Development of Digital Video Stabilization Based On Feature Point Detection

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***Abstract*—Video stabilization is a video processing technique in which the quality of input video is improved by eliminating the undesired jitters in videos captured by handheld devices like mobile phone, digital cameras and cameras mounted on unmanned vehicles. There are various methods used for stabilizing the captured videos. Most of the existing methods are either very complex or time consuming methods. Therefor in this paper we present a new stabilized video developing sequence, by eliminating the undesired motion between the consecutive frames of the hand held mobile video. Paper describes the methods of estimating global motion based on the direct pixel based method as well as feature based method. Finally it clears the concept of video stabilization in the area of motion estimation. In this Paper, We propose a practical and robust method of video stabilization that produces stabilized videos with high quality. Most of previous methods created smaller size stabilized videos with low image quality in the stabilized video while our method can produce videos by feature point extraction and motion estimation with high image quality with smoothing algorithm.**

Index Terms— Block Motion, Feature Point Estimation, Feature Point Extraction and Matching, Global Motion Estimation, Video Stabilization

I. Introduction

The videos taken from hand held mobile devices and digital cameras suffer from various undesired motions. The superiority of output video is affected by undesired and unwanted motions which causes jitter. Stabilization is achieved by creating the new stabilized video sequence by estimating and removing the undesired inter frame motion between the successive frames of captured input video. The main types of video stabilization techniques are mechanical stabilization, optical stabilization and digital image or video stabilization. Mechanical stabilization systems established on vibration feedback through sensors like gyroscope, accelerometers etc. using camcorders [13]. Optical image stabilization developed after mechanical image stabilization in which moveable lens assembly adjusts the path length of the light as it travels through the camera's lens system [15]. It is not suited for small camera in mobile phones due to lack of efficiency. The digital image stabilization tries to smooth the undesired motion by means of digital video processing.

There are numerous algorithms proposed for stabilizing videos taken from different camera system. Block diagram of Video stabilizer shown in Fig. 1. Which contains input shaky video, motion estimation block, unwanted motion detection block and motion compensation block and stabilized video.

Some stabilization algorithms have been proposed based on the estimation of global motion vectors generated by block matching of sub images. Few stabilization techniques are there which involves global motion estimation, [13], [16]. In this paper an improved video stabilization algorithm for hand held mobile camera videos is introduced which gives best stabilized videos with high quality video.

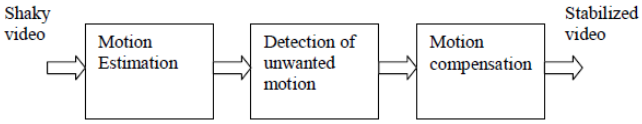

Fig. 1. Stages of video stabilizer

II. Related Work

The video stabilization can be achieved by motion estimation, motion detection, motion compensation, and image warping. There are number of techniques have been proposed for stabilizing videos. One of the best and robust 2D stabilization algorithms are developed and presented in [17, and 18] Hansen et al. [17] define the application of an image stabilization system based on a mosaic-based registration technique. Burt et al. [18] designate a method which customs a multi resolution, iterative process that guesses affine motion parameters between levels of Laplace pyramid of images. Matsushita et.al [10], in 2006 proposed the direct pixel based full frame video stabilization approach. R. Szeliski, in 2006 presented an assessment on image alignment to describe the various motion models, and also presented a good comparison of pixel based direct and feature based methods of motion estimation. The efficiency of the feature based methods depends upon the feature point's selection [5]. Hu, et al [12] in 2007 proposed an algorithm to estimate the global camera motion with SIFT features.

The feature-based approach, are although faster than direct pixel based approaches, but they are more prone to local effects and there efficiency depends upon the feature points selection.

The direct pixel based approach makes optimal use of the information available in motion estimation and image alignment, since they measure the influence of every pixel in the video frame.

III. Motion Estimation Methods

A video processing technique which is used to increase the quality of input video by eliminating the undesired, jittery camera motions is called video stabilization. Digital video stabilization technique depends on motion estimation and

motion smoothing. The heart of this system is motion estimation. Higher the motion estimation achieved higher is the results.

There are various methods to achieve video stabilization. In this paper, we are going to discuss some important methods related to video stabilization.

A. Direct Methods

Direct methods are used for video stabilization because of its lots of accurate and robust presentation is ideal for motion estimation. Direct methods are

1. Phase Correlation Method and Its Extension to Sub pixel Registration
2. Block Based Method

Phase Correlation technique And Its Extension to Sub pixel Registration is based on interpolation approach. Though there are sub pixel registrations that are supported non-interpolation approach. The addition to section correlation lies in interpolation approach.

Block based approach splits each frame of video sequence into 16*16 blocks called macro block and then macro block of current frame is linked with that macro block of previous frame and motion vectors are calculated.

The matching between macro block of current and previous frame is done on the basis of block matching criteria. Lesser the value of matching criterion better is the match between macro block.

B. Feature Based Motion Estimation

In Feature based motion estimation, searching of points is not done over all pixel points. But, specific points called feature points are extracted using SIFT (Scale Invariant Fourier Transform). But, this method has lack of robustness that it gives no feature points in moving things. Also feature points may have different Depth of Field. The first disadvantage can be tackled by using RANSAC. Though RANSAC is very fast system to achieve video stabilization it has one disadvantage. When object is moving slow from the input video RANSAC method gives less accurate results. This problem can also be solved by weighting the feature points and using weighted least square algorithm.

IV. Comparing Block matching and Feature Point Estimation

A. Block Matching Estimation

The impression behind block matching is to split the current frame into a matrix of 'macro blocks' that are then compared with corresponding block and its adjacent neighbors in the previous frame to create a vector that specifies the movement of a macro block from one location to another in the previous frame. This movement calculated for all the macro blocks including a frame which creates the motion estimated in the current frame.

The search area for a good macro block match is controlled up to *p* pixels on all fours sides of the matching macro block in previous frame. This '*p*' is called as the search parameter. Larger motions require a larger *p*, and the larger the search parameter the more computationally expensive the process of motion estimation becomes. Usually the macro block is taken as a square of side 16 pixels, and the search parameter *p* is 7 pixels.

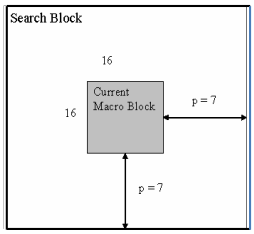

Fig. 2. Block matching a macro block of side 16 pixels and a search parameter *P* of size 7 pixels.

The idea is represented in Fig 2. The matching of one macro block with another micro block is based on the output of a cost function. The macro block that results in the least cost is the one that matches the closest to current block. There are various cost functions, of which the most popular and less computationally expensive is Mean Absolute Difference (MAD) and Mean Squared Error (MSE).

Block matching techniques are the most popular and efficient of the various motion estimation techniques used for digital video stabilization. This paper first describes the block matching motion estimation technique and then compared with our proposed system based feature point motion estimation techniques and at the end shows result of both systems using same video named Shaky Car shown in Fig. 3.

Fig. 3. (a) Unstable input frame (b) Stable output frame for "Shaky Car" video frame using block matching estimation.

B. Feature-Based Motion Estimation:

There is various feature based motion estimation methods used for video stabilization method. The first method is Scale invariant feature transform (SIFT) which extracts and connects feature points in each image which are invariant to image scale, rotation and changes in illumination. It is very suitable for estimating motion between images. Although SIFT has achieved enormous success in video stabilization, it is enable to give best result especially for low end video cameras and cell phones.

This inspires an exhaustive search for substitutes with better quality of stabilized output video which is captured with minor resolution. Obviously, the method is speeded up robust features (SURF).

Further, a new feature which forms on the oriented features from accelerated segment test (FAST) key point detector and the rotated binary robust independent elementary features (BRIEF) descriptor is proposed by the researchers for

betterment. After this FAST feature ORB is proposed. ORB (Oriented FAST and Rotated BRIEF), can be a computationally efficient replacement to SIFT. ORB has similar matching performance with that of SIFT, and is less affected by image noise. And it is also used for real-time performance. The main motivation of RANSAC is to improve the efficiency of many low quality images. Possibly, ORB performs very smoothly as compared to SIFT and SURF. Therefore, the ORB and RANSAC feature is very suitable to be used for the global motion estimation of video stabilization. The number of the detected and matched features is a very important factor, which directly affects the efficiency of the following algorithm implementation processing steps. It can be seen from Fig. 4 that the numbers of the detected and matched features are different in ORB and RANSAC, SIFT, and SURF. SURF has the maximum number of features, the number of SIFT features is smaller, while RANSAC has the minimum features. This indicates that the RANSAC feature-based motion estimation will perform faster than any other methods of video stabilization.

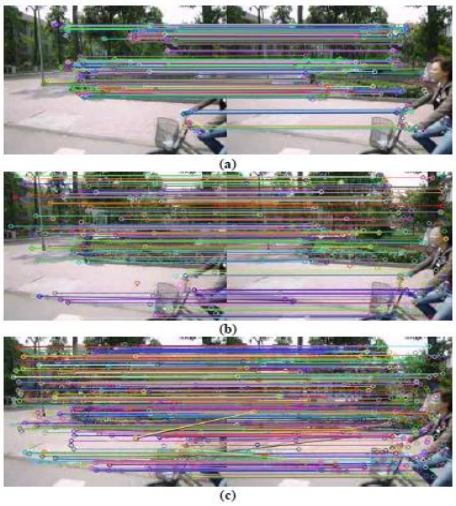

Fig. 4. Corresponding key points in two consecutive frames. (a) RANSAC (b) SIFT (c) SURF

V. Algorithm Implementation

The work of project implemented in four stages which shown in Fig. 5. [5].

A. Pre-processing of input video

This is the first task in proposed algorithm which includes capturing of video with the help of any device like mobile and then converts video to frame sequence followed by RGB frame to gray scale frame for further procedure.

B. Global motion estimation

The calculation of global motion is very important task and it is also carried out in three steps as follows

Step 1: Feature extraction

In this step, from each frame of video, the corner features are extracted which are the moving points in that input video

Step 2: Key-point matching

In this step, extracted feature key-points are then matched in between each frame.

Step 3: Affine transformation

The affine transform is applied to prepare the motion model for those feature matching points.

C. Motion smoothing by filtering

Filtering is applied on affine transform model to smooth out the shaky motion form video.

D. Video warping

To restore the original form of the video, filtered video sequences are applied to final task called video warping.

The main challenge for any video stabilization algorithm is to smooth out any shaky video with better quality of image sequences in less time and to filter the unwanted camera motion caused while capturing video by mobile, handy cam or digital cameras mounted vehicle on bumpy roads.

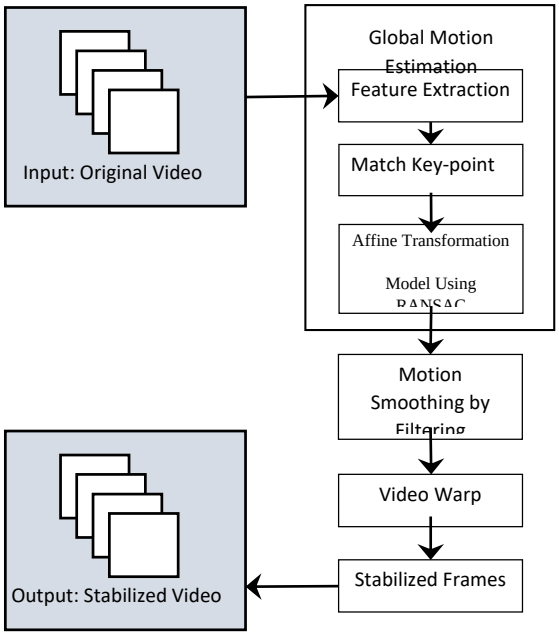

Fig. 5. Block diagram of video stabilization system

VI. Conclusion

In this paper, we propose a robust video stabilization algorithm based on feature point estimation and matching with respect to GME of sequential images captured by mobiles. The vital part of this paper is that the proposed method can be used to estimate the motion of feature points, and the algorithm based on the RANSAC feature points can be used to obtain better global motion estimation and matching. With the help of hundreds of experiments on captured mobile videos, we have confirmed the accuracy and effectiveness of the proposed algorithm. The proposed video stabilization Algorithm is tested on video sequences with the different resolution and

performance is obtained and compared with some previous techniques used for video stabilization. Global motion is used to stabilize motion between each pair of frames from input videos. MATLAB2014b is used on Intel core i3, LENOVO laptop running with 2GB RAM along with WINDOWS 10 for testing different input video sequences of .avi format every video is tested with different frame numbers. The video sequence of "Shaky Car" are used for testing purpose and the results are shown

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