine random images but it has produced accumulated error throughout the steps in getting the 3D position. However, the errors that occurred in the 3D positions were due to the limitation in SURF and human error during manual measurements with the highest error observed at 3.90 cm. Meanwhile, the transformation equation has successfully calculated that object positions to be inclined towards the direction of the actual measured position in the robot's coordinates. Finally, the real-time experiment result proved the capability of robot to perform grasping task in real-time autonomous operations with the highest object's position error produced by SURF was 1.24cm in x axis direction. All of the fingers grasped the object at the same time and lifted the object according to the reference position provided by vision.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Robotics is a combination of the two academic disciplines of engineering and science that include mechanical engineering, electrical engineering, computer science, and others [1]. To build a perfect robot is a difficult task where the robot can perform the tasks perfectly and as precise as possible. This is because robots deal with the design, construction, operation, and use of robots as well as computer systems for their control, sensory feedback, and information processing. All of these technologies are used to develop machines that can substitute humans. Robots are machines that can be used to do jobs. Some robots can do work by themselves but some of them always needs humans to guide to them do the task. The application of robot can be used in any situation and for any purpose, but today's robot applications are used in many fields such as in dangerous environments (bomb detection and de-activation), manufacturing processes, or in outer space and deep water where humans cannot survive. Nowadays, robots are built on many forms, but some of them are made to resemble humans in appearance. There are as many different types of robots as there are tasks for them to perform for example humanoid robot and industrial robot. This is said to help in the acceptance of a robot in certain replicative behaviours usually performed by people. Such robots attempt to replicate walking, lifting, speech, cognition, and basically anything that humans can do. Many of today's robots are also inspired by nature, contributing to the field of bio-inspired robotics.

Since robots not only perform hard, strenuous, hazardous, repetitive, boring as well as dangerous work, this becomes the main reason that encourages many tasks in the assembly line being replaced by robots. Furthermore, a robot that exhibits human-like skills could be used to reduce the high labour cost incurred by small-scale manufacturers who produce specialised products. The suction cup and gripper are among the types of end effectors that are currently popular in the industry due their reliability. Figure 1.1 shows some examples of suction cup and gripper robots that have been used in the industry. These kinds of end effectors have their own limitations such as having difficulties in handling object with different sizes, shapes and weight