A Study on Feature Extraction Techniques for Image Mosaicing System

Tejas S Patel[1], Asst. Prof. Rajivkumar Gurjwar[2]
[1,2]Department of computer science & engineering Parul institute of Technology,Vadodara

ABSTRACT

In Image processing, mosaicing image is the combine two or more images of the same scene into one image. Image stitching "mosaicing" is the process of assembling images of the same scene into a large image. Image mosaicing/stitching is considered as an active research various applications such as photogrammetry, computer vision, remote sensing image processing, medical image analysis ,computer graphics etc. In this paper discuss a review of different feature extraction algorithms and compare the different extraction algorithms such as Harris corner detector, SIFT SURF, FAST, MSER, ORB detector etc.

KEYWORDS: Image stitching, panoramic image, feature base detection, image blending, ORB

1. INTRODUCTION

Image mosacing is the stitching of multiple correlated images to generate single large wide-angle image with the same view. Image mosaicing is used in many applications like video conferencing; from multiple node create 3D view, astronomy, telemedicine, cartoons, virtual museums, architectural Walkthroughs [5]. Image panorama feature is almost of the digital camera. The main challenge of image stitching is the use of handled camera that may be lead to presence of parallax.

Image registration essentially consists of the following steps [2]:
1) Feature detection: It detects the salient and distinctive objects in both reference and sensed images, such as closed-boundary regions, edges, contours, line intersections, and comers.
2) Feature matching: The correspondence between the features in the reference and sensed images is established.
3) Transform model estimation: The type and parameters of the so-called mapping functions and aligning the sensed image with the reference image are estimated.
4) Image resampling and transformation: The sensed images are transformed by means of the mapping functions.

2. FEATURE EXTRACTION ALGHORITHMS

We will discuss the Harris corner detector, Harris corner detector, GoodFeaturesToTrack detector, MSER detector. In addition, we will introduce SIFT, SURF, FAST, and ORB techniques.

A. Harris corner Detector

Harris corner detection is a point feature extracting algorithm based on Moravec algorithm based by C. Harris and M.J Stephens in 1988 [6].
Harris corner detector detects the corner point. The point where the average intensity hardily high changes as compared to the previous one direction is called as 'Corner'.
The basic mathematical formula is as follows [2]:

$$S(x, y) = \sum_u \sum_v w(u, v)\,(I(u + x, v + y) - I(u, v))^2$$

$$A = \sum_u \sum_v w(u, v) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

$$= \begin{bmatrix} \langle I_x^2 \rangle & \langle I_x I_y \rangle \\ \langle I_x I_y \rangle & \langle I_y^2 \rangle \end{bmatrix}$$

Where A is structure tensor

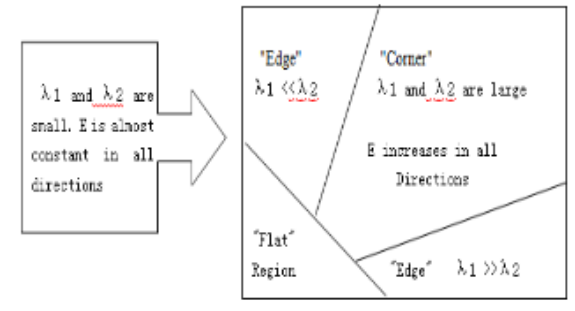

Fig 1 Harris Corner Detector [13]

Here find out the Eigen values for an interest point [2].
1. If $\lambda_1 \sim 0$ and $\lambda \sim 0$ then this pixel (x, *y*) has no feature interest.
2. If $\lambda_1 \sim 0$ and λ_2 has some large positive value, then an edge is detected.
3. If λ_1 and λ_2 have large positive values, then corner is found.

B. SIFT Detector

Scale Invariant Feature Transform termed as SIFT is used to identify locations and scales that can be repeatedly assigned under different views of the same object [2].
SIFT has four computational phases which includes: Scale-space construction, Scale-space extrema detection, key-point localization, orientation assignment and defining key-point descriptors [6].
The first stage used difference-of-Gaussian (DOG) function to identify potential interest points, which were invariant to scale and orientation. DOG was used instead of Gaussian to improve the computation speed [7].

$$D(x, y, \sigma) = \big(G(x, y, k\sigma) \quad G(x, y, \sigma)\big) * I(x, y)$$

$$= L(x, y, k\sigma) \quad L(x, y, \sigma)$$

Where * is the convolution operator, G(x, y) is a variable scale Gaussian, I(x, y) is the input image D(x, y) is Difference of Gaussians with scale k times.
A 2X2 Hessian matrix computed at the location and scale of the key point is [2]:

$$H = \begin{bmatrix} D_{xx} & D_{xy} \\ D_{xy} & D_{yy} \end{bmatrix}$$

And then rejecting the key points for which,

$$\frac{Tr(H)^2}{Det(H)} > 10$$

C. SURF

SURF uses three feature detection steps namely; detection, description, and matching. SURF speeded-up the SIFT's detection process by keeping in view of the quality of the detected points [1].
SURF selects the angle by calculating the angle and size of every pixel after Gaussian Blur in the local image, and then vote to elect the most angles in all pixels as the main direction.
SURF (Speed up Robust Features) algorithm, is base on multi-scale space theory and the feature detector is based on Hessian matrix. Since Hessian matrix has good performance and accuracy. In image I, x = (x, y) is the given point, the Hessian matrix H(x, σ) in x at scale σ, it can be define as [12]

$$\mathbf{H(x,\sigma)} = \begin{bmatrix} L_{xx}(x,\sigma) & L_{xy}(x,\sigma) \\ L_{yx}(x,\sigma) & L_{yy}(x,\sigma) \end{bmatrix}$$

Where L_{xx} (x, σ) is the convolution result of the second order derivative of Gaussian filter $\partial^2 / \partial x^2$ (σ) with the image I in point x, and similarly for L_{xy}(x, σ) and L_{yy} (x, σ).

D.FAST

FAST Corner Detector FAST (Features from Accelerated Segment Test) algorithm based on the SUSAN corner criterion presented by Trajkovic and Hedley. FAST is a high-speed feature detector with strong repeatability properties suited to real-time frame-rate applications. A further attribute of the FAST operator is its invariance to rotation and changes in scale. This represents better performance than many preceding algorithms, including the SIFT operator [1].

E.MSER

MSER Detector MSER (Maximally Stable Extremal Regions) detector was proposed by Matas et al. [13] to find correspondences between image elements from two images with different viewpoints. MSER is a connected component of an appropriately thresholded image. The word 'extremal' refers to the property that all pixels inside the MSER have either higher (bright extremal regions) or lower (dark extremal regions) intensity than all the pixels on its outer boundary. The 'maximally stable' in MSER describes the property optimized in the threshold selection process [1].

3. HOMOGRAHY USING RANSAC

RANSAC algorithm use image mosaicing it is remove the mismatch point in the inliers and outliers. Inliers i.e., data whose distribution can be explained by some set of model parameters, and "outliers" which are data that do not fit the model. This algorithm has been applied in estimating the fundamental matrix to match two images with wide or short baseline and estimating a homography. A set of inliers can be determined from an input data set of points. It proceeds as follows [9]:
I. Sample N times from the data set randomly. N is the number of trials required to achieve a confidence level p, which is chosen around 0.9 ~ 0.99
2. Select 4 pairs of sample points and make sure that no three of them are on the same line. Compute H through the sample points.
3. Compute the distance between the matched inliers after the H transformation.
4. Compare the distance with the threshold. If it is less than the threshold, keep the points as inliers. Compute the H from the sub-data-set which contains the most inliers.

4. RECENT WORK

Image Mosacing is the feature base techniques is use in the different active research are in computer vision. This section survey of the previous feature extraction techniques. A literature review had been carried out for the feature based methods that are used in the process of image mosaicing.

Rupali Chandratre, Vrishali Chakkarwar [4] presented image mosaicing algorithm where they have used Harris corner detector use to detect the corner point that is feature points. RANSAC algorithm use to choose the closest match between the two image by separating inliers and outliers. And then apply the homography estimation taking the inliers and 3*3 matrix use and then finally warped the two images into one to another image. Combining the Harris and RANSAC together, the 2D image stitching becomes the powerful and robust tool to make the Image Panorama [4].

Hemlata Joshi, Mr.KhomLal Sinha [8] presented the image mosacing algorithm Hrris and SIFT and compare the Harris and sift algorithms. Harris algorithm detects more features and is only rotationally invariant. SIFT is the both rotationally and scale invariant. The performance evaluation of proposed technique is done in terms of PSNR (peak signal-to-noise ratio), MI (Mutual Information), NAE (Normalized Absolute Error), FSIM (Feature similarity index measure), SSIM (Structural similarity index measure), and EME (Enhancement performance measure). The comparative study shows superior results for SIFT as compared to Harris and algorithm [8].

Mahesh, Subramanyam M. Y [9] is the performance of various feature point detectors in extracting feature points. Image mosacing algorithm using steerable Harris corner detector and the RANSAC algorithm apply to remove the mismatch outlier and find out the best line and Harris and compare the Harris and SUSAN corner detector. SUSAN detector a circular mask is applied around every pixel. Random Sampling Consensus (RANSAC) is an algorithm to fit a model to the data set while classifying the data as inliers and outliers. This algorithm has been applied in estimating the fundamental matrix to match two images with wide or short baseline and estimating a homography [9].

Jiaxi Wang and Junzo Watada [3] presented by the image mosacing using SURF algorithm is use in feature detection. The camera is moving, transformation becomes necessary in stitching and to get the transformation matrix of two images, corner points are detected first, and then do the comparing so that some pairs of corresponding points can be found and finally we use their coordinates to get the transformation matrix [3].

Detector	Detected Features		Times	
	Image 1	Image 2	Image 1	Image 2
Harris Corner	374	452	0.04	0.06
SIFT	1279	1538	1.48	1.79
SURF	573	628	0.58	0.67
Good feature to track	225	209	0.3	0.34
FAST	412	568	0.04	0.05
MSER	122	126	0.27	0.3
ORB	94	94	0.14	0.14

Table 1. performance analysis of fetaure detector[1]

CONCLUSION

It is very much believed that on completion of this work we would be able to make a system that will create image mosaics that would be comparatively more fast and accurate and would incorporate more images then existing. Sometimes it is very much required that the process of mosaic should be very fast and accurate where majority of

the existing algorithm fails. Speed, Accuracy, good blending strategy so as when more images are applied it gives us quality results.

REFERENCES

[1] EbtsamAdel, Mohammed Elmogy, Hazem Elbakry, "Real Time Image Mosaicing System Based on Feature Extraction Techniques", IEEE 2014
[2] Ms. Ashwini P, Mrs. Jayalaxami H, "Image mosaicing using SIFT and Corner detection alghorithm", IJATER Volume 4, Issue 2, March 2014
[3] Jiaxi Wang and Junzo Watada, "Panoramic Image mosaic based on SURF Algorithm using OpenCV" IEEE 2015
[4] Rupali Chandratre, Vrishali Chakkarwar, "Image Stitching using Harris Feature Detection and Random Sampling", *nternational Journal of Computer Applications (0975 – 8887) Volume 89 – No 15, March 2014*
[5] Mrs. Hetal M. Patel, Asst. Prof. Pinal. J. Patel, Asst. Prof. Mr. Sandip G. Patel, "Comprehensive Study and Review of Image Mosaicing Methods", International Journal of Engineering Research & Technology ISSN: 2278-0181 Vol. 1 Issue 9, November- 2012
[6] Hemlata Josh, Mr.KhomLal Sinha, "A Survey on Image Mosaicing Techniques", International Journal of Advanced Research in Computer Engineering & Technology Volume 2, Issue 2, February 2013

[7] Dilipsinh Bheda, Asst. Prof. Mahasweta Joshi, Asst. Prof. Vikram Agrawal, "A Study on Features Extraction Techniques for Image Mosaicing", International Journal of Innovative Research in Computer and Communication Engineering Vol. 2, Issue 3, March 2014
[8] Hemlata Joshi, Mr.KhomLal Sinh, "Image Mosaicing using Harris, SIFT Feature Detection Algorithm", International Journal of Science, Engineering and Technology Research Volume 2, Issue 11, November 2013
[9] Mahesh, Subramanyam M. Y., "Automatic Image Mosaic System Using Steerable Harris Comer Detector", IEEE 2012
[10] Dong Hui, Han Dian Yuan, "Research of Image Matching Algorithm Based on SURF Features", International Conference on Computer Science and Information Processing IEEE 2012
[11] Jai Prakash, Akanksha Gohil, "Image Processing: A Review", International Journal of Emerging Technology and Advanced Engineering Volume 4, Issue 6, June 2014
[12] P M Panchal, S R Panchal, S K Shah, "A Comparison of SIFT and SURF", International Journal of Innovative Research in Computer and Communication Engineering *Vol. 1, Issue 2, April 2013*
[13] Lei Yang, Jun Zhai, Xiaoyu Wu, Hui Li, "A Research of Feature-based Image Mosaic Algorithm", International Congress on Image and Signal Processing Volume 4, IEEE 2011