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Stereo Vision System for Real Time Applications

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This paper describes the design details of a stereo vision system for real time applications. Stereo vision system is widely used in various applications *viz* medical, scientific, remote sensing, industrial, military and space. We are developing the stereo vision system for planetary exploration rover mounted with an autonomous light weight 5 DOF robotic arm for space exploration. We have used a stereo camera with 1/4 inch CMOS optical sensor and a fixed base line. The developed stereo based position estimation technique is highly accurate with an accuracy of better than 0.5 percent up to the range of 5 meters. The system can completely characterize multiple objects placed in a scene by accurately computing the coordinates of the object centroid as well as the dimension of each object. Here we present the entire stereo vision process including image rectification, camera and system calibration, image segmentation, feature based stereo correspondence and sub-pixel disparity and a novel depth estimation technique. In order to improve the accuracy, we have developed and implemented two major techniques: (i) Automatic calibration of the setup to remove the systematic errors and (ii) Design of an interpolation function for computing disparity with sub-pixel accuracy and hence improving the accuracy of the measurement.

Keywords : Degree of Freedom (DOF), Interpolation Function, Rectification, Sub-Pixel Accuracy.

1. INTRODUCTION

The task of stereo vision is the computation of depth from two-dimensional input images. This is exactly what the human visual system is doing, when we perceive depth. The use of visual information to control a robot has been used extensively in many sectors for various applications. When humans grasp objects, they usually do so with the aid of vision. Visual information is used to locate and identify things, and to decide how they should be grasped. Visual feedback is used to guide the hand to the target.

The three dimensional information about the environment is essential for robot movement, pick and place operation and object inspection in robotic applications. One method of obtaining depth information is by using a stereo vision system. There are different methods to acquire stereo images: we have used a stereo camera with fixed baseline and also two identical cameras mounted on the same plane with variable baseline for our development process.

The stereo system is used to track a pointing hand, implementing a vision-based user interface which allows the operator to specify objects to be grasped and to guide the robot's motion around the work space [1]. The stereo vision technique mentioned in this paper is used to measure not only the coordinates of the various objects present in the work space but also the dimensions (width x height) of each object, which is essential for picking the object by robotic arm gripper. Figure 1 shows the block diagram of overall system being developed for the project. We have chosen an articulated structure for the robotic arm with 3 rotary joints and rest degree of freedom for end effector [2]. There are three links, connected to one another by three joints in total, one base and an end effector. Geared motors with built in encoders are used to impart the rotational motion at the joints.

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