Stabilization of Infra-red Aerial Image Sequences Using Robust Estimation

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Abstract

Image stabilization is the image registration applied to one video image sequence from a single camera, which has been identified as the key first step for the task of multi-spectral image fusion for aerial surveillance applications. The stabilization of infra-red (IR) aerial image sequences is challenging owing to the low contrast and signal-to-noise ratio of the images, and to potentially large viewpoint changes that result in images with large rotation and scale change and perspective distortion. We demonstrate a new feature-based method for IR aerial image sequence stabilization. We use the greylevel differential invariant (GDI) matching due to Schmid and Mohr which is invariant to rotation and scaling. Extensions to the basic GDI method are introduced that improve the performance of the method. We use M-estimation for the image registration parameters. The method is robust to outliers returned by the GDI method. We verify the point correspondence under orthographic projection using the epipolar constraint. Experimental results are reported for real-world and synthesized IR image sequences.

1 INTRODUCTION

Imaging sensors of different modalities, for example, visible and infra-red, provide complementary information which, if properly fused, can assist the observer in the image interpretation task. Image stabilization is a key step in this process. Image stabilization is the image registration applied to one video image sequence from a single camera. When the camera is mounted on an unsteady or a moving platform and objects are far from the camera, the 3-D space motion of the camera will affect the images.

Until now, the primary means available to stabilize images from a camera on a moving vehicle has been to mount the camera on an electro-mechanical stabilizing platform. These stabilizers are bulky and expensive. Their performance degrades with vibration in the critical 0 – 20 Hz range. An alternative stabilization method uses image processing techniques to first estimate and then eliminate the scene motion that is due to camera motion by warping each image frame into precise alignment with a reference frame.

The image stabilization task has been specified in general terms as follows. Given an image sequence usually consisting of at least 10 to 30 seconds of data, a special frame called the reference frame is chosen at or near the beginning of the sequence. Frames subsequent to the reference frame shall be registered to the reference frame in such a way that the frames are precisely aligned with the reference image.

The conventional image registration method uses block matching techniques. The block matching utilizes the full image information and can be applied to any type of image, rich or poor in texture. The block correlation is robust against random noise and has high accuracy. However, block matching can account for only translations and only approximately for other image distortions. It is expensive to compute and becomes prohibitive when the image displacement is large. Also, the cross-correlation based on image intensity similarity is sensitive to environment changes and is not applicable for registration of multi-spectral images [2].

On the other hand, feature-based image matching can account for any image deformation and can be insensitive to multi-sensor modalities by selecting structurally salient features. It is quick to compute. However, the feature-based methods will fail to find matches in structure-less areas. Its reliability depends on the feature extraction

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