EAI Endorsed Transactions
on Internet of Things
Research Article EAI.EU

Image Registration Model For Remote Sensing Images

Sabeen Gul[1], Sheeraz Memon[1], Bushra Naz[1]

[1]Department of Computer System Engineering Mehran University of Engineering and Technology Jamshoro

Abstract

Image registration is the vital technology in computer vision. By developing precise image registration algorithm will meaningfully improve the techniques for the problems in computer vision. Registration process does geometrical alteration that aligns point present in one view of an object with similar points in another view of that object or another object .Steps involved in image registration are feature finding, matching of features, image transformation and resampling. Feature finding and matching have vital role in accuracy of the process. In this paper we have used SIFT (Scale Invariant Feature Transform) for the feature detection which is invariant to scaling, rotation and noise. KNN nearest neighbor is used for matching similar points and the other efficient method in reducing miss matches in the proposed algorithm is Random sample consensus method.

Keywords: Image registration, SIFT, KNN, RANSAC, High Resolution Images

Received on 03 July 2018, accepted on 10 September 2018, published on 31 October 2018

doi: 10.4108/eai.21-12-2018.159333

* Corresponding author: Sabeenmemon22@gmail.com

1. Introduction

Image registration is one of the key technique in image processing. It is the practice of geometrical modification that overlays two or more images or aligns point present in one view of an object with similar points in another view of that object or another object. [11]. In other words it can be said that it is the process of plotting similarity between two images .These images can be from different sensors, different views or taken at different times. Registration process is a vital step in all image analysis tasks. It can be used in changed detection, image fusion, military, remote sensing and medical imaging, calculation of damage caused by disasters, and other interrelated areas. Image registration can also be said as image fusion or wrapping.

Image registration is divided in two groups .1) Feature based methods 2) Area based methods. Feature based methods are used where there are easily detectable and enough distinctive objects. And where there are less features and in medical imaging registration area based methods are used .Features may include Harris corner, Susan corner, edge feature these are the examples of common point features However they are subtle to scales, and it is quite difficult to find correspondence between different scale images. [12] A SIFT based registration method is proposed is this research. SIFT features have several properties that make it appropriate for finding the similar points in different images of a scene or an object. That makes it uniform to image rotation, scaling and partially invariant to alteration in illumination and 3D viewpoint. New outcomes can show that the proposed algorithm is robust to Scaling, translation, Rotation and addition of noise. KNN nearest neighbour is used for matching the similar points which is a fast method to match the similar points and RANSAC has been used that is a robust transformation estimation algorithm.

a) Review of feature extraction using SIFT

SIFT algorithm is used for taking out distinctive invariant features from images on which reliable matching between different objects or views can be performed.

To produce the set of features Four main stages of computation are used those are:

- Extreme detection and scale space
- Key Point Localization
- Orientation Assignment
- Key point Descriptor

b) RANSAC (model fitting)

The Random sample consensus algorithm RANSAC a robust transformation valuation algorithm, by which registration pairs can be obtained even with a small amount of external points. The stages below describe measures to remove wrong feature points using RANSAC algorithm.

Detail a data set P composed of N points, set up affine transformation model (H) between feature points, and execute the next steps by means of iteration:

1. Pick up a random subset (SI) of four similar data points.

2. Calculation of the model (H) by means of those four nominated points.

3. Represent the model between two registration images by affine transform.

$$1. \quad \begin{pmatrix} x_2 \\ y_2 \end{pmatrix} = s \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x_1 \\ y_1 \end{pmatrix} + \begin{pmatrix} t_x \\ t_y \end{pmatrix}$$

2. Related Work

The overall objective of this research was to design a method to improve the accuracy for the registration of multi modal infrared images using SAR and RANSAC [1].This research was done to reduce the false matched features in this frame work the problem was shared in two steps 1st the modified computer vision-oriented fast and rotated brief ORB algorithm along with a simple method to improve the performance of the feature point matching is proposed. Secondly a novel matching algorithm via geometric constraints, local feature descriptors based on geometric invariances is constructed to evaluate the correspondences between the points and in the end progressive sample consensus to eliminate incorrect matches and compute the space transform parameters [2]. This work was done to reduce the computational time using triangulation based approach uses (\em TRIM) to speed up the computations of the registration process by triangulation an optimal coarse triangulation is computed on high resolution images or video frames through this important features of the image can be captured [3] New mode seeking SIFT (MS-SIFT) method that described mode scale and mode rotation change for feature points. Results could be more refined by removing the outliers whose vertical and horizontal shift is far than mode translation [4]. this research contains Normalized cross correlation (NCC) to gain tie points having improved spatial distribution after SIFT initial registration [5] .The method that were first widely used were area based [6]. This Research provides an introductory survey on feature-based image registration methods explored in the previous work [7]. proposed a method SIFTOCT by which first octave of the scale space has been skipped to decrease the impact of the noise [8] A rough-to-fine method that attained the rough results by SIFT for image registration and then attained the precise results using the mutual information.[9] The authors have used SIFT Euclidean Distance and RANSAC for multi view point image registration. It has been identified by the authors the use of KNN can improve the accuracy. [10]

2.1 Proposed framework

The Major steps involved in our proposed framework are shown below in Figure 1.

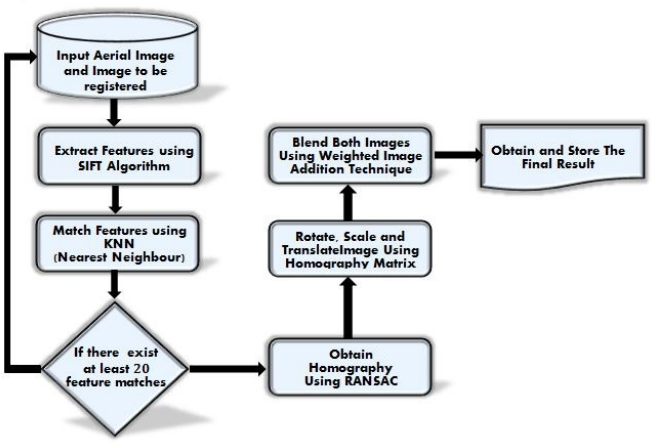

Figure 1

Brief discussion of steps:

The series of steps are related with pre-processing of images in order to apply registration techniques afterwards. This will help to judge the images are eligible for further series of steps of registration .The major steps of this category is mentioned below.

2.2 Input Images

Two image formats are required, one is RGB and other in gray scale. The necessity of getting images in two formats is to compute the homograph of the original image and image to be registered in order to find the tie points and homograph matrix grey scale image structure has been used. It is the requirement of reshaping image pixels and calculating homograph matrix. After getting homograph of pixels transformed matrix with RGB format will be used. RGB format is only used to judge the results more clearly.

2.3 Feature Extraction

The most important step of image preprocessing. In this stage we will be using the SIFT (Scale Invariant Fourier Transform). The SIFT algorithm is one of the most accurate algorithm for feature detection in Image Processing technique. Here we have used Unrestricted SIFT algorithm which means that we have not restricted the SIFT feature extraction mechanism to any limited number of pixels. However doing this will affect our computational cost but this will boost the accuracy to a good extent which we have preferred in our approach. The SIFT algorithm will returnan array of key points (features) which we will be using for further processing.

2.4 Feature Matching

Another step which will be performed after getting the feature points from both images will be matching them. We will be using the FLANN (Fast Algorithm for Nearest Neighbor) for this purpose. Value of 2 neighbors at a time has been used. Provided a condition to pick the most closest neighbor only which 0.75(Ratio defined the Lowe's research paper)[12] if it is 75% closest to both image then pick that up as a good match otherwise skip that neighbor. Once we processed all extracted features, then first analyze whether the matched features are above or equal to the minimum threshold (0.75%). After accomplishing the required matching criteria i.e. (at least 50 matches) then image is ready for registration otherwise it will be rejected.

2.5 Tie Points Extraction

Tie points are those set of coordinates which represents the all four edges of the image to be registered and represent in them in the matched features of input image. The Tie points consist of Upper-Left, Lower-Left, Upper-Right & Lower-Right edge pixel location in the input image. These are very important since using these we can find out the approximate location of our image to be registered with reference to the input image. A line is been drawn in results to show the approximately location are of image to be registered. Now mathematically there is a technique called Perspective Transform that we have used to find the coordinated of points. The perspective transform technique will return the point of edges of the image to be registered according to the plan of reference of original(input) image.

2.6 Homography Calculation

Now the final step to register the image is to find out the homographic relation between the two images which is termed as Homographcalculation. This is the most important and required to be done with minimal error in order to get a proper image registration with best possible accuracy. This step involves usage of RANSAC (Random sample consensus). This algorithm will predict the best relation within two sets of data. This will determine the best possible values of Rotation, Scale or Translation of one image with the other matched feature points of the images will be taken as source and destination point pairs and calculate homograph by using this algorithm also giving a threshold which is RABSAC threshold value (we've tested a value of 5.0 to be suitable). The RANSAC will then return the Transformation (Homograph) matrix which will be describing the Theta, the values for rotation along with two pairs of values for rotation long with two pairs of values for both scaling factor and translation coordinates pixels value. Finally the required parameters has been achieved image will be trans formed (wrapping) in to one fused image.

2.7 Image Warping

Image warping is technique of implementation of transformation matrix derived in previous stage using homographic calculation. Affine Transform will be done to transform the image to be registered according to our derived transformation matrix in previous step while using RANSAC. This transformation is required for the image to get rotated scaled or translated. The Affine Transform performs some mathematical calculation on pixels values like matrix addition, inverse calculation etc to transform each pixel accordingly.

2.8 Image Addition

This process is done just to view the final result as compared to input image. Here we will be using the weighted addition technique which uses alpha & beta values as transparency of both actual and resultant image so that the final blended result can be compare in a single image showing whether the result is accurate or not just for viewing purpose. And also we can see the rotation translation and scaling of the image and final placement in compared to original one.

2.9 Accuracy Determination

Two types of criteria has been used in this study to evaluate the performance namely, no: of correct matches and RMSE which are expressed below.

$$\textbf{RMSE}=\frac{\sqrt{1}}{N\sum_{i=1}^{N}||T(pi\ r)-pit||22}*$$

Correct matches=True positives

The true positives refer to the no: of correct matches in the final results. A point pair can be said as a good match when its expected distance is less than four pixels. RMSE values represent the ratio or index of similarity of actual input image and resultant registered image, if it is equal to 0 it shows perfect registration and as the value increases the accuracy drops. This value represent the ratio or index of similarity of actual input image and resultant registered image, if it is equal to 0 it shows perfect registration and as the value increases the accuracy drops too. After that we can judge that how our approach is working.

3. Results and Discussion

The proposed technique is tested and applied on multiple kinds of Arial images both multi-focal & multi modal and have gathered acceptable result with decent accuracy.

3.1 Images Set

Below the image 1 is the original input image and image 2 is the image required to be registered.

Figure 2. Image 1 Original Input Image

Figure 3. Image-2 Image to be registered

The above images sample will be used to register image-2 with image-1 that is the original image.

3.2 Image Pre-Processing

Below is the feature extraction of both images

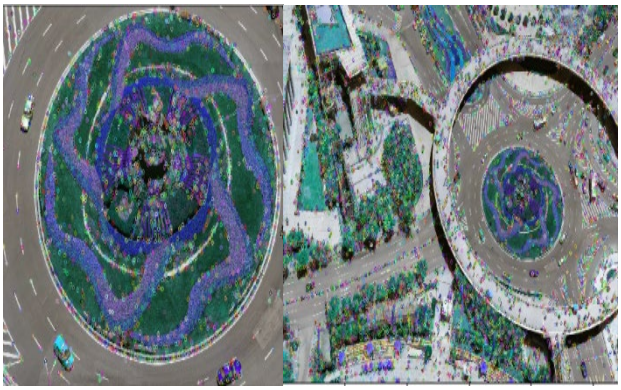

Figure 4. Image-2 Image-1

3.3 Feature Matching

After extracting the features in previous step as shown in the images above now we will match the features between both images, below is the result attached.

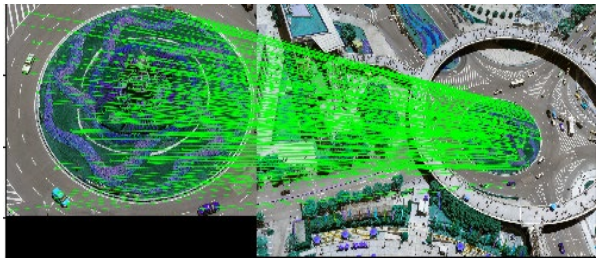

Figure 5. Image Feature Matching

3.4 Registering Image

After feature matching there are two steps are to be done, one is to locate and find the area, the homographic changes that are required i.e. rotation, scaling & translation of the image to be registered. After this the final result can be determined.

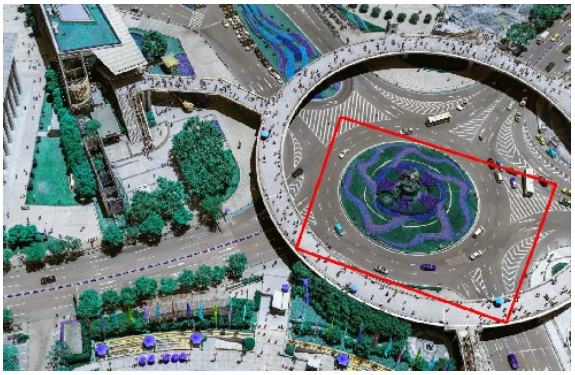

Figure 6. Determination of Image Alignments

3.5 Fused Result

Finally after doing all the processing and calculations the final result which is to be fused with the original image so that it can merge into single image. The highlighted area is the registered area of the registered image.

Figure 7. Final Resultant Fused Image (Result-1)

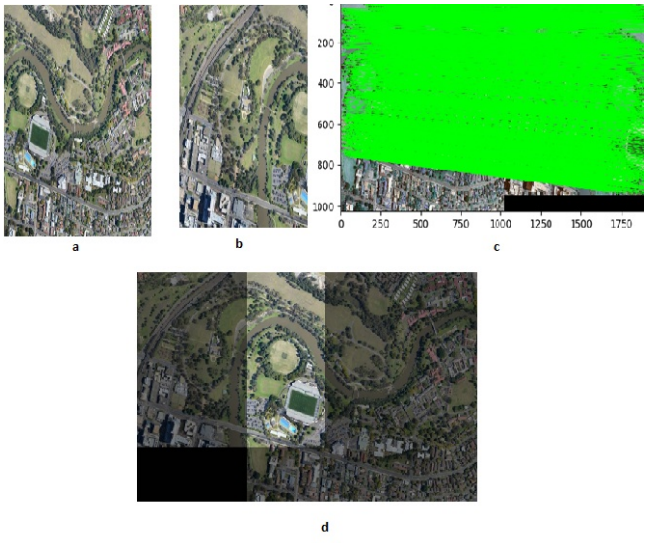

Figure 8. Result -2

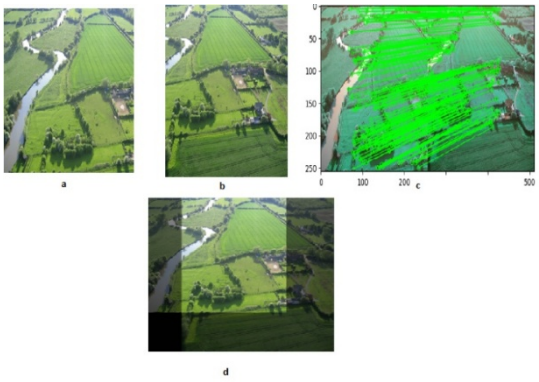

Figure 9. Result-3

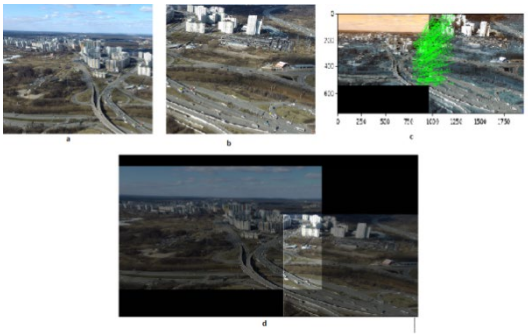

Figure 10. Result-4

In (result 2, 3 & 4) all the steps are done according to the proposed methodology to get the final result. Image a and Image b are the input images .c is the result after matching features and d is the resultant stitched image comprising of the whole scene after applying weighted addition technique.

Table 1.

S: no	Image size	Rotation angle	T_X pixels	T_y pixels	No:of matches	No:of correct matches	RMSE
Result-1	1081x708 803x595	18.82	2009.948	-48.567	8695	258	0.567
Result-2	1366x719 408x719	0	0.0434	553.88	19002	3032	0.659
Result-3	955x1000 810x1000	0.018	-56.46	0.05	698	207	0.59
Result-4	960x538 1000x750	0.015	-1213	-351	3620	345	0.64

4. Conclusion

Image registration is a basic but also a essential step in many of image processing tasks for which the concluding results can be achieved from a blend of various resources. In this paper, we proposed an accurate method for various high resolution remote sensing image registration .The main contributions of this paper are considered as follows. (i) Feature extraction using the SIFT that can deal with the large changes of rotation, scaling, and illumination amid images. (ii) Calculate homography by using this RANSAC algorithm and also giving a threshold which is

RANSAC threshold value. The improvement of the given technique falls in its capability that is to decrease the number of false matched points while recollecting high quality feature points using the Knn, neighbourhood matching method and the RANSAC algorithm overcome the outliers found in the matches and hence correct estimation of the transformation matrix is also being done. From the experimental results it is shown that the proposed technique proceeds improved performance for large rotations, scaling, variations, and intensity changes.

References

[1]Yung, Chun Pang, et al. "Efficient feature-based image registration by mapping sparsified surfaces." *Journal of Visual Communication and Image Representation* 55 (2018): 561-571.

[2]Lu, Yan, et al. "A novel image registration approach via combining local features and geometric invariants." PloS one 13.1 (2018): e0190383.

[3]Wu, Huan, et al. "Image registration of infrared and visible based on SIFT and SURF." *Tenth International Conference on Digital Image Processing (ICDIP 2018)*.Vol. 10806. International Society for Optics and Photonics, 2018.

[4]Ma, Wenping, et al. "Remote sensing image registration with modified SIFT and enhanced feature matching." *IEEE Geoscience and Remote Sensing Letters* 14.1 (2017): 3-7.

[5]Zhang, Qian, et al. "Joint image registration and fusion for panchromatic and multispectral images." *IEEE geoscience and remote sensing letters* 12.3 (2015): 467-471.

[6]Chen, Chen, et al. "SIRF: Simultaneous satellite image Zitova, Barbara, and Jan Flusser. "Image registration methods: a survey." *Image and vision computing* 21.11 (2003): 977-1000.(1)

[7]Gandhi, Vrushank H., and Sandip R. Panchal. "Feature based image registration techniques: An introductory survey." (2014).

[8]Wang, Shanhu, Hongjian You, and Kun Fu. "BFSIFT: A novel method to find feature matches for SAR image registration." *IEEE Geoscience and Remote Sensing Letters* 9.4 (2012): 649-653.

[9]Gong, Maoguo, et al. "A novel coarse-to-fine scheme for automatic image registration based on SIFT and mutual information." *IEEE Transactions on Geoscience and Remote Sensing* 52.7 (2014): 4328-4338.

[10]Subramanyam, M. V. "Automatic feature based image registration using SIFT algorithm." *Computing Communication & Networking Technologies (ICCCNT), 2012 Third International Conference on*.IEEE, 2012.

[11]ZitovaB .• and Flusser J., "Image registration methods: A survey," Journal ofimage and Vision ELSEVIER, Vo!. 21, pp. 977-1000, June. 2003.

[12]Lowe D G. "Distinctive image features from scale-invariant key points" International Journal of Computer Vision,2004,60(2):91-11 O.