AUTOMATIC MULTISENSOR IMAGE REGISTRATION BASED ON GLOBAL AND LOCAL GEOMETRIC CONSISTENT EDGE SEGMENTS

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1. INTRODUCTION

Edge based image registration is one the most efficient methods for image registration, especially for multisensor image registration, for the nonlinear distortion of gray between images gained by different sensors. Originally chain-code, invariant moment, Hausdorff distance and wavelet descriptor have been used as similarity measure for edge feature matching [1], [2], [3], [4]. However, these similarity measures are sensitive to noise and geometric distortion. In order to solve the problems, a new similarity measure is proposed in this paper. The similarity measure combines chord distance and local geometric modal. At mean time, the relationships between global and local geometric modal is considered. Initial matched edge segments are selected to resolve global geometric modal. Only matched edge segments are consistent both in global and local geometric modal are reserved as final matched result. Experiments show that the proposed method is robust in registering multisensor images with strong edges such as the edges of lakes and rivers. It is translation and rotation invariant.

2. METHODOLOGY

Edge based image registration usually includes four critical steps: edge detection, edge description, edge matching and transformation modal resolving. The proposed method will be illustrated following the four steps. The flowchart of the proposed method is described in Figure 1.

2.1. Edge detection

Canny is one of the most efficient methods for edge detection. Experiments in this research show that most of the edges in different images are accurately detected.

2.2. Edge description

Edge features are extracted from the result image of edge detection though edge tracing. They are described by neighbor points in the edge. Due to noise and gray change of different multisensor images, traced edges in input and reference images may probably not exactly the same. Inflection and corner points are supposed to be feature points in edges. An edge segment is composed of a given number of points centering at a feature point in an edge. The edge segments will be used for feature matching.

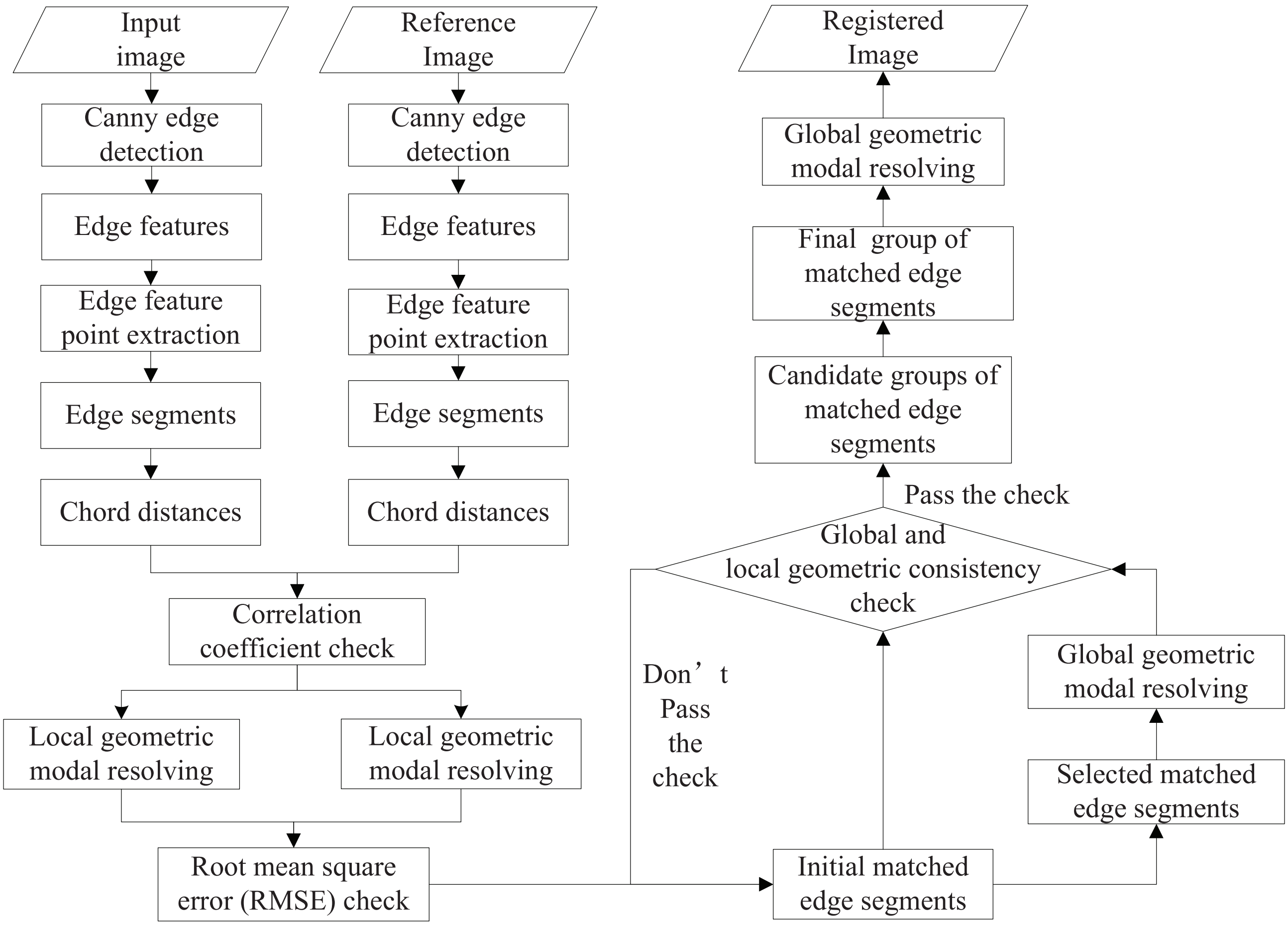

Figure 1. Flowchart of the proposed method.

2.3. Edge matching

A new similarity measure combining chord distance and local geometric modal is used for edge matching. There are four aspects about this step.

Firstly, suppose an edge segment are composed of n points which are P0, P1, … , Pn. The chord distance of each point is calculated as the distance from the point to the line P0Pn. Suppose the distances of n points are d0, d1, …, dn. The edge segment is presented as d0, d1, …, dn. Correlation coefficient of the chord distances of two edge segments are calculated, which are used as a kind of edge segment similarity measure.

Secondly, a local geometric modal is established between two edge segments. If two edges are supposed to be similar, points in the two edge segments are also considered to be similar. Thus the parameters of a local geometric modal can be calculated from these similar points. The root mean square error (RMSE) is also calculated as a kind of edge similarity measure. In this paper, first-order polynomial is used as the local geometric modal.

Thirdly, correlation coefficient and RMSE are combined as the similarity measure of edge segments. If the correlation coefficient of two edge segments is greater than a threshold Ct and RMSE is less than a threshold Et, the two edge segments are supposed to be similar and used as initial matched edge segments.

Fourthly, consistency of global and local geometric modal is checked. In order to gain the most stable matched edge segments, several groups of edge segments are selected to resolve a global geometric modal. All the points in the selected edge segments will be checked according to the global geometric modal. For every selected edge segment, the total ratio of the points passing the check will be calculated. If the passing ratio is greater than a threshold Rt, the selected edge segment is supposed to be consistent with the global geometric modal. If all of the edge segments of a group pass the check, the group is supposed be a candidate group. Other edge segments that are not selected will also be checked. The edge segments passing the check will be recorded to further evaluate the robustness of the candidate groups.

Finally, the final most robust group of edge segments will be selected from the candidate groups according to different measures, including total number of the edge segments, total number of edge points passing the check and RMSE of all edge points passing the check.

2.4. Transformation modal resolving

All the edge points passing the check will be used to resolve the final global transformation modal. Fixed number of edge point with the residual mean square (RMS) greater than a threshold will be removed. The process of resolving global transformation and removing edge points with RMS greater than a threshold will be done iteratively until RMS of all the edge points are less than the given threshold. The final global transformation modal will be used to generate the result image registered to the reference image.

2. EXPERIMENTS

A large number of images of different sensors from different series of satellites including Landsat, SPOT, IRS, ALOS, CBERS and HJ have been used to test and verify the proposed method. Here is an example of the experiments, as shown in Figure 2.

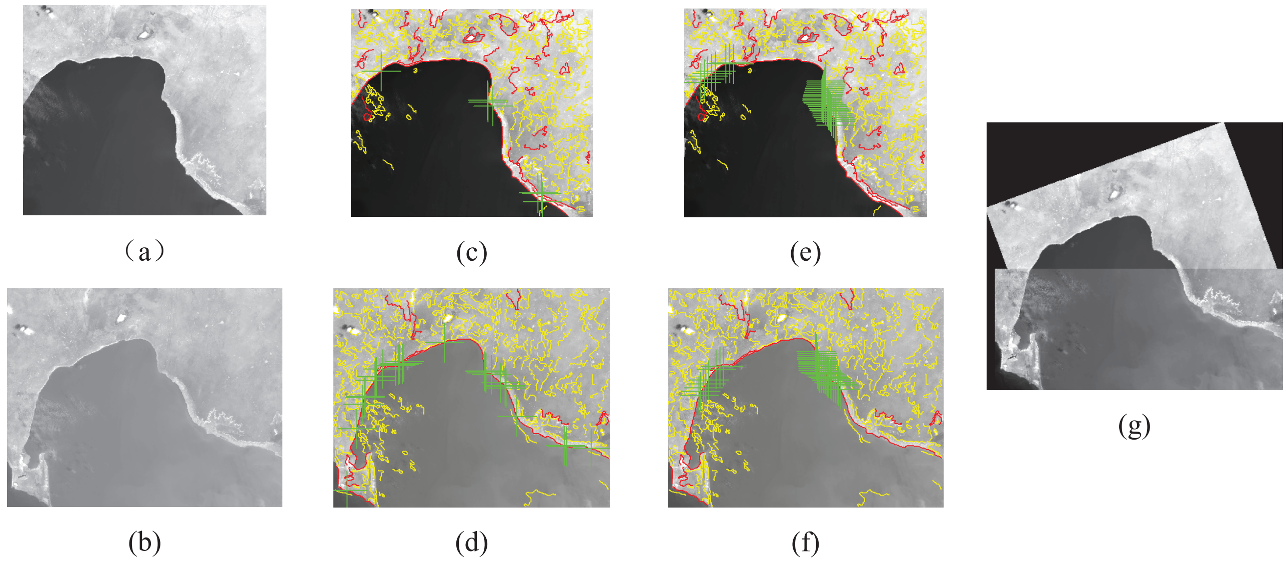

Figure 2. Registration of two test images which are resampled and cut out from original ETM+ images: (a) input image (the fourth band of ETM+), (b) reference image (the first band of ETM+), (c) and (d) initial matched edge segments passing the correlation coefficient and RMSE check with the "+" marks denoting edge feature points, (e) and (f) final edge points passing the global and local geometric consistency check with the "+" marks denoting edge points, (g) comparison between registered image and reference image by swiping tool.

3. CONCLUSION

Experiments show that the proposed method is robust in registering multisensor images with strong edges. Noises are also added to generate simulated images to validate the proposed method. In most cases stable matched edge feature segments are gained. However, the computational complexity may be reduced to register large images. In this point, this method may be more appropriate to register pyramids of images to provide coarse registration parameters.

4. REFERENCES

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