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An Enhanced Approach in Image Mosaicing using ORB Method with Alpha Blending Technique

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Abstract: Image mosaicing is one of the ongoing area of research of computer graphics and computer vision. One of the popular techniques of image mosaicing is image stitching. There are mainly two approaches namely direct techniques and feature based technique. In direct technique, the intensity of the pixels of the image is compared with each other, and feature based techniques determines the relationship between images based on the features extracted from the processed images. This paper mainly focuses on individual algorithms of feature detectors and descriptors. The steps of image mosaicing are highlighted and the results are compared. The image is fed as the input. The ORB feature extraction method with Alpha blending technique extracts the features from the image. The third step computes the extracted features using homography. Then after the features are mapped with respect to the input image and blending of the image is carried out. The last step an image masaicing system depicted the final output.

Keywords: Image Mosaicing, Feature based approach, Feature detection and description, Blending

I. INTRODUCTION

Image mosaicing is the technique which combines multiple images of the same scene and high resolution image is produced. In this multiple rows of the images is considered irrespective of the rotation of the camera. The camera is kept in perpendicular direction with respect to the subject.

Image mosaicing is performed in the various stages. First stage is feature detection and description in which different methods can be used like Harries[19], SUSAN, FAST[20], SIFT[12], SURF[4], BRIEF[2], BRISK[3], ORB[16]. The second stage is image matching wherein RANSAC[7], LMS[16], Hough Transform[10] methods are used. And the final stage is image blending in which optimal seam blending[10], feathering blending[10], pyramidal blending[10], GIST methods are used. After successful completion of all the above mentioned stages, the panoramic image with high resolution is obtained.

II. IMAGE STITCHING APPROACHES

A. Direct technique

It compares the intensity of the pixel of the image with each other. The information extracted from the alignment of the image is used by this method. The contribution of each pixel in the image is measured. The advantageous point of this technique is that it lessens the sum of absolute differences observed in between the overlapping pixels. The limitation of this technique is the execution time. The execution time increases as comparison between every pixel is made with respect to the other. And the second drawback is it's not invariant to image scale and rotation. Thirdly, this technique has a limited range of convergence [19].

B. Feature based techniques

In this, local descriptors are used to compare the feature points in one image with respect to the other image. This technique establishes the correspondences between the lines, points, corners, edges, or any other shapes. The main characteristic of this technique is the robust detection with respect to the invariance to scale, rotation, translation and noise. Here image noise indicates the information of the color is different and is usually observed due to electronic noise. It can be produced by either the circuits of the digital camera or the sensor. Example of same is depicted in Figure1.

Figure 1: Noisy image

Scale invariance is one of the features of objects which is not altered even if the scales of length or other variables are multiplied by a common factor.

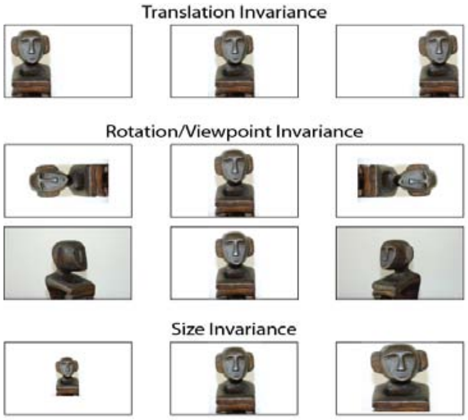

Figure 2: Images with scale, translation invariance and rotation transformation

Translation invariance means each point or pixel in the image has been moved the same amount in same direction. Rotation transformation means that either the point or the pixel in the image has been moved with some amount in any angle. These features are highly suited for shooting panoramic view of the image. The detection of the image features is accurate in feature based methods

The methods for corner detectors and descriptors are illustrated in Figure 3.

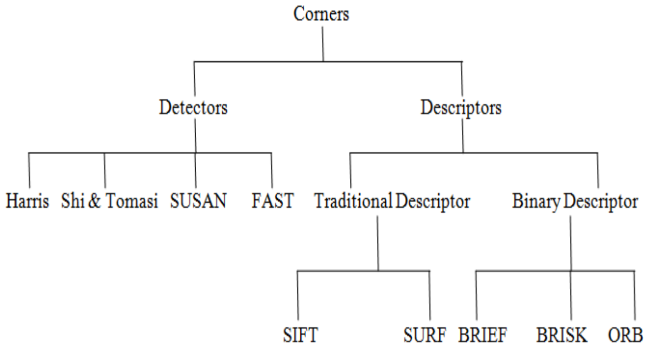

Figure 3: Classification of popular Corner Detectors and Descriptors

The advantages of feature based technique is that it is more robust, fast and has the ability to recognize panoramic view by automatically detecting the consecutive relationship between the ordered set of images.

III. FEATURE DETECTORS AND DESCRIPTORS

A. Feature detection methods

Harris[19] : Chris Harris and Mike Stephens in 1988 developed Harris corner detector based on Moravec algorithm. It was one of the low level processing step. Harris and Stephens together designed a combined corner and edge detector where results obtained were more accurate in terms of detection but the cost of requiring in terms of execution time was comparatively more as compared to other.

Good Features to Track Detector[5] : In this method, initially the corner is determined having large eigen values. The corners having the eigen vales less than the threshold is rejected. The corners left out are now considered as strong. Corner rejection does not end here. It continues to reject the weak corners that are closer than distance to a strong corner. The threshold value of 0.1 is chosen for the implementation. It depicts the monitoring of the quality of image features during tracking.

SUSAN[10] : SUSAN stands for “Smallest Uni-value Segment Assimilating Nucleus”. In this circular mask technique is used where the number of pixels having the same intensity (nucleus pixel) is calculated with a threshold value to detect corner pixels. The cost of corner detection is high for the noisy image as each pixel is compared with nucleus pixel.

FAST[20] : It was developed by Rosten and Drummond in 2006 which was then revised in 2010. Fast stands for “Features from Accelerated Segment Test”. It is mainly used for identifying feature points of image. Development of real time frame rate applications is best suitable for this algorithm. For noisy images, the computation time is high.

B. Feature descriptor methods

SIFT[12] : Scale Invariant Feature Transform termed as SIFT identifies the scales and locations which can be repeatedly assigned under various views of the same object. Computation of orientation is carried out to achieve scale and rotation invariance.

SURF[4] : This concept was given by Herbert Bay. SURF stands for speeded up robust feature. It first locates and then recognizes the objects and extract points of interest. It has three main parts: detection of interest point, description of local neighborhood and matching. The main aim of this descriptor is to give a unique and robust description of an image feature.

BRIEF[2] : BRIEF stands for Binary Robust Independent Elementary Features. It is a bit string descriptor of an image patch which is formed from a set of tests carried out by the binary intensity.

BRISK[3] : Leutenegger, Chli and Siegwart introduced Binary Robust Invariant Scalable Keypoints (BRISK) in the year 2011. It is assembly of bit string vector. The binary descriptor uses Euclidean distance. It has dramatically lower computational complexity but is faster as compared to SIFT/SURF in terms of performance. It is suited for real time requirements and low power devices.

ORB[16] : Ethan Rublee introduced Oriented FAST and Rotated BRIEF (ORB) in the year 2011. FAST technique is used at an initial stage to determine the key points. FAST does not compute the orientation and it is rotation variant. It computes the intensity of the centroid of the patch with the corner at center. The orientation is the direction of the vector from the center point to centroid. Moments are computed to improve the rotation invariance. In ORB, rotation matrix is computed using the orientation of patch and then the BRIEF descriptors are steered according to the orientation[8].

Table 1: Feature descriptor methods

Feature descriptor methods	Description
Scale invariant feature transform(SIFT)	It extract distinctive feature from images or frames which are invariant to image scale and rotation. It is invariant to rotation, scale changes and affine transformation. Slow and not good at illumination changes.
Speeded up robust feature(SURF)	SURF creates an image pyramid "stack" without 2:1 down sampling for higher levels in the pyramid. SURF integrates the gradient information within a sub patch, whereas SIFT depends on the orientations of the individual gradients of histograms, which makes SURF less sensitive to noise. SURF descriptor is fast and it has good performance same as SIFT but it is not stable to rotation and illumination changes.
Feature accelerated segment transform(FAST)	FAST is a corner detection method, which is used to extract feature points and develop an interest point detector for use in real time frame rate applications. It is comparatively faster as compared to the other existing corner detectors. It is not robust to high levels noise.
Binary robust invariant elementary feature transform(BRIEF)[23]	BRIEF is a descriptor for feature matching that performs binary tests between numbers of pixels in a smoothed image patch. Construction and matching is much faster in BRIEF as compared to other methods. It contains higher recognition rates, and also invariance to large in-plane rotations. Real-time matching performance is achieved with limited computational time. It is not designed to be rotationally invariant
Oriented FAST and robust BRIEF (ORB)[23]	FAST corner detector combined with the key matching descriptor BRIEF is called ORB. It is more efficient in feature detection and matching computationally efficient respect to SIFT. It is less affected by image noise, almost two orders of magnitude faster than SIFT and SURF. ORB is not designed to be scale invariant

IV. HOMOGRAPHY

Homography[10] is the technique of mapping the feature points of one image with that of the another image of the same scene. RANSAC, LMS and Hough Transform methods help in achieving this technique. RANSAC estimates the homography matrix based on the number of inliers within the threshold distance (***t***)[10], LMS uses "sum of squared residuals", Hough Transform uses the density of outliers[10].

A. Feature mapping methods

RANSAC Algorithm[10] **:** RANdomSAmple Consensus algorithm was given by Fischler and Bolles in the year 1981. It can estimate the undesired corners referred to as the outliers. It is a non determinist algorithm, and produces the reasonable results.

LMS[16] : Least Median of Square to find median value. It assumes that all the feature points should match with the same accuracy. In case of less than fifty percent outliers, LMS is preferred. It does not need any threshold knowledge.

Hough Transform[10] **:** In this, the estimation on the outliers is considered as compared to the inliers. In case the number of inliers are more as compared to the outiers, then it is strenuous to use RANSAC and LMS.

V. IMAGE BLENDING

This is the final step in development of image mosaicing system.

A. Image blending techniques

Optimal seam blending[15] : This technique makes a search for the curve at the overlap region where the difference between the two frames or images are minimal. After successfully finding it, each frame is then moved to the respective side of the seam. In case there is no overlapping, the no curve is detected. The visibility of the artifacts is observed in the mosaic image.

Feathering Blending or Alpha Blending[15] : In this, the average color pixel values are used to mix the pixels of the overlapped area. The value of alpha factor is "1" in case of center pixel and the value is '0' towards the border.

Pyramidal Blending[10]: In this technique, the different alpha masks are used which are combined with the various bands of frequency. At wider regions, the frequencies which are low are mixed and at the narrow region, the fine details are mixed. As a result there is a gradual transition at lower frequencies. The mosaic result is sharp and fabrications are removed because of the difference in low frequencies.

VI. PROPOSED IMAGE MOSAICING SYSTEM

The proposed image stitching system follows the following steps:

1) Different extraction techniques are applied to extract the features from the overlapping input images.
2) Descriptors of those features are then generated.
3) After extraction of the features, these are compared with each other based on their descriptor value.

4) The RANSAC (Random Sample Consensus) method removes the unwanted features.
5) Blending process is then applied to eliminate the seams between the processed images.
6) Finally, the output image is the panoramic image with a high stitching quality.

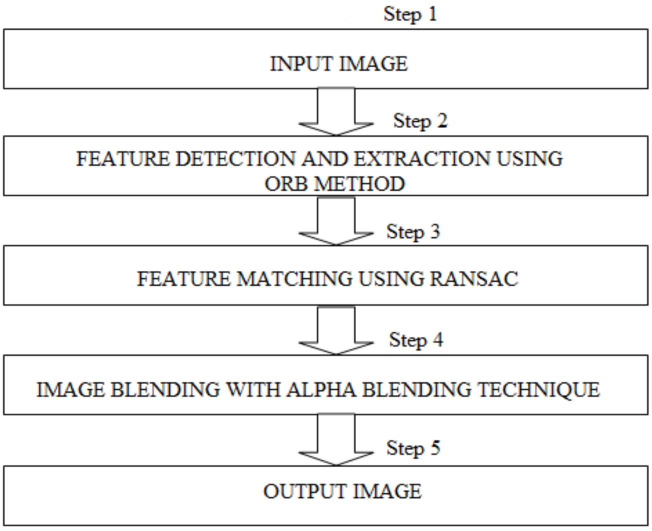

Figure 4: Image mosaicing processing steps

Feature detection and extraction: Using this technique, the unique features from the input image is extracted. ORB

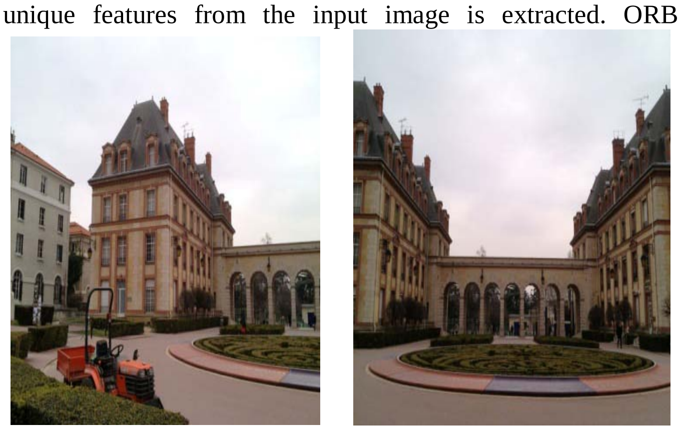

Figure 5: Set of input images

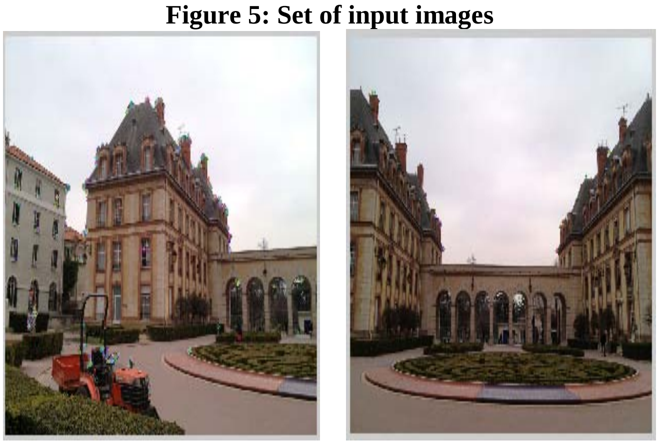

Figure 6: Feature detection and extraction with ORB method

method is used in this technique which is regarded as the the combination of both FAST detector and BRIEF descriptor. The performance of ORB is similar to SIFT in terms of robustness and invariance to distortion and lighting. The stable key-points along with the strongest features are detected using FAST technique and then the orientation is calculated using BRIEF.

Feature matching: RANSAC technique generates the candidate solutions by using the minimum number of data points. RANSAC has an advantage to carry on estimation of parameters with a high degree of accuracy though having a outliers. In this way RANSAC computes a greater number of iterations.

Image blending: In this step, Alpha blending method is used which creates a final “blending” of input images. The average value at each pixel is calculated. In case the pixels of the image is aligned well with each other, then the feathering blending approach is found to have better results.

VII. EXPERIMENTAL RESULT

Desktop computers with 2.26 GHz Intel(R) Core(TM) i5 CPU processor and 4 GB RAM with Windows 7 (64 bit) Operating system is used for the above mentioned proposed work. The output is visualized with the help of one of the popular tool of image processing and that is MATLAB R2013b.

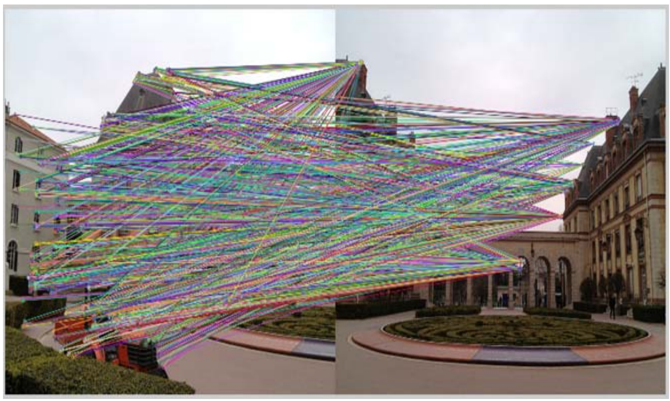

Figure 7: Feature matching with RANSAC method

VIII. CONCLUSION

The paper proposes the image mosaicing system. The phases can be summarized as feature detection, feature description, homography computation and image blending. Different methods can be used in different stages to compute the output. Each of the methods have got its own pros and cons as discussed in the paper. To summarize, SUSAN corner detector detects the corner with respect to scale invariant but noise in image is observed, Harries corner detector is robust but scale variation is suffered and FAST is both rotation and scale invariant but does not perform well with respect to the noisy images. SIFT observes good quality image but the processing is slow. The performance of SURF is comparatively better with respect to other algorithms and is considered to be to SIFT with respect to execution time. BRISK[10] is able to detect the image in good quality and ORB is faster. RANSAC algorithm as depicted achieved better results in Homography. Alpha blending method yields better result in order to remove seams of the output image.

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