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Fuzzy control for obstacle detection in stereo video sequences

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ABSTRACT

One of the most important problems in 3D tracking is the occlusion effect produced by obstacles. To solve this problem, we have developed a tracking system based on optical flow and stereo vision, combined with adaptive filters to predict the expected 3D velocities of objects. The critical point of the system is the coupling between tracking and predictive algorithms. We propose the use of a fuzzy control system to solve this coupling problem between the different velocities. This technique has been previously tested in 2D video sequences, providing great robustness to the tracking algorithm.

1. Introduction

Video tracking deals with the problem of following moving objects across a video sequence, and it has many applications as, for example, traffic monitoring and control [1,2], robotic tasks, surveillance, etc.

In this work, we study algorithms for tracking objects in a video sequence, based on the selection of landmark points representative of the moving objects in the first frame of the sequence to be analyzed. The movement of these points is estimated using a sparse optical-flow method [3]. We analyze simple algorithms for 3D tracking objects in a stereo video sequence, by combining optical flow and stereo vision [4].

Methods of this kind are fast, but they are not very robust. Particularly, they are not able to handle the occlusion of the moving objects in the video. To improve the performance of optical flow-based methods, we propose the use of adaptive filters to predict the expected instantaneous velocities of the objects, using the predicted velocities as indicators of the performance of the tracking algorithm [5].

The critical point of the system for solving the occlusion problem is the coupling between optical flow and predictive algorithms. This coupling is governed by different parameters. We propose the use of a fuzzy control system [6] to solve the mentioned coupling. In previous works, this system has been successfully proved in 2D tracking [7].

2. Handling occlusion

In order to predict the velocities of the objects, we follow the next steps:

1. We calculate velocities for N_{in} frames of each sequence by using the Lucas and Kanade algorithm and stereo vision, and we use this sample to initialize the filter coefficients.
2. For the N-th frame, we calculate the velocities v_{LN} and v_{RN} in the following way:
   a. We calculate v_{LN}^{of} and v_{RN}^{of} by using optical flow and stereo vision.
   b. We estimate v_{LN}^{es} and v_{RN}^{es} by using an adaptive filter.
   c. If $|v_{L,RN}^{of} - v_{L,RN}^{es}| < tol_{L,RN}$, then $v_{L,RN} = v_{L,RN}^{of}$. Else $v_{L,RN} = v_{L,RN}^{es}$.
3. We use $v_{L,RN}$ and $N_{in} - 1$ previous samples to update the filter coefficients.

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