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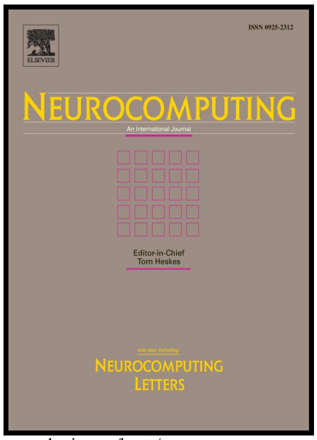

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Neighborhood Geometry Based Feature Matching for Geostationary Satellite Remote Sensing Image

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Abstract

In this paper, we focus on Global Self-consistent, Hierarchical, High-resolution Geography (GSHHG) database registration for remote sensing images taken from geostationary meteorological satellites. While the accuracy of feature matching is the key component. To improve it, we propose a neighborhood geometry-based feature matching scheme which includes three steps: neighborhood coding, verification and fitting. 1) Neighborhood coding represents landmarks of GSHHG as a descriptive bit-matrix, and quantifies remote sensing images to a probability-based edge map and a binary geometry-based edge map. As a result, both gradient and geometry similarity of local features in the remote sensing image and GSHHG can be measured. 2) Neighborhood verification is to encode spatial relationship among local features in neighbor, and discover outliers. 3) Neighborhood fitting fits the shorelines of GSHHG with the landmarks registered by neighborhood verification to improve recall. Experimental results on 25 pairs of newly annotated images show that the proposed method is competitive to several prior arts with respect to matching accuracy. What is more, our method is significantly more efficient than others.

Keywords: feature matching, neighborhood geometry, geostationary satellite remote sensing image, GSHHG database

1. Introduction

Edge is the region of interest in remote sensing image analysis [1, 2]. Since landmarks of shoreline correspond to the edges in remote sensing images, landmark registration serves as the basis for geo-stationary meteorological satellite (GSMS) application. For example, it can be utilized to adjust the satellite attitude angles [3]. Fig. 1 shows the shorelines in a remote sensing image taken by a geostationary meteorological satellite and a landmark image generated by GSHHG database. The aim of landmark registration is to align the GSMS image with the landmark image. In general, landmark registration is implemented through feature points matching. However, due to particular characteristics of GSMS remote sensing images, it brings new challenges for local feature matching.

Local feature matching is a common step in many remote sensing image registration methods. Due to the invariance to affine transformation, SIFT [4] and its variants, such as SURF [5], ASIFT [6, 7] and Perspective-SIFT [8], are shown to be the most successful local appearance features for remote sensing image registration [9, 10]. TCSIFT and LMSIFT are applied for large-scale video copy retrieval [11] and 3D face authentication [12]. However, in GSMS images, different landmarks tend to have similar local appearances, which inevitably lead to outliers even with SIFT-based features.

In order to address the above problem, some geometry-based methods are proposed for feature matching verification. Among these methods, Random Sample Consensus [13] (RANSAC) is the most popular one. It utilizes geometric coordinates to remove outliers [14]. Others such as Graph Transformation Matching (GTM) [15], Restricted Spatial Order Constraints (RSOC) [16] and the Triangle-area Representation of the K Nearest Neighbors (KNN-TAR) [17] are also proposed for feature matching verification. GTM and RSOC discover mismatched points according to neighborhood geometric structure, while KNN-TAR verifies feature matching based on the triangle-area representation of the K nearest neighbors.

However, due to particular characteristics of GSMS images, the previous methods have three limits: 1) SIFT based landmark registration inevitably leads to outliers. 2) The geometric similarity methods, such as RANSAC, GTM and RSOC, are extremely time consuming due to large number of pixels existing in a GSMS remote sensing image. For example, a visible image captured by FengYun-2 meteorological satellites has almost $100,000,000$ pixels. 3) The constraint specified by some geometry based methods, such as KNN-TAR, is so strict that the recall rate is low.

To address the three problems, we propose a neighborhood geometry-based feature matching scheme including three steps: neighborhood coding, verification and fitting. Before neighborhood coding, GSHHG database and GSMS images need to be preprocessed. GSHHG database is transformed to the landmark image (as shown in Fig. 1(b)) by modeling the geo-stationary satellite image. The edges of GSMS images (as shown in Fig. 1(c)) are extracted. Neighborhood coding extracts local features

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