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RESEARCH ARTICLE

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AN EFFICIENT VIDEO STABILIZATION USING MATCHING TECHNIQUES

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ABSTRACT

The main aim of this paper is to introduce a new approach to stabilize image sequence. In this paper a logical and computationally efficient technique for video stabilization and enhancement has been presented. The recent significant development in video stabilization is to create a new video sequence where the motion between frames has been removed effectively. The newly developed algorithm FAST detection algorithm presented in this work provides a fast and robust video stabilization system, and alters real-time performance.

Keywords: Image processing, video stabilization, corner detectors, fast detection algorithm

1. INTRODUCTION

Recently, the market of handheld camera has growth rapidly. However, video capturing by non-professional user normally will lead to unanticipated effects. Such as image distortion, image blurring etc. Hence, many researchers study such drawbacks to enhance the quality of casual videos. There are hardware equipment attached directly to the camera and also software like pre-processing and post-processing techniques, but still there are draw backs to overcome when multiple objects are moving in the background.

Digital video stabilization is the process of removing unwanted movement from a video stream. Digital video stabilization is different than mechanical and optical stabilization. Mechanical stabilization Physically dampens out vibration or unintended movement with gyroscopes. Optical stabilization is when sensors detect

Mechanical movement and shift the lens slightly. Both of these methods stabilize the image before it is converted to digital. Digital video stabilization modifies each input frame to maintain a steady image after it is converted to digital. A transformation matrix is calculated via different motion estimation methods and is used to move the image.

Generally the processes of stabilization have to go through three phases namely

1) Motion estimation
2) Motion smoothing
3) Image composition.

For the first phase the purpose is to estimate the motion between frames. After that the parameters of estimated motion which is obtained from the first phase will be sent to motion compensation, where removing the high-frequency distortion and calculating the global transformation, which is very important to stabilize the current frame. Next, warping will be done by image composition for the frame under processing. These three-step frameworks are the essential steps in most of the video stabilization algorithms.

2. EXISTING METHODS

The first corner detectors were developed in the late 1970's, dozens of corner detectors have been proposedLabeebMohsin Abdullah, NooritawatiMd Tahir and MustaffaSamad [1]had proposed an algorithm to stabilize the image sequence by using Harris corner detection technique. Corner Detector System Object is used to find corner values using Harris Corner Detection which is one of the fastest algorithms to find corner values. AleksandrShnayderman, Alexander Gusev, and Ahmet M. Eskicioglu had proposed to measuring SVD based gray scale image quality[2]. This is evaluated based on SVD based grayscale Image value and graphical measurement Edward Rosten, Reid Porter and Tom Drummond, proposed “FASTER and better A machine learning approach to corner detection “.After the salient points from each frame are obtained the Correspondence between the points that are identified previously need to be picked [3].

For each point, the matching of lowest cost between the points that existed in frame A and B are also needed to be found for all points. Hence, it is necessary to divide the sequence of frames image into 9×9 block. The matching cost means the distance between frame A and B measured in pixel. To find this cost, the technique of Sum of Squared Differences (SSD) can be used between the consecutive frame images. Problem of corner detection is still an open problem as no universally good corner detector exists. Harris corner detection techniques are used .Harris corner detection technique does not improves the image quality and efficiency also very less. The computational time is also very high.

3. PROPOSED METHOD

Features from accelerated segment test (FAST) is a corner detection method which could be used to extract feature points and later used to track and map objects in many computer vision tasks. FAST is an algorithm proposed originally by Rosten and Drummond for identifying Interest points in an image. It is fast and indeed it is faster than many other well-known feature extraction methods, such as Difference of Gaussians (DoG) used by SIFT, SUSAN and Harris. Moreover when machine learning method is applied, a better performance could be achieved which takes less time and computational resources. An interest point in an image is a pixel which has a well defined position and can be robustly detected. Interest points have high local information content and they should be ideally repeatable between different images. Interest point detection has applications in image matching, object recognition, tracking etc.

4.ALGORITHM& IMPLEMENTATION

The Flow chart of the proposed method of video stabilization algorithm and implementation is shown in below Fig. The total process of video capturing and analysis has been performed in several steps.

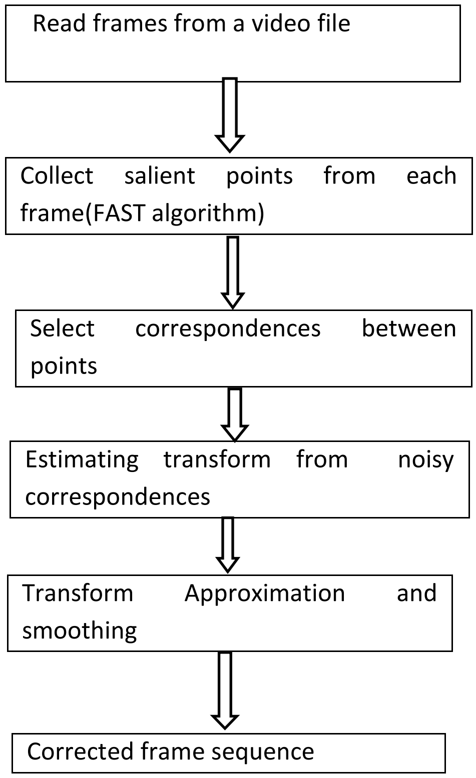

Fig 1: Overview of the proposed method of video stabilization

A.Read Frames from a Video File

The data related intensity of images has been separated from color. The intensity data is

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fed as input to the stabilization algorithm. It is also observed that speed of processes has been increased drastically because of the usage of gray scale images. Two consecutive frames of images after processing using above criteria are shown in figure 2. A real cyan color composite is produced to illustrate the pixel wise difference between them. It can be read from the frames represented in figure 2 that there is obviously a large vertical and horizontal offset between the two frames

B.Collection of Salient Points from Each Frame

Our goal is to determine a transformation that will correct for the distortion between the two frames. We can use the Geometric Transform for this, which will return an affine transform. As input we must provide this function with a set of point correspondences between the two frames. To generate these correspondences, we first collect points of interest from both frames, then select likely correspondences between them.

In this step we produce these candidate points for each frame. To have the best chance that these points will have corresponding points in the other frame, we want points around salient image features such as corners. For this we use the one of the fastest corner detection algorithms. The detected points from both frames are shown in the figure 3. Observe how many of them cover the same image features, such as points along the tree line, the corners of the large road sign, and the corners of the cars.

FAST Detection Algorithm

FAST is an algorithm proposed originally by Rosten and Drummond [4] for identifying Interest points in an image and is shown in figure4.An interest point in an image is a pixel which has a well-defined position and can be robustly detected. Interest points have high local information content and they should be ideally repeatable between different images [10]. Interest point detection has applications in image matching, object recognition, tracking etc.

Features detection using FAST:

1. Select a pixel "p" in the image. Assume the intensity of this pixel to be IP. This is the pixel which is to be identified as an interest point or not.
2. Set a threshold intensity value T, (say 20% of the pixel under test).
3. Consider a circle of 16 pixels surrounding the pixel p.
4. "N" contiguous pixels out of the 16 need to be either above or below IP by the value T, if the pixel needs to be detected as an interest point.
5. To make the algorithm fast, first compare the intensity of pixels 1, 5, 9 and 13 of the circle with IP. As evident from the figure above, at least three of these four pixels should satisfy the Threshold criterion so that the interest point will exist.
6. If at least three of the four pixel values - I1, I5, I9, I13 are not above or below IP + T, then P is not an interest point (corner). In this case reject the pixel p as a possible interest point. Else if at least three of the pixels are above or below IP + T, then check for all 16 pixels and check if 12 contiguous pixels fall in the criterion.
7. Repeat the procedure for all the pixels in the image

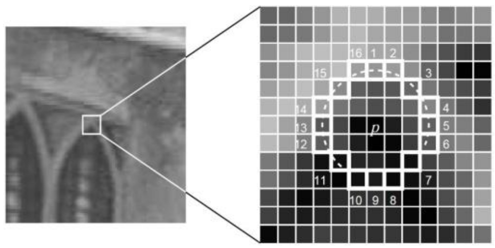

Figure 2: Image showing the interest point under test and the 16 pixels on the circle

C. Select Correspondences between Points:

An interest point in an image is a pixel which has a well-defined position and can be robustly detected. Interest points have high local information content and they should be ideally repeatable between different images Interest point detection has applications in image matching, object recognition, tracking etc.

In this step, correspondences between the points derived in the step B have to be picking up and consolidation shall be done. For each point, we extract a 9-by-9 block centered on it. The matching cost that is used between these points is the sum of squared differences (SSD) between their respective image regions. The figure5 shows the same color composite of figure 6, but added are the points from frame A in red, and the points from frame B in green. Yellow lines are drawn between points to show the correspondences selected by the above procedure. Many of these correspondences are correct, but there are also a significant number of outliers.

D.Estimating Transform from Noisy Correspondences

Many of the point correspondences obtained in the previous step are identified with limited accuracy. To rectify this problem, a new robust estimate of the geometric transform between the two images using the Random Sample Consensus (RANSAC) algorithm, which is implemented in the Geometric Transform Estimator System object is developed and presented. Affine Transform: It is any transformation that can be expressed in the form of a matrix multiplication (linear transformation) followed by a vector addition (translation). We can use an Affine Transformation to express:a)Rotations(linear transformation) b)Translations (vector addition) c)Scale operations (linear transformation) In essence, an Affine Transformation represents a relation between two images. The methodology followed to perform the implementation of above technique is as follows. For added robustness, the Geometric Transform Estimator System object will be run multiple times to calculate a cost for each result. This cost is obtained by projecting frame B onto frame A according to the derived transform, and taking the sum of absolute difference (SAD) between the two images. From this, the best transform as the one that minimizes this cost is taken as outcome. Below Figure 6 shows a color composite showing frame A overlaid with the re-projected frame B, along with the re-projected point correspondences. It is clear from this figure that the results are favorable, with the inliers correspondences nearly exactly coincident. The cores of the images are both well aligned, such that the red-cyan color composite becomes almost purely black-and-white in that region.

E.Transform Approximation and Smoothing

In this step we are construct a new S-R-T transforms for this

- We extract scale and rotation part of sub-matrix from affine transform of matrix 3-by 3 as shown in the above step.
- Compute theta from mean of two possible arctangents.
- Compute scale from mean of two stable mean calculations
- Translation is remain same as original S-R-T transform and
- Finally reconstruct new S-R-T transform and is shown in below figure 7.

F.Corrected Frame Sequence

During computation, we computed the mean of the raw video frames and of the corrected frames. These mean values are shown side-by-side below. The left image shows the mean of the raw input frames, proving that there was a great deal of distortion in the original video. The mean of the corrected frames on the right, however, shows the image core with almost no distortion. While foreground details have been blurred this shows the efficacy of the stabilization algorithm.

5. SIMULATION RESULTS

In this a video namely shaky _car is considered. FAST detection method is applied for the video mentioned and the results in terms of SVD based grayscale quality and computational time will be analyzed.

A.Results of video (shaky_car video)

Video 1(shaky _car) has the following specifications: the length of 4 seconds, width x height of 320x240, frame rate of 30 frames/second and size of 1.2 MB.

Two consecutive frames of images from video are shown in Fig 3. A real cyan color composite is produced to illustrate the pixel wise difference between them as shown in Fig 4. It can be read from the frames represented in Fig 4 that there is obviously a large vertical and horizontal offset between the two frames.

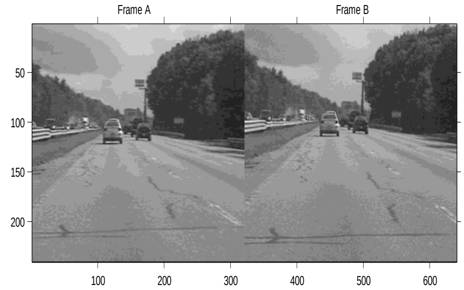

Fig 3: Reading the two frames from a video sequence

The detected points from both frames are shown in the Fig 5. Observe how many of them cover the same image features such as points along the tree line, the corners of the large road sign, and the corners of the cars. Corner detector produces the candidate points in each frame.

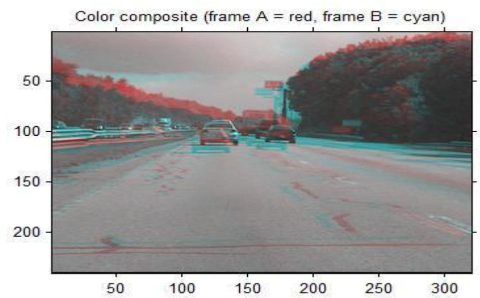

Fig 4.Color composite of frame A and frame B

To have the best chance that these points will have corresponding points in the other frame, the points around salient image features such as corners are wanted points. For achieving wanted points one of the fastest corner detection algorithms namely FAST detection technique is used.

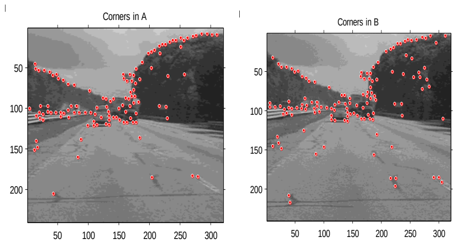

Fig 5. Collection of salient points from both frames

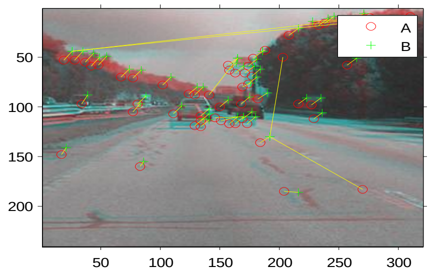

Fig 6.Select the Correspondences Points from Both Frames

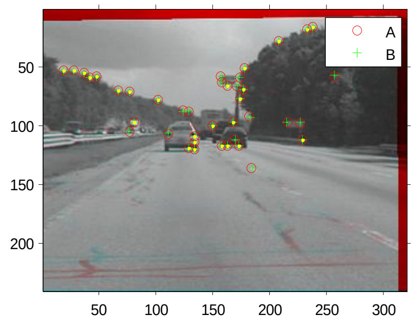

Fig 7 color composite showing frame an overlaid with the re projected frame B

Next pick up correspondences between the points derived in the frame B. For each point extract a 9 x 9 block centered on it. The matching cost used between points is the Sum of Squared Differences (SSD) between their respective image regions. Points in frame A and frame B are matched and select the correspondences points from Both Frames as shown in Fig 6

The Fig 7 shows the same color composite of Fig 6, but added are the points from frame A in red, and the points from frame B in green. Yellow lines are drawn between points to show the correspondences selected by the above procedure. Many of these correspondences are correct, but there are also a significant number of outliers.

Fig 7 is a color composite showing frame A overlaid with the re projected frame B along with the re projected point correspondences. The inliers correspondences are nearly and exactly coincident. The corners of the images are both well aligned such that the red-cyan color composite becomes almost purely black-and-white in that region.

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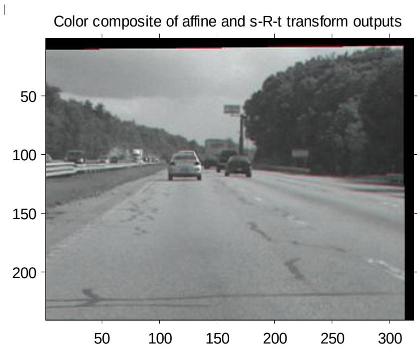

Fig 8: Color Composite of Affine and S-R-T Transform

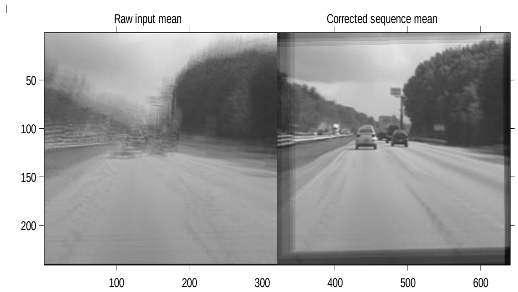

Fig 9. Corrected frame sequence of the jittery video

Color composite of Affine and S-R-T Transform is shown in Fig 8.During computation, the mean of the raw video frame and of the corrected frame are computed. The mean values of raw video frame and the corrected frame are shown in Fig 9. The Fig 9(a) shows the mean of the raw input frame proving that there is a great deal of distortion in the original video. The mean of the corrected frame Fig 9(b) shows the image with no distortion.

B.Measurements

The output video quality is also measured based on the proposed methods. This is evaluated based on SVD based grayscale Image value and graphical measurement.

SVD Based Grayscale Image Quality

Singular value decomposition (SVD) is developed as a new measurement that can express the quality of distorted images either graphically that is in 2D measurement or numerically as a scalar measurement, both near and above the visual threshold. The experiments here utilized SVD based measurement that outperformed the normally used PSNR [4] and corresponding results as shown in table 1The following Equation represented the computed value for this purpose:

$$M - SVD = \frac{\sum_{i=1}^{(\frac{k}{n})x(\frac{k}{n})} |D_i - D_{mid}|}{(\frac{k}{n})x(\frac{k}{n})}$$

Where

D_{mid}represents the midpoint of the sorted D_{is}

k is the image size

n is the block size

M –SVD is the measurement of Singular value decomposition.

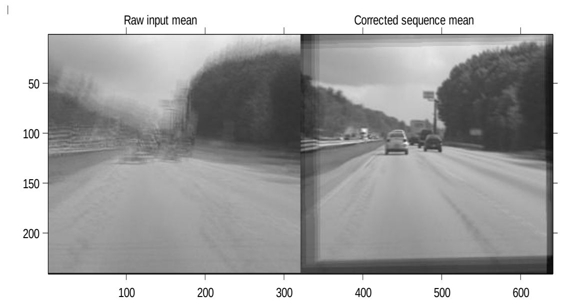

Fig 10: shaky _car video with different stabilization need to be done since recorded in different circumstances.

Graphical measurement

The criteria of measuring graphical quality in any image or frame can be done as shown in Figure 11 Graphical measurement will indicate the condition of video due to distortion.

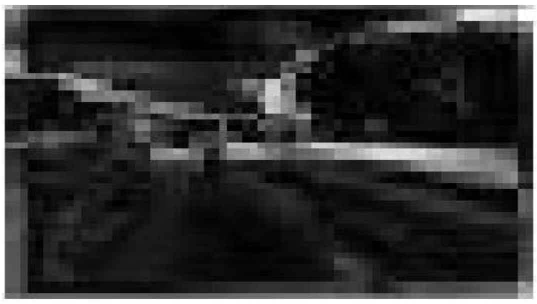

Fig 11: Graphical measurement for each sample video (shaky_car) as quality stabilization indication

For example if we consider our video and calculate the numerical value and quality value for a sample picture as shown in the figure 4 then the values would be like this:

Computational time(S):8.078

Numerical measure: 30.4%

Measure svd value (Quality):69.6%

C. Advantages

- The main advantage of this technique is reducing the effect of shakings on the video.
- Computational speed compared to existing algorithm.

D. Comparison between Existing and proposed techniques

The comparison between existing and proposed techniques is shown in below Table. It is concluded that the proposed technique (FAST corner detection) is computationally high speed and good quality than Harris corner detection technique.

Feature detection	**Measured svd Value (quality)**	**Computational Time(S)**
Existing technique	40.50%	9.28%
Proposed technique	69.84%	8.078

Table: Comparison between Existing and Proposed Techniques

From the above table we can say that, our proposed method is computationally high speed and quality compared to proposed method.

6. CONCLUSION

The proposed technique is logical and computationally efficient approach in terms of stabilizing high jitter videos suffered from distortion. The newly developed algorithm FAST detection algorithm presented in the work provides a fast and robust stabilization system and improves real-time performance.

The quality and computational time are measured and compared for video1.The same parameters are evaluated and compared by using Harris corner and FAST corner feature detection techniques for a given frame of video1. The use of FAST detection method shows improved result in terms of stabilization and discarded distortion from the output videos recorded in different circumstances. FAST detection technique is useful in enhancing the quality of low-grade video surveillance cameras. FAST detection technique is particularly helpful in identifying people, license plates, etc. from low-quality video surveillance cameras.

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