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A Study on Image Registration for Remote Sensing Images

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Abstract

Image registration is one of the challenging tasks in image processing problems. The problem of image registration is to find a geometrical transformation that aligns points in one view of an image with corresponding points in another image or similar image. As image registration is widely used in remote sensing, this paper discusses the methods, process and descriptors used for image registration.

Keywords: Image Registration, Remote Sensing, SIFT, SURF.

Introduction

Image Registration is mapping of similar points of source image to reference image taken at different times or different angles or different sensors. It is widely used in various applications in the fields of remote sensing, medical imaging and computer vision. In remote sensing image registration is used for image classification, environmental monitoring, change detection, image mosaicing, weather forecasting and integration of images into GIS. In Medical Imaging, image registration is used for combining CT and MRI data, tumor growth monitoring and treatment verification. Computer Vision, image registration is used for target localization, quality control, stereo matching and face tracking. Being image registration is used most widely in remote sensing fields here we have discussed image registration methods, process and commonly used descriptor SIFT and SURF.

Image Registration Methods

Registration algorithms can be broadly classified as feature-based or area-based approaches [1]. In the feature based, image features such as corners, edges, or shapes are used to define the geometrical mapping between images. In area-based methods, pixel intensities are compared directly for a sub-region of an image. Apart from this there are number of image registration methods based on its application and registration process.

Image Registration Methodology

By [3] Image registration applications can be divided into four main groups according to the type of image acquisition.

Multiview analysis: Images of the same scene are acquired from different viewpoints.

Multitemporal analysis: Images of the same scene are acquired at different times.

Multimodal analysis: Images of the same scene are acquired by different sensors.

Scene to model registration: Images of a scene and a model of the scene are registered. The model can be a computer representation of the scene, for example maps or digital elevation models (DEM) in GIS.

Registration Process

The four major steps involved in image registration are Feature Detection, Feature Matching, Transformation Model Estimation and Resampling and Transformation (Shown in Fig:1) [2].

Feature detection: The two main approaches for feature detection are Area based methods and Feature based methods [3]. In area based feature detection the intensity values of both the images are compared. In feature based, the image features such as regions, lines and points. These should be efficient, spread over image and detectable in both the images. The area based detection is used in medical imaging and feature based detection are used in remote sensing.

Feature matching: By [3] the correspondence between the features detected in the sensed image and those detected in the reference image is established. Various

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feature descriptors and similarity measures along with spatial relationships among the features are used for that purpose.

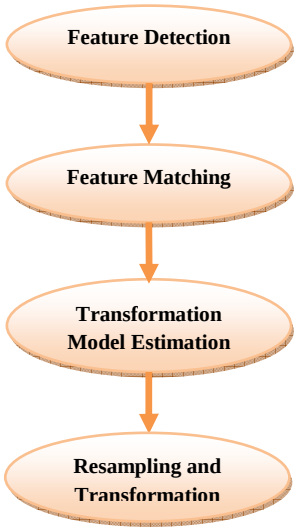

Fig:1 Steps involved in Registration

Transform model estimation: By [3] after the feature matching has been established the mapping function is constructed to transform the sensed image to overlay it over the reference one. The correspondence of the CPs from the sensed and reference images should be as close as possible after the sensed image transformations are employed in the mapping function design. The parameters of the mapping functions are computed by means of the established feature correspondence.

Image resampling and transformation: By [3] the mapping functions constructed before are used to transform the sensed image and thus to register the images. The transformation can be done in a forward or backward manner. In forward method each pixel from the sensed image can be directly transformed using the estimated mapping functions. In backward approach the registered image data from the sensed image are determined using the coordinates of the target pixel and the inverse of the estimated mapping function.

Image Registration Descriptors

Different approaches have been proposed for describing control points to compute a descriptor vector for each interest point which is highly distinct and partially invariant to the variations such as illumination, rotation, etc. SIFT and SURF are two such descriptors.

SIFT (Scale Invariant Feature Transform): By [5] the steps involved in SIFT-descriptor are

Key point localization in scale-space: The key points are obtained by repeatedly applying Gaussian blur to the image. To obtain Difference of Gaussian image each image is subtracted its direct neighbors.

Elimination of weak key points: To eliminate weak key points the candidate key is found by comparing its 8 neighbors and 9 neighbors from one scale up and down. A candidate key is a point which is bigger or smaller than its candidate key. Eliminate the candidate key on edge and have poor contrast.

Assigning rotation: An orientation histogram is calculated around the key points. A new key point with maximum orientation is created and to normalize the key point is rotated in this direction.

Construction of the descriptor: The area around key point is sub divided into 4X4 sub regions. The orientation histogram is calculated for this region. This creates a vector descriptor.

SURF (Speeded Up Robust Features): By [6] there are three main steps in SURF.

Detection of Interest Points: Interest points are picked at unique locations in the image, such as corners, blobs, and T-junctions. The most important property of an interest point detector is to find the same interest points under different viewing conditions.

Construction of Vector: The neighborhood of every interest point is represented by a feature vector. This descriptor has to be distinctive and, at the same time, robust to noise, detection errors, and geometric and photometric deformations.

Matching of Interest Points: The descriptor vectors are matched between different images. The matching is based on a distance between the vectors, e.g. the Mahalanobis or Euclidean distance.

The SURF is better than SIFT both in speed and accuracy. The descriptor is easily extendable for the description of affine invariant regions [6].

Conclusion

Image registration is an important task in image processing. Thus this paper gives a study on image registration for remote sensing images. In this paper the methods and process of image registration are discussed. And the descriptor SIFT and SURF are compared which justifies SURF is better than SIFT.

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