Hybrid Method for Efficient Real-Time Image Matching in Computer Vision

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Abstract - *Image matching is essential in applications related to remote sensing or the real time implications. The images are affected by number of parameters: lighting conditions, sensor resolution, altitude and direction of image viewing. Regarding the extraction of features from images, degraded by contrast and haze, many method, based on image matching has been extensively presented in the past years. But it is found that the development of algorithms based on features has been limited by the weak robustness for disturbance, invalidation problem during extracting features and low computing performance. Hence, in order to extract the features from hazy images accurately the focus is given on best method using SIFT descriptor has been proposed. The method uses SIFT descriptor along with regression step which has become one of the most impressive method for image matching and object recognition.*

Key Words: SIFT, Real-time image match, Feature extraction, Object Recognition, Stepwise multiple regression, NCC, Similarity Kernel, Scale invariance.

1. INTRODUCTION

The image matching is a process of matching two images for common features existing among them. Each image is represented as a collection of features of the patches. Weights on the edges shows the matching probabilities between feature pairs so that the similarity between two images is obtained. So the main key in all types of image matching processes is that how well does the method extracts the features. With the Remotely sensed images the Image matching is quite a difficult task. While sensors are trying to aquire the remote images from large distance there are many problems come across such as non- common illumination, changes in frequency and contrast may also differ. 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 precise registration of such images is necessary for integrating or fusing complementary information from different sources into a composite form.It will provide synergistic information about the objects under examination and thus, help in the assessment of such images which are affected by several environmental factors.

With the Images affected with haze, dims the clarity of an observed scene due to the particles such as smoke, fog and dust. As a result the original contrast is degraded and gradually the scene features are faded. Therefore selection of correct feature extractor is important. Feature descriptors must be invariant to small changes in illumination, viewpoint, contrast and noise. In some method SURF descriptor is used but when compared SIFT has good scale invariance and robust to illumination and viewpoint changes. Owing to the scale invariance of the detector and the descriptiveness of the descriptor, SIFT-based methods have been successfully used in image matching and registration. Compared with the template matching feature based matching such as SIFT has higher precision. In such methods selection of the features is main problem. The performance enhancement and better robustness for noise and contrast can be achieved by employing some hybrid method.

Effective image matching can be done using nearest neighbours patch-match based approach, image match by visual along with relaxation labeling techinique. But the main point here is to extract the correct point pairs using precise method. The point pairs will be the resultant outputs which are going to provide the closest matching between the input image and the reference image. The results will be definite and able to reduce misjudgement rate. But the existing methodolies have their drawbacks with respect to the scale changes since it should be able to work with real time images also.

While images are captured remotely or in real time they may get affected by haze, contrast, illumination and quality is degraded. To improve their quality, robustness, accuracy and matching probability the method will be using the SIFT descriptor along with iterative approaches which are applied in order to get the optimal results. The methods used for matching previously are based on the standard algorithm of SIFT(scale invariant feature transform).But the results have scope for improvement as they are not robust and satisfactory. The proposed method can improve certain parameters like SNR(sound to noise ratio), robustness, time for match, intensity, uniformity of features and the weight of resultant images. The method is the combination of SIFT with various iterative methods for evaluating feature matches. It can be proven to be resistant to the scale changes and the iterative approach will apparently lead to optimal and accurate results with decreased mismatch ratio. The mathematical technique used will help to achieve improved results.

2. BACKGROUND

There are several methods proposed for image matching of remotely sensed images using 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. One of the methods has used the SIFT feature to extract the extrema point in the scale space using scale-space extrema in the Difference-of-Gaussian function. The extrema point is in the DoG function is scale-invariant, therefore, this feature can be used to match the different 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 the sub-pixel level also. In another method, it has used the feature extract algorithm based on Harris Operator for multi-scale space to reject those points that not suit for photogrammetric processing. However, a fully automated matching algorithm, called uniform robust SIFT (UR-SIFT) has been presented previously. This module has 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 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. To reduce the matching time and improve efficiency, and improved feature matching algorithm has been proposed previously. This method combined normalized cross-correlation with the SIFT algorithm. The improved algorithm is not only as robust as SIFT but also improved in calculating speed and matching accuracy.

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 the similarity between points in two or more images. But it possesses the drawback of outliers. In computer vision, detection and tracking of targets is a very complex problem and demands sophisticated solutions.

Different strategies can be utilized in the feature matching process. It has been introduced a probabilistic matching strategy in the matching process as a generalization of a family of similarity learning approaches, including (similarity kernel)SK, (matching kernel)MK, and (optimal assignment kernel)OAK. In this approach, the similarity between two images is defined as the inner product of their feature similarities and the corresponding feature matching probabilities(FMP) denotes their similarity. The aim is to perform the probabilistic feature matching between two images automatically. The results outperformed the state-of-the-art methods. But there is no guarantee that the similarity matrix generated by this approach is a valid kernel. Another method is called "Fast image matching algorithm based on affine invariant" which plays an indispensable role in automatic target recognition (ATR) by utilizing the geometry feature of extended centroid to build affine invariant. The robustness is achieved against noise, but when multiple targets are contained in a complex optical image, they may be invalid.

Local stereo matching methods have focused on robust cost computation and edge-aware cost aggregation. Some researchers have been seriously paid to the disparity refinement. They showed that the simple box aggregation with a weighted median filter can be almost as good as the other sophisticated aggregation method. A method was suggested to provide a simple and practical solution for intermediate view interpolation using a simple block-matching and a guided image filtering. But since it uses a hierarchical block matching to estimate disparity map, makes it computationally ineffective. Already, Scale Invariant Feature Transform (SIFT) method has been proposed to address the challenges of image matching. SURF has been proposed to scale down the computational complexity. The descriptor based on sampling operation is robust to viewpoints because the viewpoint variations correspond to the variations of two controllable parameters in elliptical sampling. Since the circular regions in the original image are transformed to the elliptical regions in the matched image, perform circular sampling in the original image and elliptical sampling in the matched image respectively. But here key points are chosen randomly. Since it encodes more details with large values of sampling points, the distinctiveness increase, and when it is large enough, there is no improvement in performance.

In the case of hazy images the Contrast-based techniques used which aim to enhance the hazy images without estimating the depth information. Since the haze effect is not constant across the scene, various locations in the image are spoilt differently. A novel strategy to enhance images degraded by the atmospheric phenomenon of haze has been developed earlier called a single-based image technique, does not require any geometrical information. The method is built on the basic observation that haze-free images are characterized by a better contrast than hazy images.

The generalized matching algorithm can operate on any common image descriptors and unlike many of the tree structures, supports any distance function. The algorithm, which accelerates the problem of finding the nearest neighbor patches by 20–100 x over previous work. The algorithm is a randomized approximation algorithm, it does not always return the exact nearest neighbor, but returns a good approximate nearest neighbor quickly, and improves the estimate with each iteration. In contrast to all previous work, the proposed reshuffling method is fully interactive but do not always produce the expected result. The "patch match" algorithm combines approaches—deterministic update of a previous solution while allowing improvements from random guesses—to give a fast, approximate nearest neighbor algorithm for image patches that avoids getting stuck in bad solutions. It has also proven to be faster.

An efficient way has been developed to find approximate nearest neighbors for the case of patches within image data. It is one of the fast methods to guess a matching patch, given the match to the spatial neighbor. It has fixed the problems by matching patch at random positions in the database region which eventually leads to good matches. But there is still scope for improvement with this method. A fast image matching method where ORB is introduced, a fast image descriptor that is shown to have very low computational cost with satisfactory accuracy. To achieve flexible matching and avoid aggregating quantization error, match two multi-order visual phrases by

1) Firstly matching their center visual words.

2) Then check the number of their neighbor key-points showing similar visual and spatial clues.

If two of their neighbor key-points are matched, call this match a two-order match. Similarly, there are three-order and four-order matches. It shows obvious advantages over existing visual phrases in the aspects of flexibility, efficiency, and repeatability. As SIFT features are scale and affine invariant, there is an increased possibility of detecting the same features in both images of a stereo pair.

The methods which are proposed by many scholars for image matching discussed above and hence it can be said that they are somewhere facing problems in robustness or computationalism. The drawbacks can be reduced to some extent with the use of the proposed method in this paper, which is based on utilizing the hybrid approach. It can be proven to be resistant to the scale changes and the iterative approach will lead to optimal and accurate results with decreased mismatch ratio. The advantage of this method is that it helps to accurately find the points predictable for getting matched. It provides unique information which is often not available from independent analysis. The other advantage 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. The hybrid approach is used by combining several previously existing methods, which together can improve the final outcome. Thus as a result of successful procedure one would only keep those features that contribute the most to the discrimination between groups which further used for getting optimized results leading to correct matches.

3. PROPOSED METHODOLOGY

The methods discussed previously are still needed some research in order to expand the understanding and accuaracy. The method proposed here is good and can be proven to be robust. The images taken in real time or from multiple sensors at long distances suffers the problems of inadequate data extraction. Since such images are prone to be inaccurate and noisy. Their quality got degraded because of haze, contrast, illumination and scale changes. Thus an improved methodology is presented here which can help to reduce the mismatch ratio while comparing such images with the database or reference image. The workflow of the method is as shown in the following Figure 1.

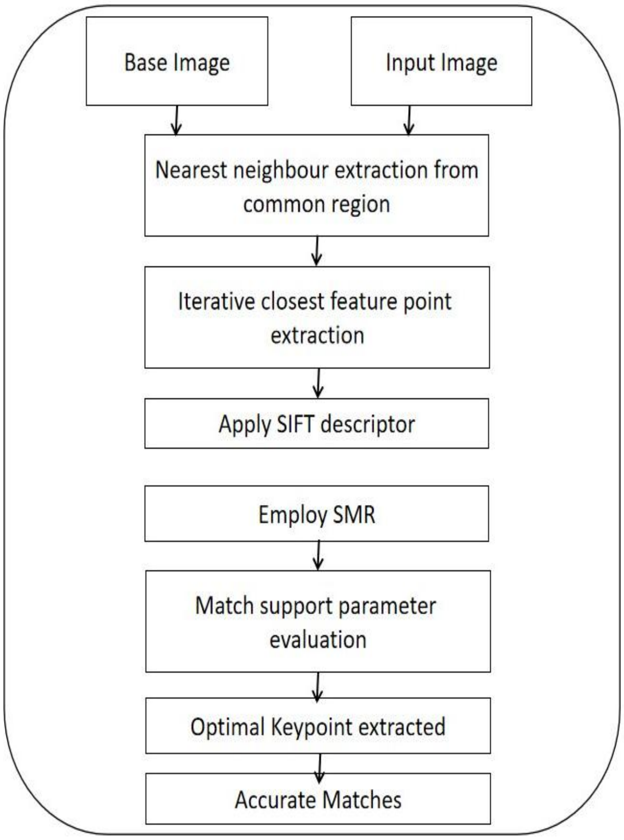

Fig -1: Flowchart

The method can be best described with following points.

3.1 Nearest neighbor extraction:

It is best approach used while the images taken from remote sensors or in real time. The image registration plays very important role. The regions can be extracted from the images which are common. The regions are divided into blocks. For each block, the ratio of the nearest neighbor and second-closest neighbor is computed based on k-means tree points. If the ratio is less than a threshold, the corresponding point pair will be selected as the reasonable point pair predictable to get matched.

3.2 Iterative feature extraction:

The iteration for closest feature is used based on some threshold value it will eliminate the redundant one and the one not satisfying the threshold value. And thus get the input for next stage.

3.3 SIFT descriptor:

Scale Invariant feature transform which is the classic algorithm for feature keypoints detection is applied. This stage will help to extract the features keeping their invariance. Thus the features affected by environmental factors will be exactly detected with the use of SIFT descriptor. Hence robustness is achieved with this method.

3.4 Employ SMR:

The stepwise multiple regression is used so as to eliminate the points which are less predictable to get matched. The forward regression is used to find the most predictable points, while the backward stepwise regression will remove the one which are less predictable. Thus as a result more optimal points are now available to be processed further.

3.5 Match support:

The match support proven to better for getting the accurately matched points among the predictable outcomes. Here the match support parameter will be calculated for each point and the one which will be having the highest value of this parameter will be included in final output. The threshold value can be set for the match support parameter. The results obtained will de definitely the exact matches among the two images that is the input image and the reference image or the base image. It can be proven to be invariant to scale changes, illumination, intensity of light. SNR i.e. the sound to noise ratio will be definitely improved. Since the noise effect is also going to be reduced with this method. The quality of exact matches obtained going to be better than the other state-of-the-art algorithms and methods.

The advantage of this method is that it helps to accurately find the points predictable for getting matched. It provides unique information which is often not available from independent analysis. The other advantage 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. An efficient method for image matching of remotely sensed images is proposed here. The hybrid approach is used by combining several previously existing methods, which together can improve the final outcome. Because the high resolution remote sensing image is sensitive to terrain relief, several techniques are combined here to face this problem. Thus as a result of successful procedure one would only keep those features that contribute the most to the discrimination between groups which further used for getting optimized results leading to correct matches.

This method detects point pairs by employing approach of fast approximate nearest neighbours projection theory. Though there are certain problems associated with the change of scales among the images, it can acquire more scale invariance .The regional match strategy is used to not only reduce the computation of feature point matching, but also make the control point pair distribution reasonable and more exact. Much improved matching results can be obtained with this method resulting into the increased matching rate. This method is also beneficial to improve the accuracy of remote sensing image registration.

Also by using a proper scale invariant feature detector along with forward and backward stepwise multiple regression method, this process can be robust to a strong blur and scale changes and also change of illumination. The method is useful because of its property of successfully finding the exact feature points from the hazy and blurred images with the use of SMR. The final results will be the optimized results. The proposed matching decision strategy is appropriate and effective as per the final decision is considered.

4. CONCLUSIONS

The image matching is one of the important task to be accomplished while learning Image processing. There are enormous methods for extracting and matching the two image features. This paper discusses some of them with their flaws and also the advantages. In order to extract the features from affected images accurately, the focus is given on method using SIFT descriptor has been proposed in this paper. The method uses SIFT descriptor along with regression step which can be an impressive method for image matching and object recognition. The method is robust, accurate and helps to find exact point pairs to be matched thereby beneficial for hazy, robust and blurred image matching process.

REFERENCES

[1] Jyoti Joglekar, Shirish S. Gedam, and B. Krishna Mohan"Image Matching Using SIFT Features and Relaxation Labeling Technique—A Constraint Initializing Method for Dense Stereo Matching"IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, vol.52, issue no.9,pp-5643-5652,September 2014.

[2] Shiliang Zhang, Qi Tian,Qingming Huang,Yong Rui "Embedding Multi-Order Spatial Clues for Scalable Visual Matching and Retrieval" IEEE JOURNAL ON EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS,vol.4,issue no.1,pp-130-141, March 2014.

[3] Connelly Barnes, Dan B Goldman, Eli Shechtman, and Adam Finkelstein "The Patch Match Randomized Matching Algorithm for Image Manipulation" Communications of ACM, vol. 54 ,no. 11,pp-103-110, November 2011.

[4] William T. Freeman" Technical perspective: A Perfect'Match'" COMMUNICATIONS OF THE ACM, vol.54,issue no.11,pp-102, November 2011.

[5] Wen Zhou, Chunheng Wang, Baihua Xiao, and Zhong Zhang (2014)"SLD: A Novel Robust Descriptor for Image Matching" IEEE SIGNAL PROCESSING LETTERS.

[6] Cosmin Ancuti, Codruta O. Ancuti (2014)"Effective Contrast-Based Dehazing for Robust Image Matching" IEEE GEOSCIENCE AND REMOTE SENSING.

[7] Ziming Zhang, Ze-Nian Li, Mark S. Drew (2010)"LEARNING IMAGE SIMILARITIES VIA PROBABILISTIC FEATURE MATCHING" IEEE.

[8] Amin Sedaghat, Mehdi Mokhtarzade, and Hamid Ebadi "Uniform Robust Scale-Invariant Feature Matching for Optical Remote Sensing Images" IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING,vol 49,no 11,pp-339-342, November 2011.

[9] Ran li (2011)"Muti-Source Remote Sensing Imageries matching based on SIFT Feature with Match-Support Measurement" IEEE.

[10] Xingxing Shen & Wenxing Bao (2013) "The Remote Sensing Image Matching Algorithm Based on the Normalized Cross-Correlation and SIFT" Springer. 2013.

[11] Xiaohui Yang, Lijun Cai (2013) "Adaptive region matching for region-based image retrieval by constructing region importance index" IET journal.

[12] Bin Li, Delie Ming, Wenwen Yan, Xiao Sun, Tian Tian, & Jinwen Tian (2014) "Image Matching Based on Two-Column Histogram Hashing and Improved RANSAC" IEEE GEOSCIENCE AND REMOTE SENSING LETTERS.

[13] Humera Siddiqua, .H.Shanthakumara & Md. Shahid (2014)"Feature based image matching for Airborne platform" Proceeding of IRF conference,pp- 14-21.

[14] ZHANG Yi, LU Kai, GAO Ying-hui (2013) "Fast image matching algorithm based on affine invariants" Springer

[15] Xiaochun Liu , Qifeng Yu, Xiaohu Zhang, Yang Shang, Xianwei Zhu & Zhihui Lei (2012) "Multi-temporal and multi-sensor image matching based on local frequency information" International Archives of ISPRS Congress, Australia, pp- 485-490.