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COMPARATIVE ANALYSIS OF MULTISENSORY SATELLITE IMAGES

Bhavin Patel[1], Mr. Mohammedsayeemuddin Shaikh [2], Prof. Sanjay D Joshi[3]

[1]Electronics and Communication, LJIET, Ahmedabad,bbpatel_23@yahoo.co.in
[2]Electronics and Communication, LJIET, Ahmedabad,sayeem.shaikh@gmail.com
[3]Electronics and Communication, Vishwakarma Government Engineering College, Chandkheda, sdjoshi_74@yahoo.co.in

Abstract — *In the area of image processing, search for the "points of interest" is a biggest issue. For the same many methods and algorithms have been proposed. It is very essential step in evaluation process. There are many existing methods for matching interest points and most of them are related to the parameters of the detectors. In this paper, we have present a feature point detection and feature matching with a local description and spatial constraints. For finding detection of feature points from image using combination of Harris, SURF and SIFT algorithms.*

Keywords- *Image registration; Feature detection; Feature matching; Image transformation component; Harris; SIFT; SURF; Landsat-7*

I. INTRODUCTION

Vision is the most advanced of our sensors, so it is not surprising that images play the single most important role in human perception [1]. In parallel with space application, digital image processing techniques began in late 1960s and early 1970s to be used in medical imaging, remote earth observations and astronomy [1]. It is very important part of computer vision and digital image processing the feature detection, feature extraction and matching technology, and has been widely use in the object detection, 3D reconstruction and image registration. The detail information of individual image senses in temporal and spatial domain can be combined to produce unsegment panorama using images of smaller field of view.

The purpose of image registration is to merge images taken of the same scene at varying times from varying but related view points by different sensors [2]. Image registration is classified in to two categories: Intensity based method and Feature based method. In Intensity based method finding a geometric transformation between two images, optimizing a similarity measure between two images. The feature based method basically estimation the geometric transformation between images by establishing reliable feature matches.

Feature point extraction and characterization are related to repeatability creation that evaluates the noise of feature point detectors, stability and robustness under the image transformations. If matches are not properly found, a misleading transformation function is produced and most probably yield a completely wrong result. The problem of image matching consists of identification for two or more images at same scene.

The work presented in this paper focus on feature matching based on points of feature based on two images of the same scene with different resolutions. The main goal of this work is to detect a feature points and compare many feature point detectors like Harris, SIFT, SURF in terms of repeatability. We accomplished a practical comparison of feature detectors. A numbers of experiments were performed to evaluate feature point detectors.

II. INTEREST POINT DETECTION

A. Harris Detector

The Harris corner detector is an improvement of the classical Moravec operator, was proposed by Harris [3]. The advantage of this method deals with auto-correlation function and is able to increase the accuracy of localization.

A statistical comparison of the similarity of the image window in relation to the original image is slightly shifted from the concept of auto-correlation. The correlation matrix that describes the structure of each pixel in the neighborhood. Comparison of changes in equity for every window in the neighborhood to take a significant issue, it indicates that the feature exists in the window. The Harris corner point detector response function determines the auto-correlation matrix R from the point of weight.

$$R = \det(A) - k * \text{trace}(A)^2 \quad (1)$$

Different points of the edge, to establish the value of the parameter k is chosen between *0.0*1 and *0.6*. This gives positive values to negative values and points in the case of straight edges. Finally, the position of an interest po ints is determined by local non-maxima suppression.

B. SIFT

Scale Invariant Feature Transform, SIFT is a feature detector/descriptor which are invariant to image rotation and scaling and partially invariant to change in illumination and 3D camera viewpoint. It is very popular for image feature detection in images with high resolution. SIFT consist a four stages: scale space extrema detection, key point localization, orientation assignment and key point descriptor. The first stage identify the potential interest points using difference of Gaussian (DOG) function which is invariant to orientation and scale.

$$L(x, y, \delta) = G(x, y, \delta) * I(x, y) \tag{2}$$

The second stage accurately locating the feature key points and reject low contrast points. The third stage assigning orientation to the key points around the stable key points. Orientation is assigned to each key point based on local image gradient directions. Now the last stage describing the key point as a high dimensional vector. To select a stable key point, the local extrema value of D (x, y, δ) must be higher than a threshold. The threshold value of 0.6 is proposed by Lowe [4].

C. SURF

A Speed-Up Robust Features based algorithm developed by Herbert Bay in 2006[5]. It is a preferment scale and rotation-invariant interest point detector and descriptor. It is famous for its computing speed, better result, repeatability, distinctiveness and robustness. This algorithm is also based on scale space theory. It creates a "stack" without down sampling for higher order to restore the same resolution. The improvement of the performance of the integral images. It can be calculate through regional fast summation to speed up the image convolution. The Hessian matrix of an image at any point X=(x, y) T is

$$H(x,\sigma)=\begin{bmatrix} Lxx\ (X, \sigma) & Lxy\ (X, \sigma) \\ Lyx\ (X, \sigma) & Lyy\ (X, \sigma) \end{bmatrix} \tag{3}$$

Where, $L_{xx}(X,\sigma)$ represents the convolution of middle point X with the Gaussian filter $\partial^2\left(\frac{\partial g(\sigma)}{\partial x^2}\right)$

To enhance the computing speed, Bay purposes the following formula Box Filter Figure. The determinant of Hessian matrix ΔH can be reduced to

$$\Delta H = Dxx\ Dyy - (wDxy)^2 \tag{4}$$

The feature points are select by comparing with the neighboring values through non-maximum suppression each points in the scale space will be compared with horizontal direction dx and vertical direction dy to get local extreme points.

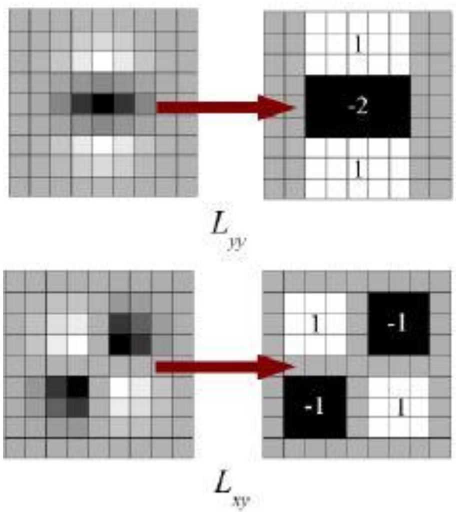

Figure 1: SURF approximates Lyy and Lxy using box filters

We also extract the sum of the absolute values of the responses, |dx| and |dy|. Hence, each sub-region has a four-dimensional descriptor vector v for its underlying intensity structure

$$v = (\sum dx, \sum dy, \sum |dx|, \sum |dy|) \tag{5}$$

So as to form a 4*(4 × 4) = 64 dimensional descriptor vector.

III. EXPERIMENTAL SETUP

The objective of the present experiments to describe the image for a selection of images from the best interest point detector match with points of interest is to evaluate the effectiveness of our proposed approach. Detectors evaluate our experiments. We choose to test geometric transform and scale. We have only three methods of evaluation time, which shows the trend of time and expense is the result of a relative, such as size and image quality of the factors that influenced the results, image types (spatial resolution or texture), and the parameters of the algorithm.

Experiment environment: Operating system: Windows 8 Pro, processor: Intel(R) Core(TM) i3-2330U CPU @ 2.20 GHz and 4.00 GB RAM. Development environment for the MATLAB software.

In this experiment, image of the capture by Landsat 7, different time, and same resolution and image of the size is 2329*2353pixels and input image-1 is capture by landsat-7 at 4 January 2013 and input image-2 is capture by landsat-7 at 3 February 2012. The size of images are 6.10 MB and 6.23 MB. The satellite images which it produces can be searched interactively and downloaded free for use in academic studies from the United States Geological Survey (USGS) website (http://glovis.usgs.gov/).

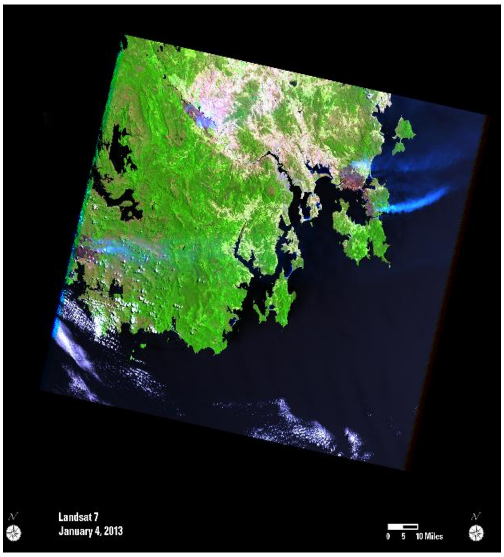

Figure 2: Input Image-1

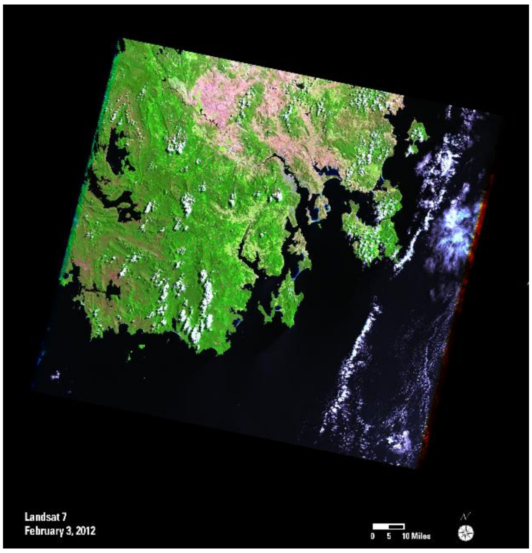

Figure 3: Input Image-2

Time is counting for the complete processing which include feature detecting, feature extracting and matching.

TABLE 1: The overall performance of Data Comparison

Algorithm	Extract number of input image-1	Extract number of input image-2	Match number	Time (s)
SIFT	26373	32218	3067	289.9060
SURF	7850	9930	632	8.9247
Harris	8524	12023	89	13.5829

Table 1shows that SURF is faster than Harris and SIFT, SIFT is slowest but it finds more matches. The successfully matching feature points using SIFT, SURF and Harris.

IV. EXPERIMENTAL RESULT

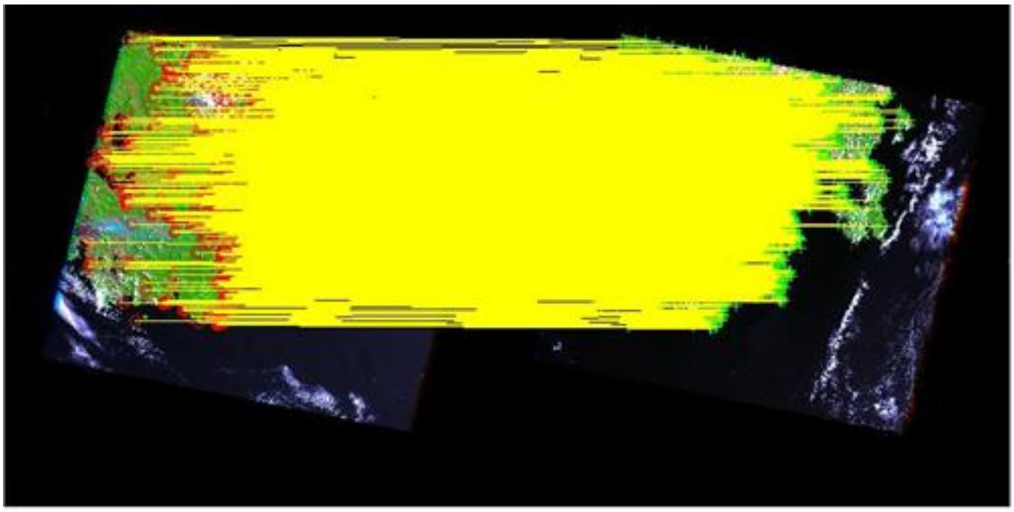

Figure 4: Feature extraction and Feature matching with SIFT

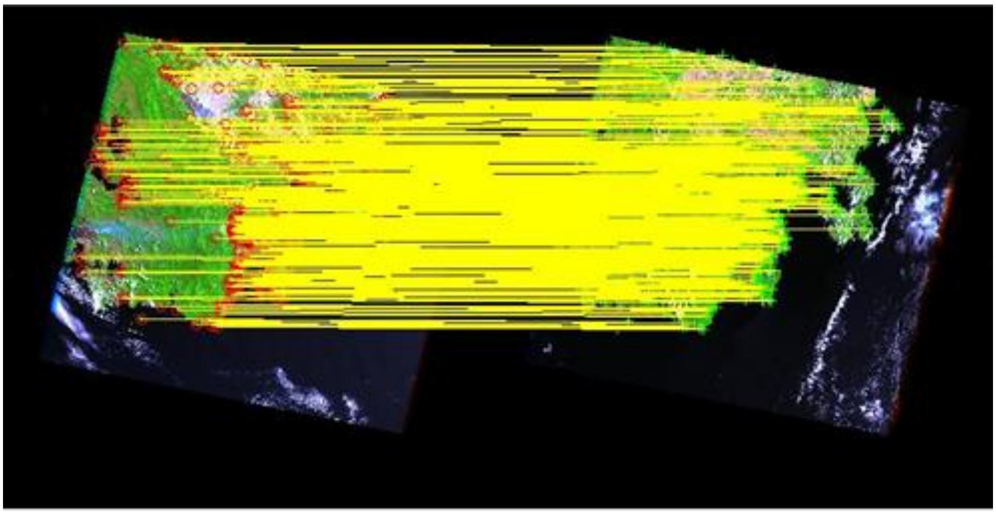

Figure 5: Feature extraction and Feature matching with SURF

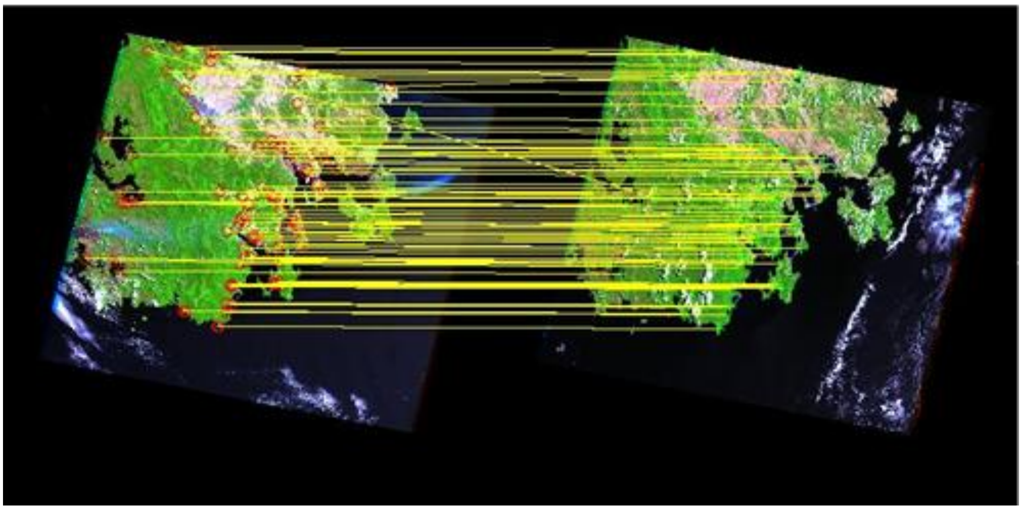

Figure 6: Feature extraction and Feature matching with Harris


Figure 7: SIFT response


Figure 8: SURF response

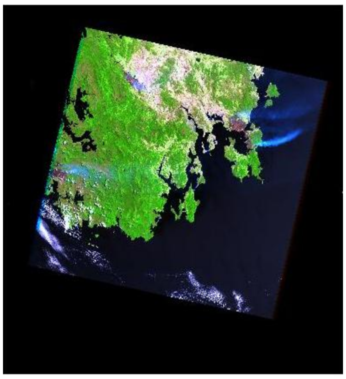
Figure 9: Harris response

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V. CONCLUSION

After experiment we can conclude that SIFT is detecting more number of feature points but at the same time the amount of time taken by algorithm is also large. In SURF algorithm, it took less time but it considered less feature points. SURF is more efficient compare to SIFT. We can also increase the efficiency by changing the scale of rotation. We can also take a note that Harris algorithm is detecting less no of points compare to SURF and SIFT.

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