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Vision Based Manipulation of a Regular Shaped Object

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Abstract

This paper proposes to attempted is to manipulate an object by a set of three contacts (fingers) i.e. three end effector of the delta robots. As the point of contact with the finger and object changes dynamically, making the problem to have a large degree of variability.This proposal is limited to direct feedback of the object position with respect to the world coordinates and interfacing with the delta robot controlling in real time environment.Detection of markers by three cameras is achieved using ArUco augmented reality library. Experimental results are presented to support the approach in this paper.

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Keywords: Augmented Reality; Manipulation; Delta robot; Multiple View

1. Introduction

The manipulation based on vision refers to the use of computer vision with one or more camera data in order to manipulate the object using the delta robot.Visual servo loop is also implemented to control the motion of a delta robot. Vision based manipulation is a mature research field. As over the last few years, various vision based manipulation works have been published.

Antonio Morales et al.[1] implemented a strategy for computation of vision based three finger grasps taking as input an image of the object to be grasped. Strategy is described in three steps: first, extraction of grasp regions; second, region suitability test; last, determination of grasp points. It computes outer and inner contours for generating grasps within minimum time.Anton Nikolaev et al.[2] presented a transparent gripper for robot vision that allow vision sensors to take images of an object without occlusion. Image shift caused by refraction is compensated by the presented algorithms. The transparent gripper has two applications: first, it improves the perceptual ability of the robot system and second, task of automatic generating of 3D object models. Hasimah Ali et al.[3] presented development and design of the gripper which is smart and it comprise of vision sensor. In this approach integration of vision sensor and applying controlling techniques, so that in order to grasp the object without error by appropriate force. This system incorporates vision sensor for object detection. In the first phase, the smart gripper is set to the initial position. The proposed gripper in this paper has a limitation of lifting and grasping the object that have different weights.

Goro Obinata et al.[4] presented a method for the estimation of contact state of objects having varying shape using

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tactile sensor which is based on a vision. Estimating the position of the object is achieved by contacting dots. Translational displacement of the object corresponds to the contact dots displacement. In this approach the sensor does not give enough information about the orientation of the object. In this approach use of an LED light, CCD camera, touch pad and transparent acrylic plate are used.
Robert Haschke et al.[5]presented a control strategy in which estimation of the contact point locations is achieved. In this paper use of tactile sensor has been implemented. Object manipulation has been achieved using two stage process, i.e. on the first stage, local manipulation controller is achieved as in this stage object moves in a small amount. In the second stage global re-grasp planning using finite state machine (FSM) is performed. In the global planning state definition and the actions which is to be performed has been designed. The validation of the experiments is performed using Vortex, a physics engine.
Mohd. Suhaib et al.[6]presented dexterous manipulation to control the robot's finger to generate the rotational motion using a sphere as manipulation object. Keeping the limitation that fingers ordering around the sphere edge should not change during manipulation. In this paper, grasp stability and equilibrating force analysis has been performed. They have used IK solver of 3ds max. The coefficient friction assumed 0.3 for all fingers.
Augmented Reality[7,8,9,10,11] is a technology that supplemented real world environment of the computer generated objects/elements. The key challenge in this field is tracking and registration of the object.Registration is the proper alignment of the virtual objects in the real world. Occlusion is also the major concern as when tracking is performed, determination of surface which may not visible to the camera viewpoint is also taken care of. It describes the manufacturing, defense, entertainment, path planning has been explored.
The paper is organized as follows. Section A briefly describes the method of the framework. Section B depicts the Camera calibration, Computation of position and orientation wrt to the fixed frame, inverse kinematics of delta robot.

1.1. Method Framework

The basic problem being attempted to manipulate a cube by a set of three contacts (fingers) i.e. three end effector of the delta robots. The point of contact on the finger and object changes dynamically, making the problem to have a large degree of variability. Practically it poses challenges in robot force allocation, control strategies, motion planning and direct feedback of the object position. The system architecture comprises of vision module, hardware interface module, delta robot and the dynamic analyzing software in order to predict the nature of the object in offline. So, the synchronization of all the modules in an effective manner in order to do the manipulation is required.In the experimental setup as shown below in Figure 1, three Delta robots are arranged symmetrically along the vertices of an equilateral triangle. Collaborative manipulation has to be done to orient an object (cube) in space maintaining positive contact force. Interfacing with the delta robot for controlling in real time environment using Arduino Mega 2560 and MD22 H bridge driver integrated circuit.

Fig. 1: Experimental Setup

In our proposed experimental setup computation of orientation (α, β, γ) and position $(X, Y, Z$ wrt to the fix base frame is done. In this setup three cameras are used and each of that is placed along the vertices of an equilateral