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Multispectral panoramic mosaicing

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Abstract

Image mosaicing overcomes the limitations of a camera's limited field of view by aligning and pasting suitably transformed frames in a sequence of overlapping images. This paper deals with multispectral mosaicing for enhancement of spectral information—information from the thermal infra-red (IR, hereafter) band and visible band images is directly fused at the pixel level. All subsequent operations can be carried out using the fused mosaic instead of the individually sensed images. We develop a geometric relationship between a visible band panoramic mosaic and an IR one. Our system uses a fast algorithm for automatic panoramic mosaicing. We show results of inter-band mosaic superposition in support of the proposed strategies.

Keywords: Mosaicing; Multispectral mosaicing; Geometric hashing; Least-squares estimation

1. Introduction

The general problem of mosaicing is to create a single seamless image by aligning a series of spatially overlapped images. The result is an image with a field of view (FOV) greater than that of a single image. Traditional image mosaicing mainly addresses the extension of FOV, while other imaging dimensions are not improved in this process. The objective of this paper is to detail how mosaicing can be used for enhancement of the spectral information.

Now-a-days various kinds of sensors have been made and are widely used in the industry. However, due to limited resources of material, sensors can be made only sensitive to certain signals. For example, CCD cameras are designed for collecting visual signals, thermal infrared sensors for measuring temperature, electro-magnetic induction sensors for metal detection. Optical images from Landsat provide information on chemical composition, vegetation, and biological properties of the surface. In most cases the information provided by each sensor may be incomplete, inconsistent or imprecise. In many cases, some ambiguities will

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be caused when we use only one kind of sensor to perceive the real world. Additional sources may provide complementary data in addition to the redundant information content. Merging of redundant data can reduce imprecision, and fusion of complementary data can create a more consistent interpretation. Therefore, it is useful to combine and analyze the multisource data to take advantage of their characteristics and enhance the information extraction process. Besides overcoming the ambiguity problem, fusion can also bring some benefits to our perception of the real world.

In many applications, it is necessary to combine multiple images of the same scene acquired by different sensors, which often provide complementary information about the scene being surveyed. For example, one can consider panoramic images of a house—both in the visible band, as well as in the thermal IR band. The latter would be important for example, to check for seepage in the walls. In a military application for example, soldiers and tanks could stand camouflaged with the background. Having registered images from a visible band camera and a thermal IR one, it helps one to identify the camouflaged entities in relation to their surroundings. The images from different sensors are registered, and these images can be directly fused at the pixel level and subsequent operations such as target detection and recognition can be carried out using the fused images instead of the individual sensor image. This saves on computation, and increases target detection accuracy and recognition rate because subsequent operations benefit from spectral and geometric differences brought out by fusion operations.

Automatic registration of visible band and thermal IR data is very difficult because of the inconsistent features present in the data, as features present in thermal IR images are not often same as those in the visible band images. If the images are similar, as in those formed from similar sensors, one could rely on correspondence on gray levels or texture for registration. However, in images taken with sensors operating on different spectral bands (for instance visible band and thermal IR images) texture and gray-levels do not often match. In some special cases, as in registration of medical images from different sensors, contextual considerations give additional information about the images to register, but these cannot be generalized for the registration of real world scenes.

Schechner and Nayar (2002) describe wide FOV multispectral imaging. A limitation of their approach is the use of special types of filters attached to the camera. Multispectral data is obtained in an extended FOV, using push-broom imaging spectrographs (Wellman, 1981) which are generally rather complex and expensive. Rignot et al. (1991) describe a conceptual approach that integrates a variety of registration techniques and selects the candidate algorithm based on certain performance criteria. The performance requirements for an operational algorithm are formulated given the spatially, temporally and spectrally varying factors that influence the image characteristics and the requirement of various applications. The authors use a feature-based method for registration. The authors use the binary correlation and chamfer matching technique for matching the features. This technique is not applicable for registration of all types of sensors. In (Hui and Manjunath, 1995; Hui, 1996), the authors register images from Landsat and Spot satellites using a contour-based approach. A disadvantage of the above approach is the high computational complexity associated with their feature extraction as well as the registration processes.

The simplest forms of mosaics are created from a set of images whose mutual displacement are pure image plane translation. This is approximately the case with satellite images. Such translation can either be computed by manually pointing to corresponding points or by an image correlation methods (Dani and Chaudhuri, 1995). Other simple mosaics are created by rotating the camera about its optical center, using a special device and creating a panoramic image, which represents the projection of the scene onto a cylinder (Szeliski and Yeung, 1991; Peleg and Rousso, 1998). Since it is not simple to ensure a pure rotation around the optical center, such mosaics are used only in limited cases. For large rotation around the optical axis, a few methods have been developed in the literature. An efficient scheme is that of Dani and Chaudhuri (1995), which utilizes the angular histogram for