Ultra Wide Angle Real Time Video Surveillance

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Abstract— Illustrating the method to create Ultra wide angle and high-resolution (720p) videos from video sequences by stitching together individual overlapping video frames, in this work, video stitching is formulated as a multi-frame matching and blending problem. The SURF algorithm is used to find matches of key points between images and blending them together. Camera postures are estimated and fixed according to these key points' information.

Key words: Blending, Image Stitching, Warping

I. INTRODUCTION

The aim of video stitching is to concatenate video frames from multiple video feeds. It is basically the next step of image stitching [1].The process involves capturing of videos simultaneously with multiple cameras and then applying algorithm used in image stitching [1].

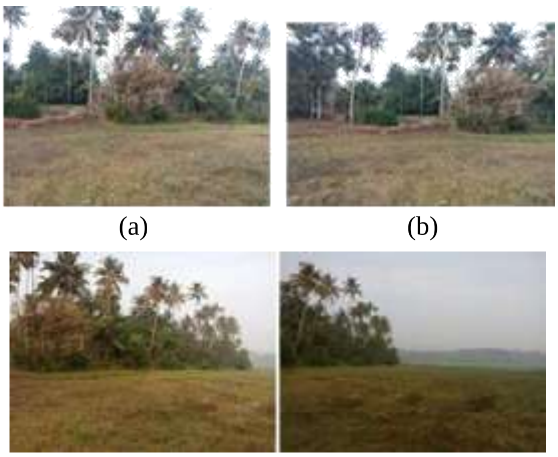
The paper aims at extending the concept of video stitching to the field of real time security surveillance. From the various algorithms used in image stitching ie. SIFT, SURF, ORB [1][2] the most optimum technique was chosen and extended to stitching video frames. The remaining section of the paper would focus in detail on the algorithm used for video stitching.

II. TECHNOLOGY

A. Registration

Image registration transforms images from different views into one coordinate system. Registration of a large number of images is performed by adding new images to the panorama one at a time, aligning the most recent image with the previous ones already in the collection and discovering, if necessary, which images it overlaps. Image registration techniques can be area-based and feature-based. This work makes use of the feature-based technique. Feature-based methods estimate features (control points), such as corners and lines that can be registered between the given images.

Once all of the input images are registered with respect to each other, a decision has to be made on how to produce the final stitched mosaic image. This involves selecting a final compositing surface (flat, cylindrical, spherical, etc.) and view (reference image). It also involves selecting which pixels contribute to the final composite and how to optimally blend these pixels to minimize visible seams (a major problem when stitching images of different intensities, a case in point being the images in Fig. 1), blur, and ghosting



(a) (b) (c) (d)

Fig. 1: (a) and (b) Two registered input images having the same intensity (c) and (d) Two registered input images having different intensities

B. Blending

Once the seams between images have been determined, we still need to blend the images to compensate for exposure differences and other mis-alignments as shown in Fig. 2(a). In the process of blending the low pass filtering of image components is done to remove the effects of a visible seam. It is difficult in practice to achieve a pleasing balance between smoothing out low-frequency exposure variations and retaining sharp enough transitions to prevent blurring.

(a)

(b)

Fig. 2: (a) Stitching result with visible seam. (b) Stitching result after blending

C. Warping

Warping involves changing the image geometry in order to fit to the adjacent images that should contribute to a panorama. Without this remapping process, the images will not stitch together correctly. Warping includes conversion of camera image to sphere, Image alignment, setting screen projection.

D. Image Stitching

Image stitching algorithms for aligning images and stitching them into seamless panorama are among the most widely used in computer vision. These algorithms create high-resolution photo-mosaics used to produce digital maps and satellite photos.

Fig. 3: Stitched Image (16 images) (16889 x 2427)

One technique is directly minimizing pixel-to-pixel dissimilarities. The commonly used technique is to extract a sparse set of features and match them to each other. Such feature-based approaches to image stitching have the advantage of being more robust against scene movement and are potentially faster. Fig. 3 shows a high resolution panoramic image obtained as a result of stitching 16 images. Feature-based approaches can help discover automatically, the adjacency (overlap) relationships among an unordered set of images makes them ideally suited for fully automated stitching of panoramas taken by casual users.

III. ALGORITHM

There are two basic methods for stitching of two video frames:

Direct method wherein stitching process involved comparing each pixel of the images which was very complex and was unsuitable if the two pictures differed in scale and angle of rotation

Feature based method: This method compares features present in the pictures to determine the common region. It is scale and rotation invariant. This method is more robust in case of scene movement and can discover overlaps in unordered image set. These features make them most suited for video stitching.

The feature based technique was implemented in the algorithm. Some of the popular feature based techniques are:

SIFT: It is the most used feature matching algorithm. It determines the feature points which are stored in a descriptor matrix. This technique is complex and time consuming.

SURF: Sped up version of SIFT. Keypoints are selected at regions like corner and T-junction. Keypoint descriptors are then compared with other images to determine matches

ORB: The above two methods used vector based features. ORB employs another form called binary keypoint descriptor. This is faster, requires lesser storage space and easier to compare.

Due to the above mentioned advantages, the ORB feature detection algorithm was employed in the program. Fig 4. Represents the control flow of the program.

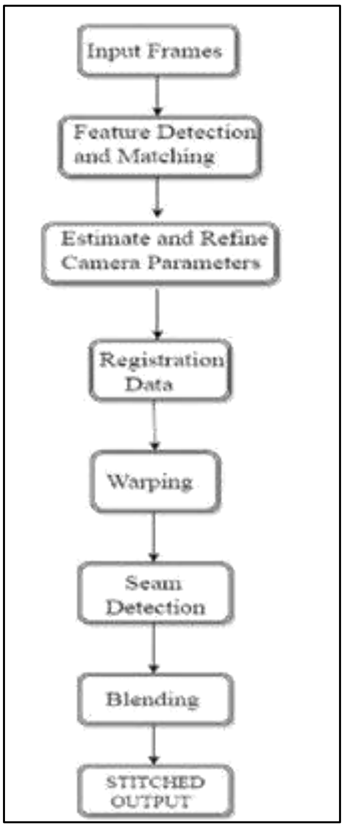


Fig. 3: Stitching control flow

Three webcameras connected to the processing system via USBs were calibrated and setup to capture real-time videos simultaneously. Stitching process involved: extraction of individual frames from the video feeds, determining the feature points for each frame and finally stitching all the three frames corresponding to each of the video feeds. Color blending was performed to obtain a uniform color grading. The above process was repeated for all the successive video frames.

IV. SIMULATION

The work initially started of with the stitching of a set of still images to form a panoramic image. The main challenge encountered at this stage was the presence of a visible seam at cross points of two successive images. After feature detection Fig.4 and matching Fig.5 was performed, image blending algorithms, which mainly include the low pass filtering of image content was incorporated to remove the visible effects of sudden variations in image parameters at these cross points, to even out the seam. The images before and after blending are shown below.

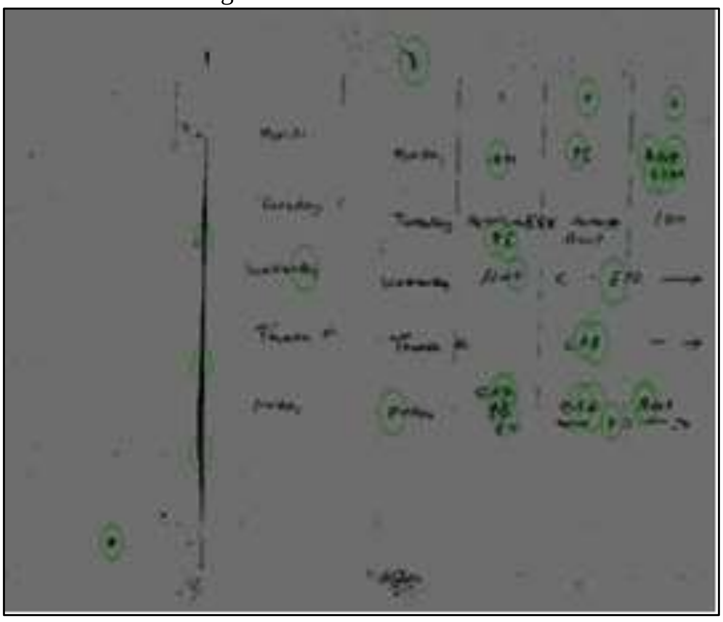


Fig. 4: Feature detection

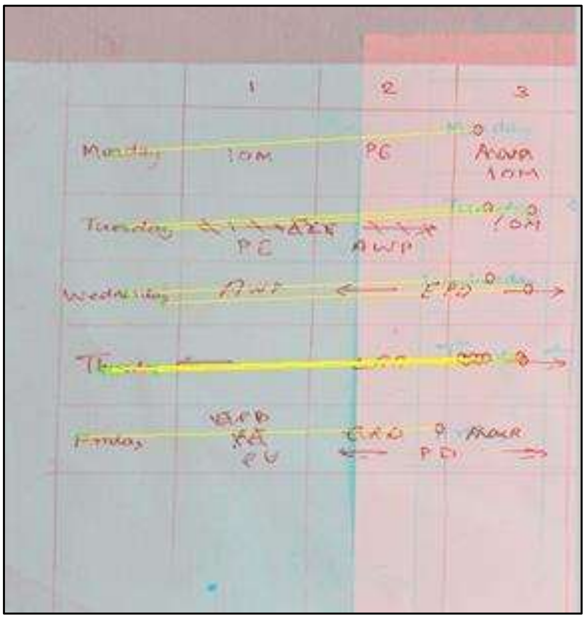


Fig. 5: Feature matching

The frames from videos captured from multiple cameras were extracted and the algorithm mentioned in previous section was used to stitch these frames in real time. The use of an ordinary CPU led to excessive delays in processing. So real times processing with close to zero delays were achieved by using high performance Graphical Processing Units (GPU).

Simulations were performed to demonstrate the usefulness of this technology in military surveillance. The multiple camera array, after proper calibration, was fixed on a platform. This set up can be placed at any desired point of examination. The security personnel can keep watch, and get the continuous seamless 360^0 view without putting his/her life at risk.

Fig. 4: Two consecutive frames of a stitched video

Real-time stitching required the objects to be atleast 50cm away from the camera setup otherwise discrepancies in the region of overlap was observed which prevented successful stitching of the corresponding adjacent frames. Also optimal stitching required that there should be at least 20% overlap between the adjacent frames.

V. Conclusion

In this paper, the idea of image stitching is extended to stitch videos with some additional changes to accelerate the process. The idea was also extended to real time security surveillance applications. SURF algorithm, the most beneficial for the application in hand was adopted for further implementations. Incorporation into a wider range of applications like endoscopy (medical field) and detection of mechanical faults can be done by overcoming the constraint of the least distance of separation between the camera and the nearby objects.

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