International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

The Feature based Image Stitching Techniques

R Arun Kumar, K Sathesh Kumar, T Prasanth, K Balakrishnan

Abstract: ***The photographic images taken from different sources are integrated into one to form a new panoramic image which has high resolution when compared to the original image. Usually, image stitching can be done using any computer software. Image stitching helps us in extracting the actual information from shredded data. The torned paper can be reconstructed by means of image stitching process which is applied in forensic department. Digital maps and satellite photos can be reconstructed through image stitching algorithms which is also known as Image mosics. In recent days, many researchers introduced various algorithms to address the issues in Image stitching technique. Feature based Image stitching technique plays a vital role in most of these algorithms. In feature-based technique, local descriptor is used to compare an image's feature points with another image's feature points to predict the feature points for the given pair of image. In this paper different image stitching techniques, comparisons between various features descriptor and the steps involved in Feature extraction in Image stitching method are discussed.***

Index Terms: Blending, Panorama, Image Calibration, Image registration, Image stitching.

I. INTRODUCTION

Panoramic imaging is the process of merging two or more images with coinciding fields of view is merged together to form a new panoramic image. The other name for this process is image mosaicing. The word panorama is the Greek word in which the word "pan" refers "everything" and "horama" refers "to view". The image stitching [11] process comprises the exact overlap between sequence of images and identical coverages to produce smooth image.

Usually camera is used to take pictures which covers within its scope of view, it fails to cover a larger area within a single frame. This problem can be resolved by using Panoramic imaging [16] concept which merges the images taken from various perspective views into a single image – covers larger area. The entire process starts by taking lot of pictures by different cameras, at different means of time or from different perspective viewpoints. The major applications of Image Stitching are in the field of 3D image reconstruction, video compression, video conferencing, satellite imaging, video stabilization and also in several other medical applications it exists. In today's digital world, a high resolution digital maps and satellite images are created with the help of this Image stitching technique. It can also be employed to create a panoramic scene with different portion of perspective view are animated individually.

The similar parts of the overlapping portion of adjacent images are calculated first to stitch images and form a panoramic image. For this purpose, large amount of computation need to be calculate in case of Intensity-based algorithms and this scheme will not be an appropriate one for the image if it is rotated and scaled to perform image alignment. This problem can be rectified by the frequency-domain based algorithm which provides faster result and could be able to handle all transformations in a well manner. Inspite of its advantage, it has its own flaw when the image has very smaller overlapping regions. Feature based algorithms [17] overcome the above mentioned limitations and reduces the computational complexity since it requires less information for its process. .

The reminder of this paper is organized as follows: Section 2 describes major components of Image stitching, Section 3 highlights the Image stitching technique classification, Section 4 compares the various feature descriptors in terms of its quantitative measure, Section 5 describes various stages involved in Image stitching technique and finally concluded the paper in Section 6.

II. MAIN COMPONENTS OF IMAGE STITCHING

There are three main components of Image Stitching: Calibration, Registering the image and Blending as shown in the below Fig.1.

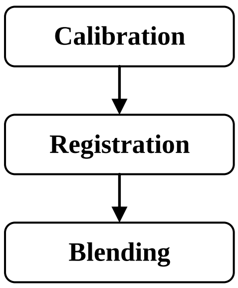

Fig .1. Image Stitching Components

1. Calibration

Optical shortcomings such as exposure deviations exhibit between images and distortions [13] leads to deviations in between the original lens and model lens.

Revised Manuscript Received on 30 July 2019.
***** Correspondence Author
R Arun Kumar*, Department of IT, Bannari Amman Institute of Technology, Sathyamangalam, Tamilnadu, India – 638401. Email : itsark1987@gmail.com
K Sathesh Kumar, Department of IT, Bannari Amman Institute of Technology, Sathyamangalam, Tamilnadu India – 638401. Email : satheshkumark@bitsathy.ac.in
T Prasanth, Department of CSE, Jain University, Bangalore, India - 562112. Email : t.prasanthmtech@gmail.com
K Balakrishnan, Department of Information Science & Engineering, Sri Venkateswara College of Engineering, Bengaluru, India - 562 157 Email : bala.k.btech@gmail.com.

This shortcoming can be resolved by means of Image calibration. In order to define the location and orientation of the camera

reference frame with respect to a known world reference frame and to associate the image's pixel values along with the corresponding coordinate values in the camera reference frame, camera parameters like extrinsic and intrinsic are reconstructed [14].

2. Registration

The process of merging two or more images which are captured from different point of perspectives is known as registration. After this smooth transition from one image to another can be achieved using Image blending.

3. Blending

It is the process of making the stitching to be seamless so that there will be smooth transition between the images occurs.

III. IMAGE STITCHING TECHNIQUES

Image stitching techniques can be broadly classified into two different techniques:

1. Direct Technique
2. Feature based Technique

1. Direct Technique:

The Direct Technique compares intensities of each and every pixel with one another. The overlapping pixels may have deviations in its sum of absolute differences between them and it can be minimized by means of this direct technique. It can also be achieved by means of any other cost operative technique. These methods compare each and every pixel window to others, and due to this it is computationally complex. It iteratively updates the homographs and uses information from all pixels. Phase – correlation can also be used in determining the homographic parameters.

The primary gain of this scheme is that it optimally uses all the information present in the image. Each and every pixel in the image plays a vital role while measuring the parameters. The major drawback of this scheme is that its convergence range have a very limited value [12].

2. Feature-based technique

In feature-based technique, the primary step is comparing all the feature points in one image against another image to predict associated feature points for the given image pair. This process can be achieved by using local descriptors [12]. The major steps involved in feature based image stitching are (1) Extracting the feature points, (2) Registering the image and (3) Blending process. Initially it starts establishing relationships between points, lines, edges, corners or other parameters. A robust detector must include the main features such as scale invariance, rotation transformations, translation invariance and invariance to image noise. Some of the famous feature detector techniques are SIFT [5], SURF [6], KAZE [7], AKAZE [8], ORB and Rotated BRIEF [9], and BRISK [10] can be used for feature extraction.

The most commonly used Canny Edge detection algorithm [2] was used in object detection, image segmentation, image mining and face recognition. In face recognition applications, Canny Edge and Sobel edge detection algorithms were also applied [3] to extract edges of face in face images.

SIFT algorithm use the Gaussian filter to extract the features by building the image pyramid. Even though SIFT has good robustness it has some flaws such as it does not neither preserve object boundaries nor smooth the same level and noise at all scales. An alternative approach namely A-KAZE algorithm [1] overcomes this problem where the multi-resolution fusion algorithm is used to fuse the image in order to achieve a satisfactory seamless image of high resolution.

The main advantages of the Feature-based methods are its robustness and its faster process even though there is scene movement. It detects the panoramas automatically by means of predicting the adjacency relationships between set of unordered images. This peculiar feature makes the Feature-based method, a best fitted scheme for fully automated panorama stitching [15]. Due to advantages in Feature-based methods and limitations in Direct Technique, the Feature-based methods are widely adopted by scientific communities for image stitching process.

IV. COMPARISON OF VARIOUS FEATURE DESCRIPTORS

The following table shows the comparison [4] between various feature descriptors such as SIFT (blobs), KAZE (blobs), SURF (blobs), ORB (corners), AKAZE(blobs), and BRISK (corners). These techniques are compared with respect to image matching and registration

Table - I: Comparison of various feature descriptor (SIFT, KAZE , SURF, ORB, AKAZE, and BRISK)

S No.	Quantitative Comparison	Hierarchy Order
1	Ability of predicting features	ORB>BRISK>SURF>SIFT > AKAZE>KAZE
2	Computational efficiency with respect to feature-detection-description	ORB>ORB(1000)>BRISK> BRISK(1000)>SURF(64D)> SURF(128D)>AKAZE>SIFT>KAZE
3	Efficient feature-matching	ORB(1000)>BRISK(1000)> AKAZE>KAZE>SURF(64D)> ORB>BRISK>SIFT> SURF(128D)
4	Total image matching Speed	ORB(1000)>BRISK(1000)> AKAZE>KAZE>SURF(64D)> SIFT>ORB>BRISK> SURF(128D)

V. IMAGE STITCHING MODEL

The various stages of Image stitching model are described in the below flow diagram which involves Input image, Feature detection, Matching the Image using RANSAC Translation Estimation, Global Alignment, Blending and Composition and finally Panoramic Image (output).

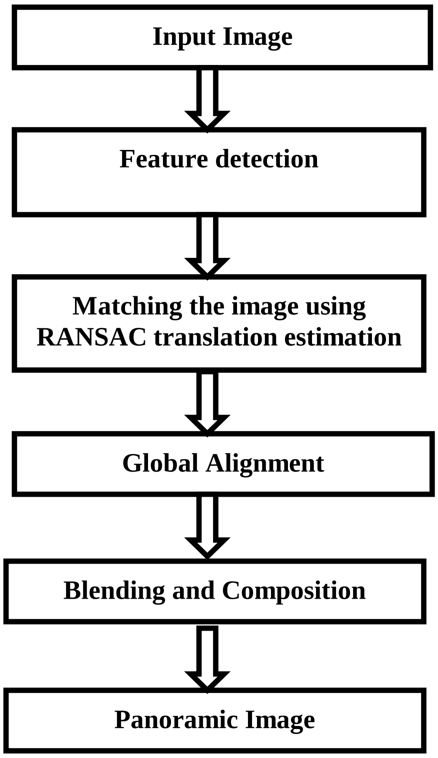

Fig .2. Various stages in Image Stitching Technique

1. Image Acquisition

The foremost step in Image Stitching is Image Acquisition [15] where we extract images from different sources. In General images required from image stitching is attained by performing the following preliminary steps like sequence of translation and rotation. It composed of translate camera parallel to the sight and followed by the camera is rotated about its vertical axis. Additionally image enhancement techniques can be applied if the image is not retrieved properly. The acquired images should have enough overlapping so that stitching can occurs without any distortion.

Fig. 3. Input Image

2. Feature Detection and Matching

It is the second step where the elements of a particular image composite the features of the image. To detect the image features, the basic idea is that, the superior points are taken individually and then it is processed by means of applying any one of the feature detection methods [15]. The most crucial thing in Feature detection is that how faster we extract the feature from an image. This plays a major role many applications like video stabilization, image registration, simultaneous localization and mapping (SLAM) visually and reconstruction of 3D image.

The feature points need to be detected and defined individually in order to compute the association between different perspective views consistently and efficiently. This overall process need to be faster as possible in case of Real-time applications. To attain the better matching of image features between pair, it is best to consider the corner feature. A corner feature will show sudden intensity change in case of neighborhood image. In order to match the best image pairs, corners are need to be matched sufficiently.

Local feature detectors are used to represent a pixel of an image with respect to its local content. The major requirement for these detectors are it is mandatory to maintain consistency even though there is any transformation and noise. SURF, SIFT, PCA-SIFT,HOG are the good examples for local feature descriptors.

3. Image Matching RANSAC Translation Estimation

The detected features in the previous step is used in matching images of all pictures. Next step of the Image stitching process is to obtain the neighboring pixels so that its features are extracted. RANSAC algorithm is used for this purpose. Since it doesn't ensure that we will get the acceptable result it may also be known as non-deterministic algorithm. It is mainly applied to predict the outliers iteratively which estimates the homographic model parameters from the set of perceived values. RANSAC employs the following four value pairs: homography H, inliers, set of largest inliers, and finally least-squares H estimate among all the inliers. The main advantage of RANSAC algorithm is that it provides high degree of accuracy even there is a significant number of outliers are available. The downside of this algorithm is its larger computational time and there is no limit on its upper bound for its computation.

4. Global Alignment:

Bundle adjustment is the process of combining two or more images which belongs to the same scene and converted them into a new 3D image. It is the commonly used technique for global alignment. The primary objective of this alignment is in reducing the miss - registration among the set of images and it can be performed by predicting the consistent set of alignment parameters globally. Initially features of 3D location and camera location estimates need to be computed. Then by using a bundle adjustment scheme least - squares algorithm, we could minimize the log-likelihood of the overall errors in feature projection.

5. Blending and Composition

It is the process which involves choosing final compositing surface either flat or cylindrical.

Initially it selects any one of the image from the various set of reference images and then bind all other remaining images into the reference coordinate system. This final binding is also known as flat panorama. Since the resultant surface still remains a perspective projection, the straight lines remain straight in the final image. Different projective layouts are available for the process of image stitching. It uses rectilinear projection where the stitched image is projected on a 2D plane and this plane intersects the panosphere in a particular single point.

Sequences of two or more images are taken by means of camera and warpped to construct a cylindrical panorama. Forward warping and inverse warping are two types of cylindrical warping employed here. In case of forward warping, the cylindrical surface is used to plot the given input image, but there may be chance to have holes in the destination image. Each destination image's pixel value is mapped to the source image in case of inverse mapping.

Featuring image blending, Image Pyramid blending and gradient domains are the different pixel blending techniques employed in image stitching. The process of computing the weighted average of all pixel values present in the blended regions between two overlapping images is known as featuring image blending. It is mainly used to smooth and blur the edges of the images. This algorithm works better if all the images are caught by using high quality camera and taken at the same time.

Fig. 4: Final Image after the completion of Image stitching process

An important scheme of image blending is Image Pyramid blending where we use to represent the image with respect to the set of different frequency-band images. Some of the major applications of image pyramid blending are image analysis, noise reduction image enhancement, etc.

VI. CONCLUSION

In this review paper, major techniques of Image stitching: Direct technique and Feature based technique are discussed here. The various Feature descriptors like SIFT, KAZE, SURF, ORB, AKAZE, and BRISK were compared. Finally it can be concluded that the overall work quality of SIFT and BRISK is found to be better among all other types of geometric transformations and SIFT may be referred as the most accurate algorithm among the discussed feature descriptor. Feature based Image stitching model involves the following stages : Image acquisition/Input image, Feature detection, Matching the Image using RANSAC Translation Estimation, Global Alignment, Blending and Composition also described here briefly. This paper briefly outline the overall process of the Feature based Image stitching technique.

REFERENCES

1. Zhong Qu, Wei Bu, Ling Liu, "The Algorithm of Seamless Image Mosaic Based on A-KAZE Features Extraction and Reducing the Inclination of Image", IEEJ Transactions on Electrical and Electronic Engineering, Vol. 13, pp. 134-146, 2018.
2. Mohd Ismail Jolhip, Jacey-Lynn Minoi, Terrin Lim, "A Comparative Analysis of Feature Detection and Matching Algorithms for Aerial Image Stitching", Journal of Telecommunication, Electronic and Computer Engineering, Vol. 9, pp. 85-90, March 2018.
3. S. Vijayarani and M. Vinupriya, Performance Analysis of Canny and Sobel Edge Detection Algorithms in Image Mining, International Journal of Innovative Research in Computer and Communication Engineering, vol. 1, issue 8, pp. 1760-1767, October 2013.
4. Shaharyar Ahmed Khan Tareen and Zahra Saleem, "A Comparative Analysis of SIFT, SURF, KAZE, AKAZE, ORB, and BRISK", International Conference on Computing, Mathematics and Engineering Technologies, March 2018.
5. D. G. Lowe, "Distinctive image features from scale-invariant keypoints", International Journal of Computer Vision, Vol. 60, no. 2, pp. 91-110, 2004.
6. Herbert Bay, Andreas ESS, TinneTuytelaars and Luc Van Gool, "Speeded-up robust features (SURF)", Computer Vision and Image Understanding, Vol. 110, no. 3, pp. 346-359, 2008.
7. P.F. Alcantarilla, A. Bartoli and A.J. Davison, "KAZE features", Proceedings of the 12th European Conference on Computer Vision, Florence, Italy, 7–13 October 2012; pp. 214–227.
8. P. F. Alcantarilla, Jesus Nuevo and Adrien Bartoli, "Fast explicit diffusion for accelerated features in nonlinear scale spaces", British Machine Vision Conference, Bristol, BMVC, 2013.
9. Ethan Rublee, Vincent Rabaud, Kurt Konolige and Gary Bradski, "ORB: An efficient alternative to SIFT or SURF", IEEE International Conference on Computer Vision, Barcelona, ICCV, 2011, pp. 2564-2571.
10. Stefan Leutenegger, Margarita Chli and Roland Y. Siegwart, "BRISK: Binary robust invariant scalable keypoints", IEEE International Conference on Computer Vision, Barcelona, ICCV, 2011, pp. 2548-2555.
11. Richard Szeliski, "Image Alignment and Stitching: A Tutorial", Vol. 2, December 2006.
12. K.Shashank, N.SivaChaitanya, G.Manikanta, Ch.N.V.Balaji and V.V.S.Murthy , "A Survey and Review over Image Alignment and Stitching Methods", The International Journal of Electronics & Communication Technology (IJECT), ISSN: 2230-7109 (Online), March 2014.
13. Zhengyou Zhang , "A Flexible New Technique for Camera Calibration" IEEE Trans. Pattern Anal. Mach. Intell., Vol. 22, Issue 11, pp. 1330-1334, November 2000.
14. Xianyong Fang, "Feature Based Stitching of a Clear/Blurred ImagePair",IEEE International Conference on Multimedia and SignalProcessing, Vol. 1, pp. 146-150, 2011.
15. P. P. Dahale, G.A. Chillure and Y. N.Thakre, "A review on automated image mosaic using PCA", International Journal of Science, Engineering and Technology Research, Vol. 3, Issue 4, April 2014.
16. Matthew Brown and David G. Lowe, Automatic Panoramic Image Stitching using Invariant Features, International Journal of Computer Vision, vol. 74, pp. 59-73, August 2007.
17. M. Hassaballah et al., "Image features detection, description and matching," in Image Feature Detectors and Descriptors, Springer International Publishing, 2016, ch. 1, pp. 11-45.

Retrieval Number: B3344078219/19©BEIESP
DOI: 10.35940/ijrte.B3344.078219
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

AUTHORS PROFILE

R Arun Kumar received the M.E.., degree in Computer Science and Engineering from Anna University, Regional Centre, Coimbatore, India in 2013. He is currently pursuing the Ph.D. degree at the Anna University, Chennai, India. He is an Assistant Professor in the Department of Information Technology at Bannari Amman Institute of Technology, Sathyamangalam. His research interests include machine learning and image processing.

K Sathesh Kumar received the M.E.., degree in Computer Science and Engineering from Sethu Institute of Technology, Virudhunagar, India in 2015. He is an Assistant Professor in the Department of Information Technology at Bannari Amman Institute of Technology, Sathyamangalam. His research interests include machine learning and image processing.

Balakrishnan K received the M.E.., degree in Computer Science and Engineering from United Institute of Technology, Coimbatore, India. He is an Assistant Professor in the Department of Information Science & Engineering at Sri Venkateswara College of Engineering, Bengaluru,. His research interests include machine learning, automated systems and image processing

T. Prasanth received the M.Tech., degree in Database Systems from the SRM University, Chennai, India in 2011. He is currently pursuing the Ph.D. degree at the Anna University, Chennai, India. He is an Assistant Professor in the Department of Computer Science Engineering at Jain University, Bangalore. His research interests include big data analytics, machine learning and social network analysis.