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Approaches and Challenges in Real Time Image Stitching

Kavita Joshi
Electronics and Telecommunication dept.
Dr.D.Y.PatilInstitute of Engineering, Managementand ResearchPune,India

Abstract: Image stitching is an area of research in Computer graphics or computer vision. It is the process that combines multiple images together using various algorithms, techniques to encompass Field Of View(FOV) to create Panoramic view in a single, large high resolution frame using computer software. In recent years many algorithms, techniques are developed to handle challenges in image stitching. The demand of panoramic view is increased in various fields. Super-resolution images with wide angles are created by image stitching used in medical image stitching, photo mosaics with high resolution, satellite photography , Telemedicine and more. This paper represents recent approaches utilized in Image stitching. Finally, challenges in image stitching is alsodiscussed.

Keywords: Image stitching, Panoramic view, Field of view

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I. INTRODUCTION

Image stitching or photo stitching is the process of combining multiple photographic images or frames with overlapping area of view to produce a photomosaic high- resolution image performed with help of computer software. To create seamless high resolution image, requires overlapping field between two images and identical exposures. Image stitching enables the combination of multiple shots to create a larger picture that is beyond the normal aspect ratio and resolution of the camera's individual shots. The most popular use of image stitching is in the creation of panoramic images, often used for landscapes. Wide-angle and super-resolution images created by image stitching are used in artistic photography, medical imaging, high-resolution photo mosaics, satellite photography and more. Image stitching is widely used in camcorders, digital maps, satellite photos, medical imaging, video stitching applications. Major issues in image stitching are presence of parallax, seamless image under varying illuminating conditions, scene motion, and exposure differences.

Human visual system has a field of view of around 135 x 200 degrees where as a typical camera has a field of view of only 35 x 50 degrees. Therefore, to create a panoramic image, multiple camera images are stitched together and provides larger field of view[2]. The quality of image stitching is calculated by the resemblance of the overlapped portion of the stitched image and the visibility of the seam between the stitched images [3]. Image stitching is the challenging field in image processing field. It can be used widely in real time applications as satellite imaging, video stitching, advanceddriverassistance

II. IMAGESTITCHING

Image stitching basically divided into three main components as calibration, image registration, and blending[8] asshown in Fig. 1. External and internal camera parameters are estimated in camera calibration. Multipleimages are compared in image registration and it find out the translations to align the images. After registration, in Blending, multiple images are merge together to create a single, large image In Brief discussion of these three components is given below. Location and orientation of the ideal reference frame and camera reference frame are the extrinsic parameters and pixel coordinates of the defined window of an image and the corresponding coordinates in the camera reference frame [9] can be linked in intrinsic parameters.

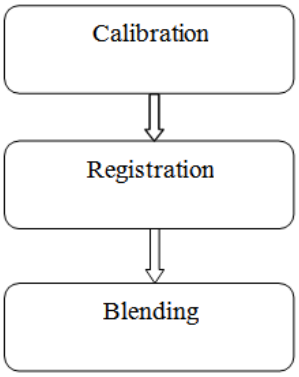

Fig. 1: The main components of image stitching

A. Calibration

Exposure differences and optical defects results the

differences between ideal lens model and camera lens combination. Image calibration minimizes this difference[8]. 3-D image can be reconstructed from the pixel coordinates of the image by recovering the intrinsic and extrinsic parameters of a camera.

B. Registration

Image registration is the core of an image stitching process. It is the process of transforming different sets of data as multiple photographs, sensor images etc. It creates geometric correspondence between the images and hence we can compare these images and can apply other steps properly. [20]. Inthis technique, two or more images which are captured from different point of perspectives arealigned.

C. Blending

Image Blending executes the adjustment figured out in image calibration as remapping of the images, color correction between images. Images are merged to create a seamless large image. The seam while stitching can be reduced with gain adjustment. It minimizes the difference between the overlapping pixels intensities of the two images. Alpha feathering and Gaussian pyramid are the two well knownmethods of blending[10]. The cases where well aligned image pixels are present with only differenceinintensity between two images, then alpha blending works extremely well. Gaussian pyramid [20] is another popular approach where images at two different frequency bands are merged together and then filtered together.

III. IMAGE STITCHINGAPPROACHES

Multiple images are stitched together to generate a single large image. There are two main approaches, The direct and feature based techniques for image stitching. The direct techniques work on the pixel intensities between the two images. In the feature based techniques, features on the images are located and then matched[11].

A. DirectTechniques

In this technique each pixel in every block of an image is compared with the corresponding pixel in the another image minimizes the sum of absolute differences between overlapping pixels of the images. Its a complex technique and not invariant to image scale and rotation. Direct Technique has high computational costs and works very slowly. This technique is not suitable for real time applications. Another disadvantage of the direct stitching techniques is that they need a lot of initialization which means there must be a lot of human interaction to make sure the stitching occurs correctly. This initialization includes but is not limited to rotation (orientation) of images to be stitched. Direct Technique is not invariant to image scale and rotation. Advantage of the Direct method is that it makes best possible use of the information available in image alignment However, limited range ofconvergence
[11] is the biggest limitation of direct techniques.

B. Feature based Techniques

Images received by the feature detector is analyzed and metadata is extracted from the image which gives the information about the features in the images. To find all matching feature points, the simplest way, in an image pair is to compare every feature of one image to every feature of another image using one of the local descriptors. Unfortunately, this is could be not feasible for some applications.[11].

The steps required for feature based image stitching techniques are: feature extraction, registration, and blending Feature based image stitching methods begin by setting up correspondences between points, edges, lines ,corners, or other geometric entities. Local detectors used in this technique should scale, noise, rotation and translation invariant.. There are many feature detector techniques, such as Harris [18], SIFT [13], SURF [14], FAST [15],PCA-

SIFT [16] and ORB [19] techniques. The renowned technique SIFT (Scale-Invariant Feature Transform) [13] is very powerful, but due to the computation time can notbe used in real-time applications. To detect the features Harris corner detector [18] is used. In this technique, to match the features in two or more frames, a normalized cross-correlation of intensity values are used. Harris corner is not scale invariant to changes. The feature based technique ,SURF (Speeded Up Robust Features) [14] improves the computation time compare to SIFT technique. It is more faster than SIFT and hence can be applicable for real time applications. Recently, Binary feature descriptors usesbinary string as ORB are faster than other techniques and nave high accuracy so popularly used in real time applications. ORB is very robust to affine and noise transformations and scale and rotation invariant. Feature based methods are more advantageous and popular than direct methods confers good results against scene movement.[3].

IV. IMAGE STITCHINGMODEL

The image stitching model as shown in Fig. 2, shows five stages , images acquisition, features detection and matching, RANSAC estimation, global alignment, and imageblending.

A. ImageAcquisition

Image acquisition is the first step in any vision system. In this images are recovered from any source. To create panoramic image, these multiple

images are acquired using three methods, shown in Fig.3.Images can be captured by camera rotating with its vertical axis keeping optical centre fixed, keeping camera parallel to scene or by using handheld camera[20].

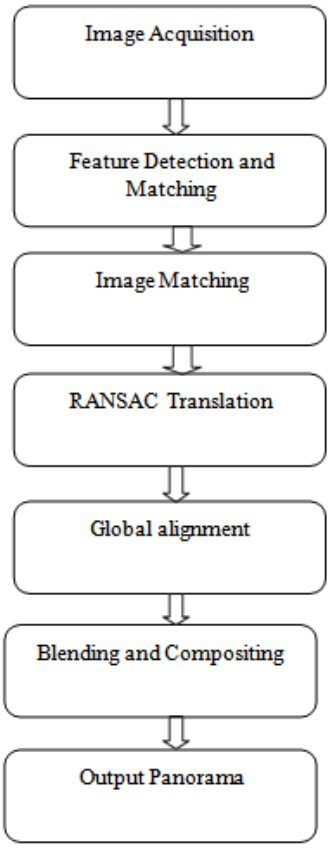

Fig.2: Image Stitching model

B. Features Detection andMatching

This is the second main stage in image stitching process. Concept used in the feature detection is that instead of looking at the full image, it selects some distinct points present in the received image and then accomplish a analysis using any one of the method..In real time applications such as video stabilization, visual SLAM, matching higher speed for feature detection in the image is a critical task. In such applications processing for Detection of features, Description and Matching should be as fast as possible. Better feature matching between two images, corners play an important role, as they are more stable against the changes in the viewpoint.

The local feature descriptors provides a pixel information of the image pair. These descriptors are to be robust to localization errors, and able to provide the information about pixel intensity with its location in the image [24]. The characteristics of local descriptor is that, it should be invariant to scale, rotation and translation. It should be also invariant to presence of noise, affine transformation, and blur. Local descriptors must be enough powerful against illumination changes, clutter and occlusion. There are many features descriptors such as SIFT [22], PCA-SIFT [16], SURF [14], HOG [17], Pyramidal HOG (PHOG),GLOH
[23], and Pyramidal Histogram Of visual Words (PHOW).

C. Homography using RANSAC

After detection of features from local descriptors, the objective of this stage is to find overlapping or matching images. In this stage, neighbourhood of the one picture to another picture, and find the correctly feature matching set

[25] .RANSAC (RANdomSAmpleConsensus) is a robust, nondeterministic estimation procedure. It uses the minimum set of sampled correspondents to find the best solution and estimate parameters for Homography. RANSAC loop involves selecting four feature pairs (at random); compute Homography, compute inliers, keep largest set of inliers, and finally re-compute least squares H estimate on all of the inliers.

D. Globalalignment

The most prominent technique used in Global alignment is the bundle adjustment. This is the most significant technique , in which a photogrammetric technique combines multiple images of the same scene to reconstruct accurate 3D image. To minimize the false registration between all pairs of images a globally consistent set of alignment parameters are to be findout.

In Global alignment, initial estimation of camera location and 3-D location features is computed. and then by applying iterative algorithm, bundle adjustment compute optimum values for the 3-D reconstruction of the camera position and the scene [26].

E. Blending andCompositing

Blending and Compositing is the final step in image stitching model. This step provides a large single panoramic image by stitching two or more images with a selection of flat or cylindrical composite surface. Once the input images a registered with respect to each other , then final stitching of the image is to be done. After selection of composite surface cylindrical or flat, images are blend together to generate a full attractive panoramicimage.

V. LITERATUREREVIEW

In the last many years, there are many researchers proposed algorithms, techniques, technologies for image stitching system. For example, Levin and Weiss [29] proposed several cost functions to improve the. quality of stitching.

Their approach is validated in the various applications, such as generation of panoramic images, in object blending, and for the removal of compression artifacts. The goal of a image stitching algorithm is to generate a visually acceptable panorama with two required properties. First, the stitched image and the input images should be as similar as possible, geometrically and photometrically. Second, the image produced should be seamless.

Authors proposed several algorithms with numerous cost functions to meet these requirements. To create attractive panorama the seam region should be invisible. The quality of stitching in the seam region is measured in the gradient domain. Brown and Lowe [32] utilizes the SIFT algorithm for a feature-based image stitching system. In the first step, SIFT features are extracted and matched between the images using panoramic recognition algorithm and then it finds overlapping or matching elements. It is necessary to match each image to a small number of neighboring images .It can offer a better solution for the image geometry. Then, a set of inliers is selected using RANSAC that are matched with aHomography between theimages.

The goal of the Color correction method is to transfer color properties from source to target image. Fabio Bellavia and Carlo Colombo Proposed a new framework for classifying the color correction[25]. Cheng-Ming,Shu-Wei, jyun-Hong introduced an efficient image stitching algorithm. It provides better image quality and requires less computational time for real time stitching for a continuous image sequences. For this they utilized dominant frames instead of all. Michael DuckjuneKim and Jun Ueda proposed[26] a rapidly moving robotic vision system to generate fast panoramic image. This vision system is used to receive blurry images and then recovered by real time de blurring method. These images are stitched together to create a panorama image using dynamic basedapproach

.This is applicable when the images are received at the rate of 30 frames per second. Chuan Li a, Zhi-YongLiu,,n, Xu Yang , Hong Qiao , Jian - Hua Su proposed an algorithm to improve the quality of noisy or contaminated images[31]. For concrete bridge inspection[33] , the current techniques are time consuming and dangerous. RenpingXie, Jian Yao*, Kang Liu, Xiao huLu, Yahui Liu, Menghan Xia, QifeiZeng proposed a novel stitching method which combines 2 D and 3 D image location point features to reducedrift.

I. CHALLENGESOFIMAGESTITCHING

Challenges in the image stitching are suchas:

- Noisy or contaminated image is to be recovered with help of different filters andalgorithms
- There is need to reduce parallaxerror
- It is required to work on processing time for real time applications.
- A panoramic image is to be developed with invisibleseam

VI. CONCLUSION

Image stiching is considered as an active research area in the fields of computer graphics and computer vision. Image stitching is applicable to various fields as real time applications, medical stitching, satellite images, wireless sensor networks, video stitching and many more. There are huge number of different algorithms for features detection and description. In this paper, a comprehensive study is offered on approaches used in image stitching and model of image stitching. Many algorithms are proposed to improve quality of noisy images or contaminated images to create a single ,large panoramic image. Image stitching is widely used in real time applications specifically in Telemedicine, guided surgery .In this field there is a scope to work on the issues like processing time required in real time applications. Also there is scope to develop algorithms to reduce parallax error, filters to recover noisyimage

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