Betterment to Image Matching Process in Remote Sensing

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Abstract— **Image registration is among the important image processing procedures in remote sensing and it has been studied and developed for a long time. However, still now, it is rare to find an accurate, robust, and automatic image registration method because the resulting image is often affected by change of scales and change of illumination, poles etc. At present, high resolution remote sensing images have made it more convenient for people to study the earth; however, they also bring some challenges for the traditional research methods. In terms of image registration, there are some problems with using current image registration techniques for high resolution images, namely: (a) precisely locating control points is not as simple ; (b) manually selecting the large number of control points required for precise registration is difficult task; (c) high data volume will badly affect the processing speed in the image registration; and (d) local geometric distortion cannot be removed very well using traditional image registration methods even with enough control points. Based on these reasons, the need for an image registration approach that will resolve these problems is necessary. This paper proposes a new image registration technique, which is based on the combination feature based registration method and match support parameter based matching method. This can be called as a hybrid approach. Local distortions caused by terrain can be greatly reduced in this procedure.**

Index Terms—**remote sensing, image matching, contrast, image registration.**

I. INTRODUCTION

Image matching in case of remote sensing applications is quite a difficult task. While sensors are trying to acquire the images from large distance there are many problems come across such as non- common illumination, changes in frequency and contrast may also differ [2-4]. Because the reference image and the searching image differ in relation of time or the type of sensor. So, while matching such images taken by sensors over large distance the images should be registered precisely .Image registration is a fundamental image processing technique in remote sensing application. It has been widely used in change detection, image fusion and other such fields. In order to integrate different kinds of sensor data and different temporal data, image registration is an effective preprocessing tool in integrating multi-source and multi-temporal images [3]. In change detection process, the image registration accuracy directly influences the accuracy of change detection result. Many methods has been proposed earlier but there is still a need to achieve high values of registration accuracy otherwise error will be induced when comparisons between images are made for the purposes of reliably matching of images. If the multi-sensor image has been registered very well, final results of matching will be easy to get evaluated.

II. RELATED THEORY

Many researchers have developed algorithms for image matching using precise registration methods. The researcher Ran li [1] observed that there are so many differences in multi-source remote sensing imageries, such as spatial resolution, imaging mechanism and so on. It makes the registration of multi-source remote sensing imagery complex and difficult .An automatic image match algorithm based on SIFT [scale invariant feature transform] features with match-support measure for multi-source remote sensing images are presented. In order to adjust SIFT algorithm applied in the matching processing for different-source remote sensing images, the author has introduced the match support measure for similarity measure. Firstly, it builds SIFT feature descriptor and selects the points which satisfied the minimum Euclidean distance for candidate match result between reference image and match image . It calculates the match-support measure among the candidates separately. Finally, it employs the relaxation method to discard the false matching pairs. The experiment performed has shown the improvement in image matching processing with this algorithm. It has provided a reliable guarantee for spatial information extraction, analysis and update in the large-scale. This algorithm is more suitable for multi-source remote sensing registration. The extra computing amount is unavoidable and still needs to improve the efficiency of this algorithm.

In another approach, presented by Amin Sadaghat et.al. [2] Stated that regardless of its distinctiveness and robustness, the SIFT algorithm suffers from some problems in the quality, quantity, and distribution of extracted features particularly in multisource remote sensing imageries. The method proposed by author is an improved SIFT algorithm that is fully automated and applicable to various kinds of optical remote sensing images, even with those that are five times the difference in scale. The main key here is a selection strategy of SIFT features in the full distribution of location and scale where the feature qualities are quarantined based on the stability and distinctiveness constraints. Then, the extracted features are introduced to an initial cross-matching process followed by a consistency check in the projective Transformation model. Comprehensive evaluation of efficiency, distribution quality, and positional accuracy of the extracted point pairs proves the capabilities of the proposed matching algorithm on a variety of optical remote sensing images. The proposed method effectively generates enough robust, reliable, and uniformly distributed aligned point pairs and thus provides the prerequisite for accurate piecewise transformations in the image registration process. Projective model, although accurate enough for remote sensing images, is prone to be failed when there are considerable mismatches in the very beginning pre-matched pairs.

Also the method proposed by Xiaochun Liu et.al. in [3] where"Multi-temporal and multi-sensor image matching have been presented which is based on local frequency information" .Developed an efficient approach to automated multi-temporal and multi-sensor image matching based on local frequency information. As these representations are both derivative-free

and threshold-free, they are robust to noise and can keep as much of the image details as possible. A new Compositional Similarity Measure (CSM) is also presented to combine the LAP and LWA with the same weight for measuring the similarity of multi-temporal and multi-sensor images. This approach is effective for matching image pairs with significant scene and illumination changes and that it has advantages over other state-of-the-art approaches. The two image representations do not involve any thresholding and, therefore, preserve all the image details. The method proven to be robust to noise but it is time consuming process.

The next approach presented by Xingxing Shen et.al.[4]is on the basis of summarizing the existing feature detection methods which is based on invariant technology, is one of the most robust and widely used image matching algorithms based on local features. However, its computational complexity is high and SIFT feature matching efficiency is not high .In order to reduce the matching time, an improved feature matching algorithm proposed under the premise of stable registration accuracy i.e. a normalized cross correlation with SIFT combination of remote sensing image matching algorithm. By this way, it can reduce the matching range. So some unnecessary calculations are properly omitted. The experimental results show that the Normalized cross-correlation plus SIFT algorithm is more rapid than the standard SIFT algorithm. But still it needed to be worked out.In method presented by Humera Siddiqua et.al. [5] has worked out on the "Feature based image matching for Airborne platform". This mainly consists of image matching for reconnaissance and Surveillance, Digital Scene Matching Area Correlation (DSMAC), Image Registration by using various correlation techniques, Mean Shift Algorithm, Cam shift Algorithm, Otsu Thresholding and Principal Component Analysis (PCA) and using Point detectors like Scale Invariant Feature Transform (SIFT) , Speed Up Robust Feature (SURF) and Saliency Map. This technique is robust for scale changes like rotation and translation. However the computation is complex. Also the methods presented in [6] and [7] had focused on the image matching of remotely sensed images, but they lacks in accuracy.

III. ANALYSIS AND DISCUSSION

There are several methods proposed for image matching of remotely sensed images using the effective image registration methods. At the same time it is trying to find out the best local matching point to determine which has the highest matching accuracy within the image region. The algorithm, [1] which is more suitable for multi-source remote sensing registration has used SIFT feature extracted to detect the extrema point in the scale space. Therefore, to efficiently detect stable feature point locations in scale space, the author proposed using scale-space extrema in the difference-of-Gaussian function.The extrema point is in DoG function is scale-invariant; therefore, this feature can be used to match the difference spatial resolution remote sensing images. However, the pixel coordinates are not sufficiently precise to locate the extrema point; it needs to locate the extrema at sub-pixel level also. In the method, it has used the feature extract algorithm based on Harris Operator for multi-scale space to reject those point that not suit for photogrammetric processing, The Match-Support measurement[as shown in table-1] is integrated into the classic SIFT feature matching algorithm and the iterative procedure used, so the matches can be updated by eliminating the error match candidates. However a fully automated matching algorithm, called uniform robust SIFT (UR-SIFT)[2] has been presented previously.The purpose of the feature extraction stage is to obtain an adequate number of high-quality point features.

TABLE I

	Match support measurement algorithm			Classic SIFT feature match algorithm		
Experi-ment image pair	Match umber	Correct match number	Cost time	Match number	Correct match number	Cost time (sec)
SPOT-5/aerial image	104	87	35	68	37	31
IKONOS/ SAR image	41	29	66	13	7	38

Features with high contrast are stable to image deformation, which is desired for an accurate matching, and distinctive ones are unique in description, which is appealed for reliable correspondence.

The corresponding module of UR-SIFT consists of two substages: pre-matching and mismatch elimination. In pre-matching, some false matches may be introduced which are the subject of elimination in the next stage.This module proven to have the ability to handle the most common geometric distortions found in remotely sensed imagery such as affine transformations.Multi-temporal and multi-sensor image matching based on local frequency information has been presented [3] which is an efficient approach to automated multi-temporal and multi-sensor image matching based on local frequency information. Two new independent image representations, Local Average Phase (LAP) and Local Weighted Amplitude (LWA), are presented to emphasize the common scene information, while suppressing the non-common illumination and sensor dependent information. The template is usually selected without consideration of its matching robustness and accuracy. In order to overcome this problem, a local best matching point detection is presented to detect the best matching template. the approach is effective for matching image pairs with significant scene changes. The LAP and LWA are independent of each other. In order to combine the information of the LAP and LWA, a new similarity measurement: CSM used that is able to take advantage of more information than those commonly used similarity measures and hence improve the robustness and applicability of image matching.

In order to reduce the matching time and improve efficiency, an improved feature matching algorithm [4] has been proposed previously. This method combined normalized cross-correlation with SIFT algorithm. The improved algorithm is not only as robust as SIFT, but also improved in calculating speed and matching accuracy.This approach involves taking a given pattern in one image and shifting a template containing the same pattern in another image until the best comparison is found. The most common and effective way of doing this task is by Normalized Cross Correlation (NCC) methods which is the most robust correlation measure for determining similarity between points in two or more images. But it possesses the drawback of outliers.In computer vision, detection and tracking of targets is very complex problem and demands sophisticated solutions. Feature based matching has been proposed [5] which mainly consists of image matching for reconnaissance and Surveillance, Digital Scene Matching Area Correlation (DSMAC), Image Registration by using various correlation techniques, Mean Shift Algorithm, Cam shift Algorithm, Otsu Thresholding and Principal Component and using Point detectors like Scale Invariant Feature Transform (SIFT) , Speed Up Robust Feature (SURF) and Saliency Map.This technique is robust for scale changes but computation is complex.

IV. PROPOSED METHODOLOGY

The remote sensing images when come across the problem of image matching there are various problems come across such as changes in illumination, scale and view. Therefore for such images one efficient and precise method of registration should be used. Image registration is the process that establishes a geometric mapping function between two different images. In order to analyze and apply remote sensing images completely, image registration is the fundamental and a key issue in remote sensing. The registration methods are of two categories, feature based registration (FBM) and area based registration (ABM). But the area based method has significant limitations such as the different distortion caused by the differences in imaging mechanism, the spatial difference etc. all in most cases, the area based method cannot work well. However FBMs are more robust[1] and more reliable than ABMs, that's why it is preferred to be used in this proposed method. By utilizing the feature based method, scale invariant feature transform algorithm, the registration points are determined along with the use of match support measure which will help to determine final improved matches. Compared to the standard representation, this algorithm can be proven to be more distinctive and more compact. The detailed methodology is described with the help of figure shown.

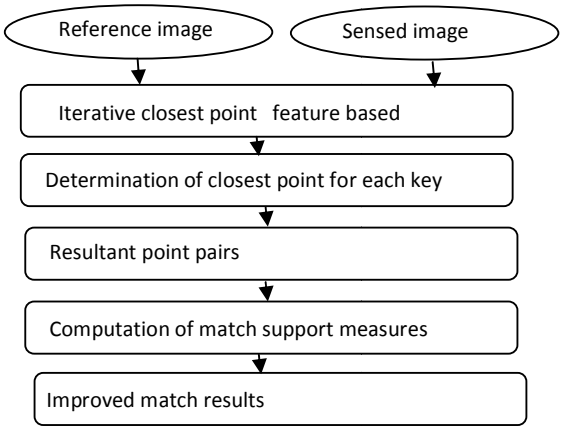

Fig.1. System overview

System overview in detail:

The work aims to co-register reference image and sensed images using a methodology in a hybrid framework which combines the feature based registration of both the images with their match support[1].The registration will allow the use of complementary information from different imaging modalities to establish a gesture.Like ABM, Feature-based methods do not use the gray value of pixels to describe matching relation, but use features, like corners, lines and regions, obtained by feature extraction algorithms from each image. In general, feature-based methods handle larger misalignments with short execution times.The purpose of this paper is to present a registration algorithm which combines feature-based approach with match support measure.The proposed hybrid algorithm divides the registration problem into two steps.

[I] In the first step, it uses the feature-based approach to build models of identifiable points in the sensed image which are matched with their counterparts in the referenced image.

[II] The second step uses the feature based method to iteratively optimize a given similarity measure between the two images. Let R and S represent the referenced image and sensed image respectively then,{XR} represents the set of points in image R and {XS} represents the corresponding set of points in image U.The purpose of proposed algorithm is to determine the registration transformation, T, which relates the position (x, y) of features in one image space with the position (x′, y′) of the corresponding features in another image space.

[III] Feature-Based Registration will help to determine the closest point pairs.The feature-based iterative closest point approach can be used that uses {XR} as model point set and {XS} as data point set to perform the registration. The approach works by iteratively finding, for each point xs, in the data set {XU}, the closest point in the model set {XR}. The process iterates until the change falls below a defined threshold.

[IV] Match support:This is the point xr in {XR} for which the the match support will be calculated.The point pairs will now be available to calculate their match support parameter and get the correct and improved matching results.More formally,a measure of support can be defined as a match, which can be called as the match support measurement.Here reciprocal of

Euclidean distances between candidate points will be matched.It can be employed as per the following steps:

1. Compute the matching support measurement
2. Update the matches by eliminating the error match candidates
3. Until no change in all match candidates, the iterative convergences.

This registration of images is essential for accurately finding the point pairs predictable for getting matched. It provides unique information which is often not available from independent analysis.The advantage of this algorithm is that it can be proven to be more accurate, reliable and nearly automatic.This can shorten the matching time and improve the matching accuracy. Its robustness is will be increased correspondingly. However the feature based method used in multi-source remote sensing registration still have same deficiencies, especially the problem of low matching successes rate.

V. Possible Outcome And Results

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Conclusion

An efficient method for image matching of remotely sensed images is proposed in this paper. The registration method which is most essential method in this type of image matching is presented with combination of previous match support measurement method for better image matching results. Because the high resolution remote sensing image is sensitive to terrain relief, the image registration technique in this paper is intended to resolve the following problems existing in registering high resolution images:-

Automatically selecting a large number of control points pairs in the sensed image and the reference image; reduce the computation time because of high volume data; reduce the local distortion existing in different sensors and different temporal images. Basically, this method can meet these requirements. However, it still needs some improvement. Time limits can be set for corresponding control points in the sensing image and reference image using some efficient method. So that overall time can be reduced.

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