

Wide Angle Image Generation based on SIFT and ANMS

Gunjan Singh¹, Akhila Nair¹, Rashika Jadwani¹, Vinni Ahuja¹, Mrs. Monali Chaudhari²

U.G. Student, Department of Electronics and Telecommunication, V.E.S.I.T, Mumbai University, Maharashtra, India¹

Assistant Professor, Department of Electronics and Telecommunication, V.E.S.I.T, Mumbai, Maharashtra, India²

ABSTRACT: Mosaicing is the process of collecting successive images that belong to the same scene and joining them to form a seamless panoramic image. It involves the processes of acquisition of the images, detecting feature points in them, matching the detected feature points and blending of the stitched images. This paper illustrates the techniques for feature detection and matching of feature points using Adaptive Non-Maximal Suppression (ANMS) and Scale Invariant Feature Transform (SIFT), image warping using homography matrix and the process of image blending.

KEYWORDS: Mosaicing, SIFT, ANMS, Harris Corner Detection, homography, warping, linear blending.

I. INTRODUCTION

It is not always possible to capture images with a large field of view using a camera. In such cases, a number of images that are small parts of the entire scene are captured and these images are later stitched to form the complete panoramic image. The process of converting these images into a panoramic image is called image mosaicing. The problem with most image mosaicing applications is that the boundary between the stitched images is not completely hidden. In order to make the seams invisible, it is necessary to apply proper geometric transformations to the images being mosaiced and follow it with the process of image blending.

The basic step in image mosaicing is the acquisition of the images captured using a camera and converting them into a format that is compatible for the process of mosaicing. Once the images are in the required format, it is necessary to detect the feature points in them. Feature points are distinct points in each image like corners or edges, also known as keypoints. There are various ways of detecting these points and we have used the SIFT and ANMS algorithms for the same. SIFT detects corner points that are scale, rotation and illumination invariant whereas ANMS uses Harris corner detection to detect the corner points and chooses the most dominant keypoints from those using a suppression radius so that the chosen points are distributed over the entire image. The process of feature detection is followed by feature matching wherein cosine angle distance is taken to match the keypoints detected using SIFT and sum of squared differences, or Euclidean distance is used to match the keypoints detected using ANMS.

Image warping is done on the matched images once the unwanted keypoints are removed using RANSAC algorithm, using a homography matrix that applies geometric transformations on the images so that they can be properly aligned. The final mosaiced output is obtained after the warped images are blended using an alpha blending algorithm.

II. RELATED WORK

Recognising a panorama using image mosaicing simply refers to the process of creating an image with a large field of view from a number of images which are snippets of the panorama to be formed. An important part of this process is the detection of features like corners and edges in the images to be mosaiced and matching those detected features. Various algorithms have been developed for this process. They include Scale Invariant Feature Transform (SIFT) [1],

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

Harris corner detection [2], Features from Accelerated Segment Test (FAST) [3], Binary Robust Invariant Scalable Keypoints (BRISK) [4] and other algorithms being developed to meet the accuracy standards required in image processing today. Kher and Thakar [1] introduced the SIFT algorithm to detect and describe image features such as contours, points, corners such that it works well in all types of cases having scale and rotation differences, and also registers the object having occlusion and clutter background. Brown, Szeliski and Winder [5] introduced the Adaptive Non Maximal Suppression (ANMS) which defines a rotationally invariant frame in which a feature descriptor is sampled. ANMS uses Harris Corner Detection Method for identifying the feature points and selects the required number of most dominant feature points using a suppression radius, thereby ensuring spatially distributed strong points. Random Sample Consensus (RANSAC) [6] algorithm is used to remove unwanted feature points and refine the produced results. The results of feature detection and feature matching using both SIFT and ANMS are compared. Homography matrix [7] is used to apply geometric transformations to the output of feature matching obtained in both methods. It is followed by the process of image blending [8] which is used to remove the visible seams in the panorama formed and give a seamless smooth transitioning image as the output.

III. FEATURE DETECTION

IV.

Feature detection is an essential and fundamental step in image mosaicing through which only the useful key points are used for further processing. Features, also called as feature key points, are those points where there is a sharp change in pixel intensity. Edges and corners can be considered as feature key points as they show variation in pixel intensity in an image. The two main algorithms used in image mosaicing in this paper are Adaptive Non-Maximal Suppression and SIFT.

A. Using ANMS

The basic corner detection algorithm which is used in image mosaicing is Harris corner detection. In Harris Corner Detector, windows are determined which produce large variations when moved in any direction. With each window, a value is associated. Based on this value, it can be decided whether it is a corner or not. However, the Harris corner detection algorithm provides uneven distribution of the detected features that would affect the accuracy of post matching causing mismatch of the features detected. Hence, ANMS is carried out after the Harris corner detection which ensures a sufficient amount of corners are detected and makes them recognizable and distributed evenly. In ANMS, a corner threshold is set to find the desired key points. For every pixel, say p , which was made as a feature key point in Harris corner detection and has a value greater than the corner threshold, it checks the value of other detected points in a pre-defined radius. If the value of p is the highest within the radius, then that pixel is considered as a corner.

B. Using SIFT

When the images to be mosaiced have similar scale and orientation, then simple corner detection algorithms such as Harris corner detector can be applied. These simple corner detection algorithms fail to detect the feature key points if the images have different scale and orientation. The SIFT detects feature key points irrespective of rotation and scale.

The SIFT algorithm is implemented in different steps. The steps can be described as follows-

1. The first step involves constructing a scale space. This is the initial preparation for feature detection. An internal representation of the original image is created to ensure scale invariance. This is done by generating a scale space. The scale space is generated by creating octaves, each octave having different scales of blur. The image is convolved with the Gaussian blur operator to get the blurred image which can be represented by the equation-

$$Lx, y, \sigma = Gx, y, \sigma * I(x, y)$$

$$Gx, y, \sigma = \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/2\sigma^2}$$

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

where G is the Gaussian blur operator, L is the blurred image, I is the original image and σ represents the scale of blur.

2. LoG approximation is the second step in SIFT. LoG is used to find out the edges and corners in an image. But the second order derivative is extremely sensitive to noise. Therefore instead of LoG, Difference of Gaussians (DoG) which is less sensitive to noise, is calculated which gives the same result as LoG.

3. The third step is to find the key points from the DoG generated in previous step. Different maxima and minima points are located using the DoG images. These points are considered as the key points. In SIFT each key point is assigned its orientation and magnitude making it as a feature vector. These feature vectors can be used irrespective of the change in scale hence making it scale invariant.

V. FEATURE MATCHING

All the features that have been detected should be matched so as to confirm that features are from the corresponding locations from completely different images. Two different methods have been used for feature matching.

After determining the feature key points using ANMS, feature key points are matched in the images which are to be mosaiced. Feature matching is done by calculating the sum of squared differences (SSD) between all pairs of 8x8 key points in one image to key points in second image. The SSD is equivalent to the Euclidean distance.

The Euclidean distance between any two points p and q is given by

$$d_{p,q} = \sqrt{(p_1 - q_1)^2} + \sqrt{(p_2 - q_2)^2}$$

For each corner in the first image, the 2 nearest neighbours are found, using SSD as the distance, in the second image. If the ratio of SSD of first point to SSD of second point is less than the pre-defined threshold, then the nearest neighbour is considered as a good match.

The SIFT algorithm can be used to represent the feature key points as feature vectors. These feature vectors are converted into unit vectors which are used for further calculation. One of the methods used to match features is using Euclidean distance but it is simpler to deal with the vectors for calculation. For this purpose, the dot product between two unit vectors from both the images is calculated. Cosine inverse of the value of dot product gives us the angle between the vectors which can be represented by equation-

$$\theta = \cos^{-1}\left(\frac{x \cdot y}{\|x\| \|y\|}\right)$$

The value of angle obtained is a close approximation to the ratio of Euclidean distances for small angles. A threshold value is set which is used for finding the matched key points. If the ratio of vector angles from the first nearest to second nearest neighbour is less than threshold, then it is considered as a matched key point.

VI. IMAGE WARPING

A. Applying RANSAC to the matched keypoints

Some of the matched key points may be of false correspondence i.e. the key points do not correspond to the same scene. Therefore it is necessary to provide robustness to avoid such errors. The inliers and outliers need to be separated so that only inliers can only be chosen as input points for further processing. The RANSAC algorithm looks for this issue. Random Sample Consensus (RANSAC) is the repetitive process for calculating the mathematical model with the help of observed set of data, containing outliers as well as inliers. This algorithm provides results with certain probability. This probability increases with increase in repetitions. The goal of RANSAC is achieved by iterative

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

selection of random subset of data points from original data, those are supposed to be inliers. Therefore, all the unwanted detected and matched feature or key points are removed with the help of RANSAC algorithm.

B. Image warping using homography matrix

After removing the false or unwanted matched points by the use of RANSAC algorithm, there is a need for estimation of transformation model between images. For the purpose of blending images, image is distorted by changing position of the points of the image. Position of the image points is changed by distorting and mapping the images from one frame to another frame while keeping the pixel value unchanged, so that they can be blended. This estimation of transformation model is done using homography. Homography is transformation from one projective plane to another. Homography matrix is calculated from the points obtained from the RANSAC algorithm. It can be shown by the equation-

$$X' = HX$$

Where X represents the points of reference image and X' represents the points of target image. Thus an image is transformed into a different plane by the matrix H .

VII. IMAGE BLENDING

The final process in image mosaicing is image blending. The effect of capturing images at different time intervals, different exposures of light or different angles creates intensity seams at the overlapping region. Image blending is used for avoiding these seams and smoothening the boundaries by modifying the grey levels at the joints. Different types of image blending are alpha blending, feathering, graph cut blending, pyramid blending and linear blending. We have used the process of alpha blending. It is the process where the foreground and background of an image are mixed or blended. The degree of translucency ranges from completely transparent to completely opaque. It is a transition smoothing algorithm, which removes the seams by slowly degrading the value of image boundaries in increasing and decreasing order according to following equation,

$$I = I1 * \alpha + I2 * (1 - \alpha)$$

The value of 'alpha' depends on the window size and varies from 0 to 1.

VIII. RESULTS

Case 1: Two images have been taken by a camera which are used for our input as shown in figures 1 and 2.



FIGURE 1: INPUT IMAGE 1



FIGURE 2: INPUT IMAGE 2

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

For feature detection, two algorithms SIFT and ANMS are implemented on the images. The ANMS features detected are shown in Figure 3 and Figure 4. Figure 3 shows the feature detection output of Figure 1 whereas Figure 4 shows the feature detected output of Figure 2.



FIGURE 3: FEATURE DETECTION OF IMAGE 1

USING ANMS



FIGURE 4: FEATURE DETECTION OF IMAGE 2

USING ANMS

The features detected using SIFT algorithm are shown in Figure 5 and Figure 6. Figure 5 shows the feature detection output of Figure 1 whereas Figure 6 shows the feature detected output of Figure 2.

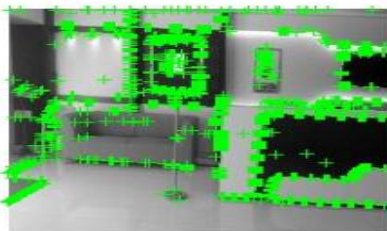


FIGURE 5: FEATURE DETECTION OF IMAGE 1

USING SIFT

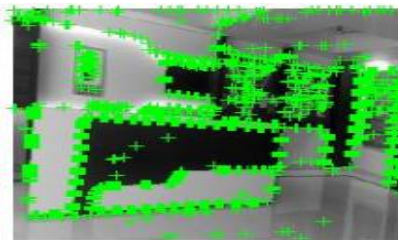


FIGURE 6: FEATURE DETECTION OF IMAGE

USING SIFT

After detecting the features, the feature matching is done by using ANMS and SIFT feature points. The output of feature matching using ANMS is shown in Figure 7.



FIGURE 7: FEATURE MATCHING FROM ANMS FEATURE DETECTION

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

The output of feature matching using SIFT is shown in Figure 8.

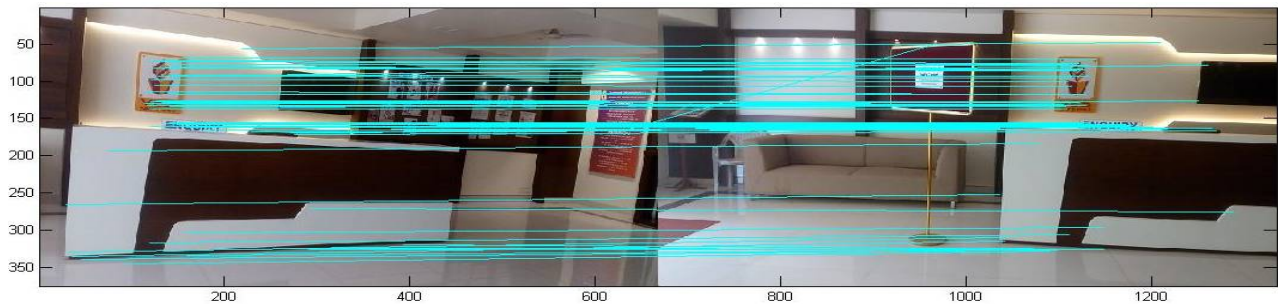


FIGURE 8: FEATURE MATCHING FROM SIFT FEATURE DETECTION

The matched feature points are then used for image warping and blending which gives us the final mosaiced output. The final image is shown in Figure 9.

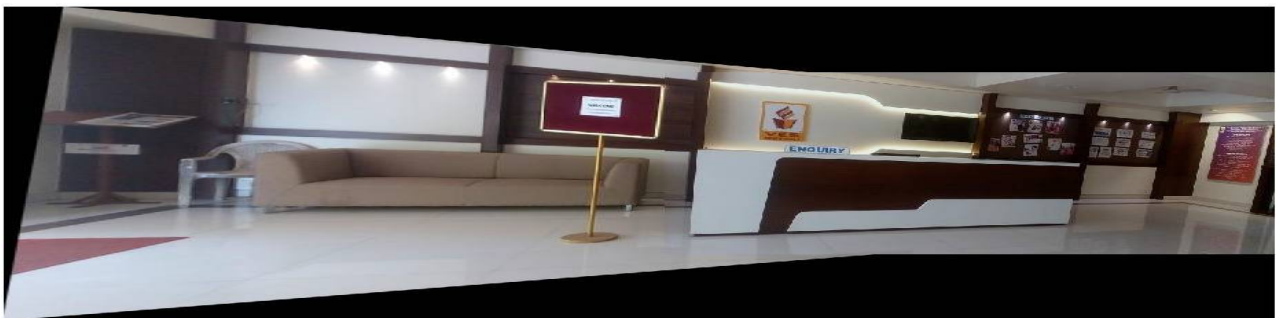


FIGURE 9: FINAL MOSAICED IMAGE

Case 2: Two images have been taken by the camera, which are used for our input as shown in figures 10 and 11.



FIGURE 10: INPUT IMAGE 1



FIGURE 11: INPUT IMAGE 2

For feature detection, two algorithms SIFT and ANMS are implemented on the images. The ANMS features detected are shown in Figure 12 and Figure 13. Figure 12 shows the feature detection output of Figure 10 whereas Figure 13 shows the feature detected output of Figure 11.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017



FIGURE 12: FEATURE DETECTION OF IMAGE 1

USING ANMS



FIGURE 13: FEATURE DETECTION OF IMAGE 2

USING ANMS

The features detected using SIFT algorithm are shown in Figure 14 and Figure 15. Figure 14 shows the feature detection output of Figure 10 whereas Figure 15 shows the feature detected output of Figure 11.

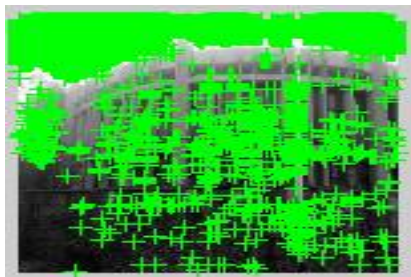


FIGURE 14: FEATURE DETECTION OF IMAGE 1

USING SIFT

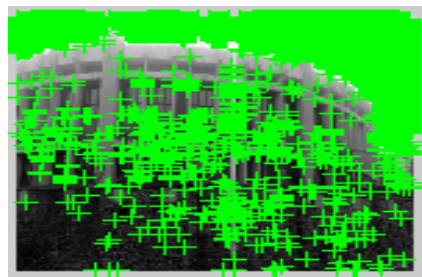


FIGURE 15: FEATURE DETECTION OF IMAGE

USING SIFT

After detecting the features, the feature matching is done by using ANMS and SIFT feature points. . The output of feature matching using ANMS is shown in Figure 16.



FIGURE 16: FEATURE MATCHING FROM ANMS FEATURE DETECTION

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

The output of feature matching using SIFT is shown in Figure 17.

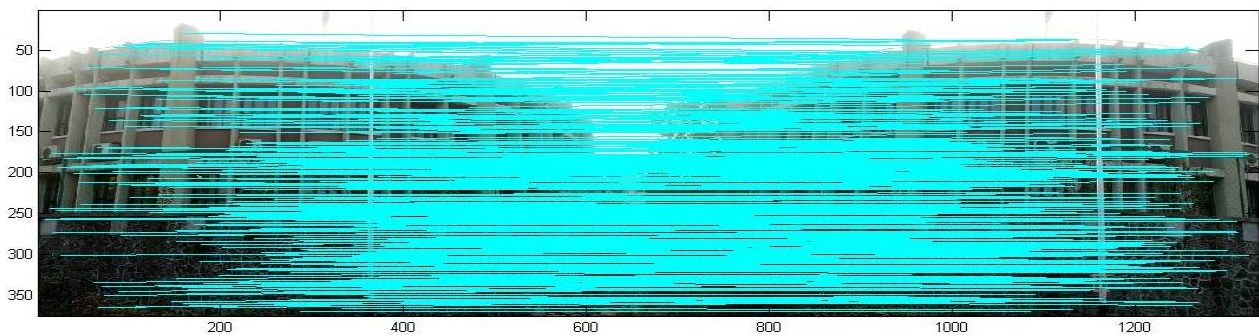


FIGURE 17: FEATURE MATCHING FROM SIFT FEATURE DETECTION

The matched feature points are then used for image warping and blending which gives us the final mosaiced output. The final image is shown in Figure 18.



FIGURE 18: FINAL MOSAICED IMAGE

IX. CONCLUSION

Image mosaicing is helpful in various fields of image processing. Image mosaicing has a wide range of applications in fields such as satellite imaging, medical applications and motion or change detection. After performing the two algorithms SIFT and ANMS for feature detection, it is seen that the run time of SIFT is 4.82 seconds and for ANMS, the run time is 3.55 seconds, showing that the run time of SIFT is higher than that of ANMS. However, the accuracy of SIFT is better than ANMS as it gives higher number of extracted feature points thus making it better than ANMS. This research can further be used for 3-D images and video processing.

REFERENCES

- [1] Kher, Heena R., and Vishvjit K. Thakar, "Scale invariant feature transform based image matching and registration", Signal and Image Processing (ICSIP), 2014 Fifth International Conference, pp. 50-55. IEEE, 2014.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 4, April 2017

- [2] Ye, Zhiyong, Yijian Pei, and Jihong Shi, "An adaptive algorithm for Harris corner detection", Computational Intelligence and Software Engineering (CiSE), International Conference, pp. 1-4. IEEE, 2009.
- [3] E. Rosten and T. Drummond, "Machine learning for high speed corner detection," 9th European Conference on Computer Vision, Vol. 1, pp. 430-443, 2006.
- [4] Leutenegger, Stefan, Margarita Chli, and Roland Y. Siegwart, "BRISK: Binary robust invariant scalable keypoints", Computer Vision (ICCV), 2011 IEEE International Conference on, pp. 2548-2555, 2011.
- [5] Brown, Matthew, Richard Szeliski, and Simon Winder, "Multi-image matching using multi-scale oriented patches", Computer Vision and Pattern Recognition (CVPR), IEEE Computer Society Conference, Vol. 1, pp. 510-517, 2005.
- [6] Fischler, Martin A., and Robert C. Bolles, "Random sample consensus: a paradigm for model fitting with applications to image analysis and automated cartography", Communications of the ACM, Vol. 24, No. 6, pp. 381-395, 1981.
- [7] Seo, Sanzwon, Soowoonz Jeonz, and Sanukeun Lee, "Efficient homography estimation method for panorama", Frontiers of Computer Vision (FCV), 19th Korea-Japan Joint Workshop, pp. 209-212, 2013.
- [8] Michahial, Stafford, "Automatic Image Mosaicing Using Sift, Ransac and Homography", International Journal of engineering and innovative technology, Vol. 3, No. 10, pp. 247-251, 2014.