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MULTIOCULAR STEREOVISION

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ABSTRACT

This article describes a computer vision technique for three-dimensional reconstruction by using multiocular stereo vision. The experimental site is based on a stereo pair of cameras attached to the last link of a manipulator, with 6 degrees of freedom. This configuration enables the position's control of the vision system. The images can be acquired at different positions simulating a multiocular system. The geometric relations between the different positions are always known. Using this possibility is possible to establish a new geometric constraint for the stereo correspondence. This constraint is based on the difference between positions when the stereo pair moves. The article describes this geometry and describes the other constraints used on the multiocular stereo algorithm. A comparative study between a biocular stereo algorithm and a multiocular stereo algorithm is presented.

1. INTRODUCTION

The studies on human vision show that visual perception is not static. In human the visual information is obtained by exploratory movements of the visual system. However, the majority of actual and old studies on computer vision uses static images as input for the algorithms. Important changes on these classical models have been made, by using the active vision concept. Active vision is a new approach to Computer Vision, that uses the cooperation between different degrees of freedom (position on the space, zoom, vergence, focus, aperture, ...) to solve problems such as recover the three-dimensional structure or motion. Studies on active vision are fundamental to obtain machines where the exploratory and functional perceptions are essential steps.

This is the case when we try to recover the three-dimensional structure using a dynamic stereo system. Images acquired by only one static camera do not allow to recover the three-dimensional structure of the environment. The projection of 3D points onto the 2D point in the image lost the depth information about the scene. The human beings use the difference between the projections on the left and right eyes to perceive the depth. This motivates the use of two cameras in different positions and defined binocular stereo vision. However, for any point (or primitive) in one image, there are many correspondent points in the other image. This matching process is defined as the correspondence process. Unfortunately the correspondence problem is hard to solve. This is mainly because the geometric constraints of binocular stereo are not sufficient to impose a unique solution. Using stereo vision with dynamics, or equivalently, a system that changes his position in the space, it is possible to simplify the correspondence problem. Using the knowledge about the trajectory of the cameras is possible to establish new constraint for the search of correspondent primitives on stereo images.

This article reports a method, that uses the knowledge about the stereovision system trajectory, to establish a new geometric constraint for solving the stereo correspondence. This new constraint can help in occlusion problems and to control the multiplicity of correspondences.

Stereovision is a computer vision technique to recover the three-dimensional description of a scene observed from two different view points. Most of the research on stereo vision has been devoted to binocular vision for which two cameras are observing the same scene from two slightly different view points. There are three main stages in any stereovision algorithm (dynamic or not) -- detecting and location primitives to be matched, matching of the primitives, and three-dimensional structure computation. Once the correspondent primitives are identified, the depths of them can be calculated by triangulation. All these steps are presented in the points described below. The point 2 describes the primitives used on the experiences. The point 3 describes the geometry used: epipolar lines, multiocular constraint and the three-dimensional reconstruction. The point 4 describes another type of constrains used during the matching process. The stereovision and multiocular algorithms and some experimental results are presented on point 5.