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Real Time Panoramic Video in OpenCV using Image Stitching Techniques

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***Abstract*—** Image stitching is basically integrating two or more images to form a single panorama. This process of integrating can be performed by overlapping the images contains common scenes. The panoramic stitching of images is widely used for virtual reality photography and 360 degree cameras. Now a day, panoramic video has also gained importance over a period of time. It has many application built in over it such as security, surveillance, computer vision, robotics, virtual reality and much more. Generation panoramic video can be divided into many steps namely extracting frames from the input video from variety of multiple devices, web-cam etc., time synchronizing the extracted frames, stitching frame to create panoramic frames and then combines those panoramic frames into video. An off-line video of such panoramic frame could be made since there is no time constraint. However generating real time panoramic video is more challenging because of computation resources required and optimization required to produce panoramic real time video. This paper describes the concept of generating real time panoramic video. It also uses the image stitching methods to generate the panorama with the help of Open CV. We are proposing to develop such application which will be very useful in security and surveillance.

***Keywords*—** *Panoramic Videos, Real-time Panoramic Video, Open CV, Video Surveillance*

I. INTRODUCTION

At present days, the technology has been developed to produce images with wide field of view. Image stitching is a process of creating large image known as panoramic image for two or more, probably with overlapping. However, a camera or a human eye can have a limited field of view. To overcome these limitations Panoramic Image stitching is now emerging. The important purpose of such panoramic image stitching is to have wide angle view of the surroundings. Panoramic image stitching is a process of combining two or more images, having overlapped common scenes between them.

From the research literatures, there are two basic methods to combine images, Direct (Pixel Based) and Feature Based. Both the methods have its own advantages and disadvantages. This paper only deals with feature based image stitching methods, since the goal is to develop a real time panoramic video with multiple cameras. Multiple videos are captured without camera motion which means that the videos do not know how they are shoot with the camera.

You-Jin Ha and Hyun-Deok Kang [1] has compared feature based image stitching speed under different conditions. In feature based image stitching first needs an overlapping area between two photos to be stitched. Within the overlapping area, we have to identify the common features, for which we already have two algorithms known as SIFT (Scale Invariant Feature Transform) and SURF (Speeded-Up Robust Features). Homography estimation is the next step. Homography is defined as the relationship between two images and it is represented in matrix form. RANSAC (Random Sample Consensus) algorithm estimates homography matrix more reliably.

Image stitching process may be well described in the following functional block diagram explained by Pranoti Kale and K.R.Singh[4] in their paper. The same is shown in figure 1. Image calibration, image registration and image blending are the three major steps involved in the process of image stitching. The camera co-ordinates and related parameters need to be calibrated in order to reduce the difference between an ideal lens model and the camera-lens combination that was used [4]. In case of multiple images taken from different cameras from different perspectives we need to have geometric correspondence between the images and this process is known as image registration. Image blending ensures that the stitched images are seamless.

You-Jin Ha and Hyun-Deok Kang [1] conducted and experiment with OpenCV image library for image stitching and used to group the images to produce panoramic images. Different experiments conducted by You-Jin Ha and Hyun-Deok Kang [1] shows that various combination of image

stitching took 40 seconds to 120 seconds for a set of fifteen images. The result shows that the time taken for stitching is exponential with number of source images. Typically for fifteen source images with size of 3000 x 2000 pixels will take 60 seconds. This will be a huge bottle neck while using image stitching to create real time video.

Shangchen Liu, Dakun Zhang [2] proposed an improved algorithm for automatic image stitching. Camera orientation estimation, Image rectification, Slice determination and finally stitching the images to create a mosaic using ray interpolation, triangulation and warping techniques. They have concluded than the algorithm used to independently choose the baseline characteristics of the block thinking, and the image of precise stitching, a pyramid-layered match the idea and then making the Image Stitching fast. Therefore, this algorithm is both good and robust has good practicality.

This paper is structured as follows: Section 2 describes the algorithms in Feature Based Image Stitching. Section 3 elaborates the techniques that are to be used to generate real time panoramic video. Section 4 describes about the Open CV and Section 5 contains conclusion and future work.

II. ALGORITHMS IN FEATURE BASED IMAGE STITCHING

This section describes the basic steps that are available in feature based image stitching

(i) Detecting the feature points

(ii) Homography estimation

(iii) Warping the image

The initial step of image stitching is to detect the key features between two or more images which are to be merged together to get a panorama. This is done by finding the features and matching it in each image. The features are the interest points or key points or local features in the image pattern which differ from the immediate neighbourhood. These documents are well documented in "Local Invariant Features Detectors".

In image stitching two algorithms are often used as feature detectors, they are: SIFT- Scale Invariant Feature Transform and SURF- Speeded Up Robust Feature. These two algorithms can robustly detect key points which are invariant to image scale rotation, and illumination.

In the SIFT (Scale Invariant Feature Transform) and SURF (Speeded Up Robust Feature) matching process, common features are identified between two or more images and the key points are stored. On the same time, there are lots of match found between the images but all of the matches cannot be reliable. So, the user has to define the "Good Matches" to decide the reliable ones.

After finding and matching the local features, the next step is to estimate the homography. The homography is the relationship between the images. The homography determine the image overlapping for the stitching process. It plays a major role determining the geometry of multiple views the homography is represented in the form of matrix with an elements. For estimating a reliable homography matrix an algorithm RANSAC (Random Sample Consensus) is used.

The last step of image stitching is warping the images according to the estimated homography. Image is warped according to the homography matrix; images can be stitched together based of the features that are detected initially.

III. TECHNIQUES USED TO GENERATE PANORAMIC VIDEO

Real time panorama video is useful to view panoramic view of the target area in the case of security and vigilance CCTV cameras and even webcam based video capturing devices may pose a delay in output because of time taken to process of creation of panoramic videos. Pritam Prakash Shete et al [5] suggested to use GPU(Graphic Processing Unit) and use of cross platform OpenGL graphics library for real-time online image processing. Further Pritam Prakash Shete et al [5] proved that they can produce a high level seamless panoramic images using nine input image streams each with 800x600 image resolution at about more than 75 frames per second using less than 90 MB of GPU Memory. The basic steps that are need is given in the Figure.1.

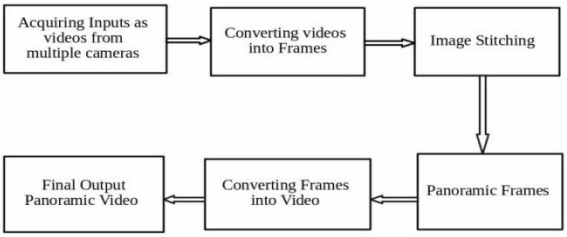

Figure 1: Block Diagram of Image stitching

A. *Acquiring Input Video*

The first stage/step of our proposed work is to obtain the input. Here video from multiple cameras are acquired for the panoramic imaging. These are videos of environment from different angle which are then processed to get a wide field view of the surrounding.

B. *Conversion of Video to frames*

To perform image stitching between the images, first the acquired Video (MP4, AVI) are to be converted into Frames (JPEG, JPG). Frames are the images extracted from the videos. Here we import FFMPEG library for the conversion process. The goal of this paper is to generate Real Time Panoramic Video. From, the survey "Design and Implementation of a Real-time Video Stream Analysis

System Based on FFMPEG paper analyses the Real Time Video Streaming"[7]. The FFMPEG library converts videos to frames and frames to videos. FFMPEG, a media frame work application software, comes handy for the purpose of various requirements such as extracting frames from videos, reduce resolutions of such extracted frames, reducing size of images, combining images back to videos and much more.
In our proposed work, we use FFMPEG for our various needs. However we need to be more conscious about the computational time required for the process and try to optimize the entire process to achieve our goal.

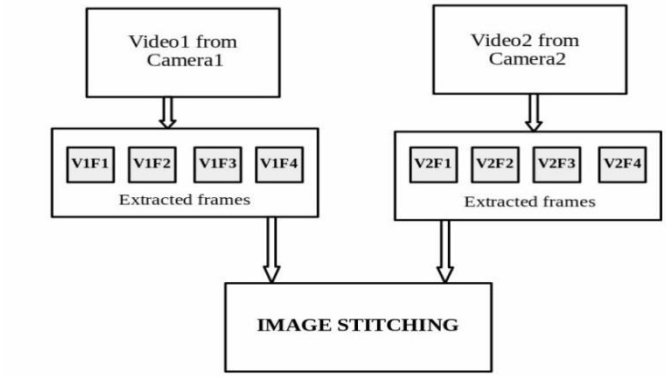

Figure 2: Image stitching from two videos

The V1F1 is merged with V2F1 to merge these; the SURF (Speeded-Up Robust Feature) and RANSAC (Random Sample Consensus) are used.

C. Image Stitching

Speeded-Up Robust Feature Algorithm is used to detect the key points in the frame is extracted from the video. These detect the geometrical features that probably overlap between the two images obtained extracted from two different video

IV. EXPERIMENTAL RESULTS

A. Extraction of Frames from Video

The Videos obtained from devices like webcam, surveillance cameras, mobile cameras etc., are stored in hard disk of the computer. Those video files, depend on the format and video capturing devices, are encoded and multiplexed. The video capturing devices actually receives light and sound in analog form. The analog information has to be converted into digital data and the process is known as encoding which is necessary to transmit, store and process the received information. It is possible to store analog input information but the resource required to store and process is much higher. The following figure illustrates the process of extraction frames:

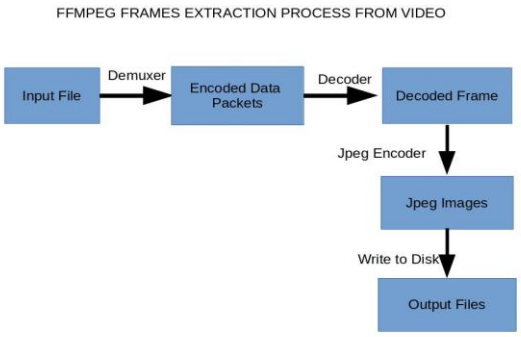

Figure 3: Image Extract from videos

Once we convert analog into digital we can apply compression techniques that reduce the storage space requirement as well as transmission bandwidth requirements. To improve security and confidentiality digital data can be encrypted before storing and transmitting. The process of extraction of frames is illustrated in the figure given above. In our project the video files are taken as input file for ffmpeg, which first de-multiplexed, then decoded to obtain frames. The frames are encoded into jpeg and finally output as jpeg image files.

B. Feature Matching

The Key Points are detected using SURF (Speeded-Up Robust Features) detector and then the descriptors computed. In SIFT, Lowe approximated Laplacian of Gaussian with Difference of Gaussian for finding scale-space. SURF goes a little further and approximates LoG with Box Filter. Below image shows a demonstration of such an approximation. One big advantage of this approximation is that, convolution with box filter can be easily calculated with the help of integral images. And it can be done in parallel for different scales. Also the SURF relies on determinant of Hessian matrix for both scale and location.

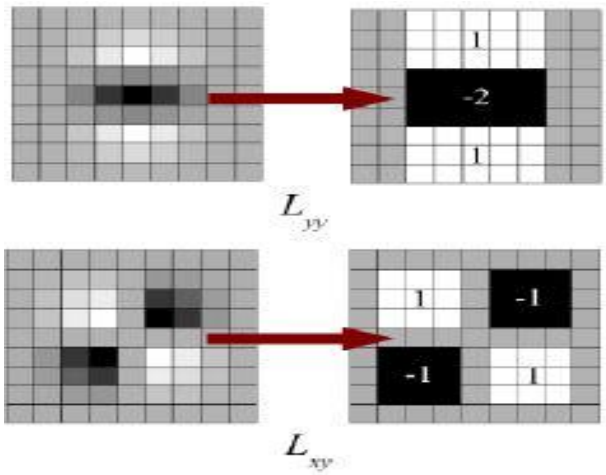

Figure 4: Feature Point Matching

Our final result is shown in the figure below. This panoramic image has been stitched with 25images to get the wide angle view of the surrounding. The existing panoramic image was stitched with 15 images. We increased the frames to get a clear view with more matching features between the frames. Our proposed real time panoramic video is making this as a real time video which provides a wider view without the camera movement.

Figure 5: Experimental Result – Image stitching with 25 frames

V. CONCLUSION AND FUTURE SCOPE

The frames from the videos are merged based time sequence between the videos. Since this is a real time video streaming, lagging can be expected. After the Image Stitching stage, the output we obtain will be a panoramic frame. These Panoramic Frames has to convert back to the video format to achieve our goal. For this process we will use the FFMPEG. We have increased the number of frames to get matching features. Our proposed work is to produce a real time panoramic video which gives us a wide field view of our environment at instances. This proposed system can be helpful, in the surveillance field where, with minimum number of cameras we can generate a panoramic video streaming.

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