Digital Video Sewing and Stabilization by Using the Bezier Curve and Optimization

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Abstract-The problem of digital video stabilization is addressed in this paper. Videos captured by hand-held devices (e.g., cell-phones or DVs) often appear remarkably shaky. Digital video stabilization improves the video quality by removing unwanted camera motions. Our work is based upon the beizer curve smoothing which is following the KLT features tracking method. Beizer curve smoothens and reduces the ouliers in each frame's features. But beizer curve method chooses the control points randomly which doesn't guarantee a converged solution. We updated it by controlling the control points of beizer curve, resulting in reduction of more number of outliers and less feature points which are coinciding in consecutive frames. Initial frame of video is considered as reference and rest frames are rotated as per angle difference from that. We introduced a novel firefly optimization for bizer curve smoothing and evaluated the results of stabilized video on the ground of PSNR, IFT and SSIM.

Several test videos are used for testing to check the efficiency of proposed solution, it has been noted that in each case proposed solution is improved upto 25% than beizer curve and 26% from the current shaky frames.

Index Terms- *Digital video stabilization, FFA, Bezier curve. Image sewing*

I. INTRODUCTION

In the present scenario expensive camera can be captured a stabilized video of a moving object and place. The shaking of video is removed by the stabilized video technique. On the left side in figure 1 shows some captures of shaky video. The video quality can be improved by digital video stabilization as shown in figure 1 on the right side.

Three main steps of video stabilization are:

- Find actual shaky camera path by evaluating the motion of camera.
- Generate a different stable camera path.
- Arrange the stabilized video by the stable camera path..

The pipeline shows in the diagram below. Firstly input is given then camera motion evaluate in 3D/2D . The video stabilization can be done as 3D,2D and 2.5D based. By using the SFM (structure from motion) algorithm in 3D based the scene can be recover and reconstruct..

II. DIGITAL VIDEO STABILIZATION

The electronic processing to control the stability of image is used in Digital stabilization. In this the components of hardware are replaced by the software algorithm. So the cost of the system is reduced and other characteristics give effective solution of the problem. Apply series of operation over the frames and obtain inter-frame global motions by taking two frames of the video. Due too much image operation the motion estimation work is complicated and time consuming. The motion estimation has inter- frame global motions which consist of intentional and non intentional motions. After motion estimation the motion correction is done and the last one set the frame according to estimate jitter. In this the stabilized video sequence is obtained with the help of same amount of moments given to the frame with respect to the estimated jitter. The drawback of digital stabilization video is distortion over the stabilized video. Some contents of the frames can be missing due to distortion. If the algorithm is optimized it can be used for both real time application and off line application. Digital stabilization causes some distortions over the stabilized video. Since interpolation is utilized to correct the frames, sharp edges and high frequency details of the frames are lost. Furthermore, movements cause also to loose some content of the frames. stabilization can be used for both real time and off-line applications. This is an advantage of digital stabilization.

III. BEZIER CURVE & ITS PPLICATION

The main application of Bezier curves are used in pictures and graphics but in statistics also it attracted a little attention. We presented a brief introduction of Bezier curves here.

The Bernstein polynomials of degree d for $i = 0, \ldots, d$ for $t \in [0,1]$ are defined as

$$B_i^d(t) = \binom{d}{i} \, t^i (1-t)^{d-i}$$

With degree d the Bezier curve has the form

$$c(t) = \sum_{i=0}^{d} P_i \; B_i^d(t)$$

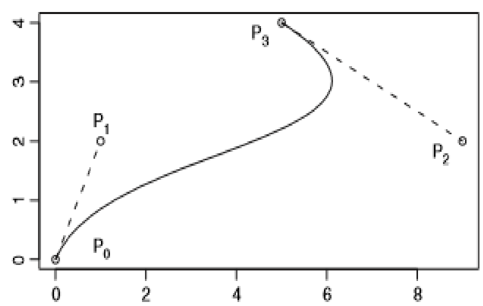

Figure 1 Bezier curve at Cubic($d = 3$) [13]

Assume $Z_0, \ldots, Z_n$ are the calculated sequence of points having q dimensions trajectory. The applicable Bezier curve C(t) of degree d for $t\epsilon[0,1]$.

So $C(0) = Z_0$ and $C(1) = Z_n$.

At the which value of t beyond the curve the C(t) must be respond with the calculated point Z_i. Suppose that the sum of square function given below. In this we required to pass non constants motion then obtain a result sum of square sequence. The parameters ($0 \leq s_1 \leq \cdots s_{n-1} \leq 1$) shows the integration of the hand with the dimensions.

$$SS = \sum_{i=1}^{n-1} Z_i - C(s_i)^2$$

The main idea behind this to select the fit points for minimizing SS to C. In some cases $s_i = {}^{i}/_{n}$,

The spaced time for arch length spacing of

$$s_i = \sum_{j=1}^{i} a_j / \sum_{j=1}^{n} a_j$$

a_j parameter is used which provide some changes in the dimension with respect to the speed changes of the variable. the value of $a_j=[Z_i-Z_{i-1}]$. But in some application the SS minimize through fit point P^.

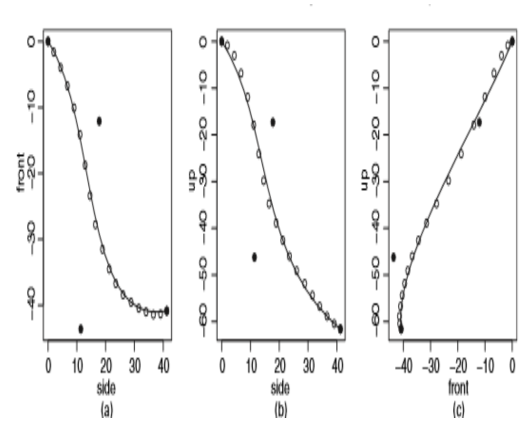

Figure 2 3D cubic Bezier curve (a) top view;(b) front view;(c) side view [13]

IV. FIREFLY (FFA) OPTIMIZATION

The basic concept of fireflies is spark an light. Mostly the fireflies are found in the tropicaland temperate areas. There is large number of fireflies present in the species more than 2000. Each fireflies produce short spark or flashes. The sample of spark is different for each species. In some cases the female can copy the other species mating flashing pattern which can be eat the male fireflies.

The function of flashes;

- To attract mating partners(communication)
- To attract potential array
- Protective warning Mechanism

V. KLT TRACKING

KLT feature tracking approach strong to digital estimation. The conventional KLT makes use of snap shots best and its operating situation is restricted to short look alternate in a pix. The main condition of the non linear optimization is used a less gradation type gyros for refining process. It improve the strength of KLT for covering the parameters in convergence. First of all the function specifies on which the picture can be tracked. As shown in figure some parameters were decided to be tracked from the image. Then the main window tracked fixed size variable.

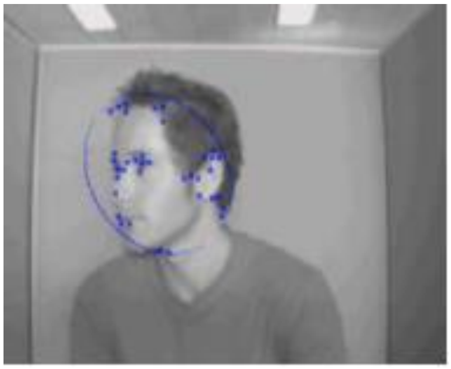

Figure 3: Detected features with an ellipse around them.

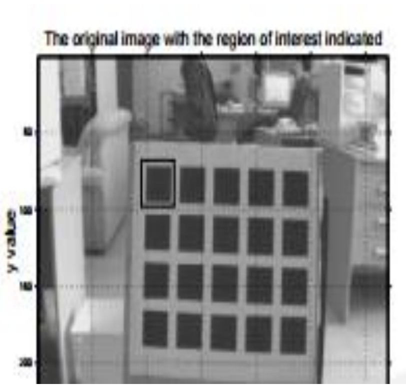

Figure 4: An image to illustrate corner detection

Above image shows the KLT approach. This technique calculates the sum of squared intensity differences among a feature in the previous image and the functions inside the present day image. The displacement of the precise feature is then described as the displacement that minimizes the sum of differences. This is carried out constantly among sequential pix so that all the feature scan be tracked.

VI. PROPOSED WORK

In some applications, it might be reasonable to use evenly spaced t but, for hand trajectories, we know that the hand does not move at constant speed. We need to allow for non-constant speeds and so we define a sequence of relative times, $0 \leq s_1 \leq \cdots s_{n-1} \leq 1$ representing the relative progress of the hand along the trajectory. We define the sum of squares for the fit as

$$SS = \sum_{i=1}^{n-1} Z_i - C(s_i)^2$$

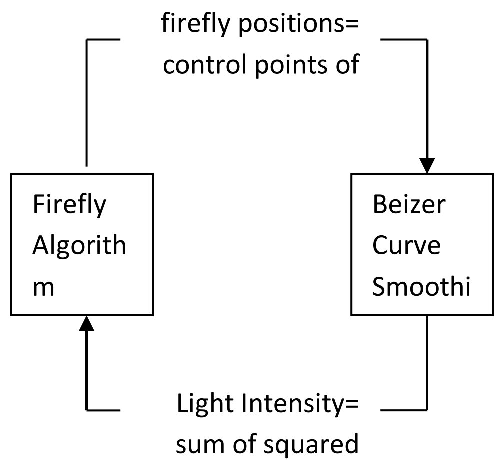

Figure 5: Representation of equilibrium of firefly optimization and beizer curve smoothing

VII. RESULTS & DICUSSION

Our work for video stability enhancement is based on Bezier curve fine tuning by firefly optimization algorithm. This work is simulated in MATLAB R2016a and various user defined functions are written for it. MATLAB's computer vision toolbox helped us a lot in saving our time to write every function form scratch. The whole work is divided into multiple steps:

1. Feature extraction using KLT features

2. Bezier curve smoothing

3. Firefly tuning of Bezier curve

Figure 6.Overlapping of KLT features in reference frame and last frame of video

Figure 7.Overlapping of KLT features in reference frame and last frame of video using firefly smoothed beizer curve

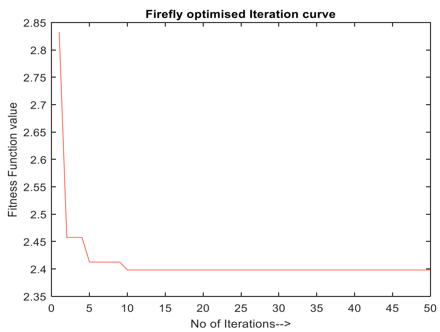

Figure 8: Optimisation curve of fitness function value for firefly tuned biezer curve

analysis is giving the clear comparison for some frames yet we evaluated the parameters to validate the comparison with previous work. We used PSNR (Peak to signal Noise ratio), Inter frame transform fidelity (ITF) and structural similarity index (SSI).

The PSNR demonstrate that our stabilization process

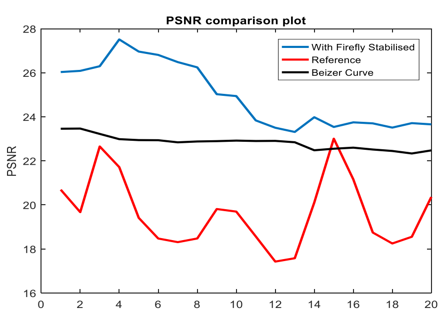

Figure9 (a): PSNR plot for firefly stabilized, biezer curve stabilized and for the reference frame with other frames

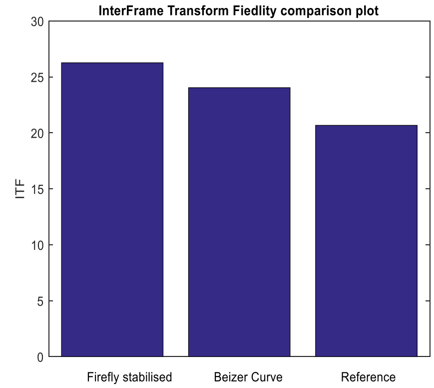

figure 9(b): ITF plot for firefly stabilized, biezer curve stabilized and for the reference frame with other frames

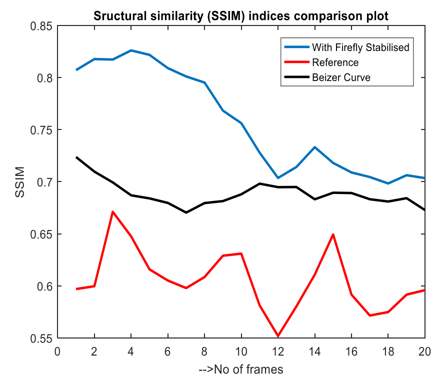

Figure 9(c): SSIM plot for firefly stabilized, biezer curve stabilized and for the reference frame with other frames

figure 9shows highest PSNR for the proposed method which is touching the value of 26 for the second frame. Since ITF depends upon the PSNR, so higher will be better. SSIM has maximum value of 1. Nearer to 1, better is the similarity in between subsequent frames. For some frames in images it is touching the mark of 0.83.

figure10(a)KLT feature tracking by beizer curve

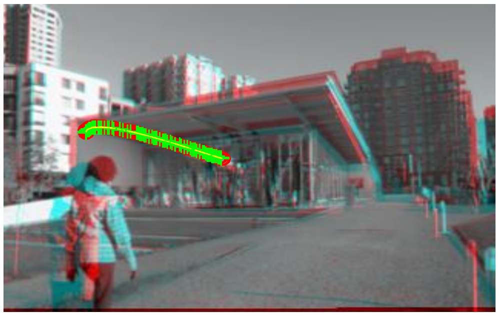

Figure10(b). KLT feature tracking by firefly optimised beizer curve

Higher the value of PSNR, god is the robustness. 9.(a We have tested results for other videos also which have complex background, with less fps in video. shows those figure's last stabilized frame along with mean of evaluation parameters for all frames. This table shows that as the video background is getting more and more complex, the performance of the algorithm reduces but still in each case, proposed solution is winning the competition.

VIII. CONCLUSION & FUTURE SCOPE

We have proposed a novel video stabilization method is based on reducing the features points in beizer curve. KLT feature tracking method is used for features tracking and initialized by SURF features of first reference frame. In subsequent frames these corresponding features are tracked and by image warping method followed by firefly tuned beizer curve smoothing, image is transformed to stable state. MATLAB's computer vision toolbox saved our time to write the code of SURF features, KLT tracking, image warping etc and we could focus on beizer curve smoothing algorithm.

We used PSNR, ITF and SSIM as the evaluation parameters for stabilization work and proposed method results are compared with beizer curve and reference frame. For different videos with complex background and low fps, proposed method is performing good than others. For a case we were able to see the improvement of 25% by the proposed from beizer curve and 26% from the reference frame while only beizer curve smoothing could see it 1% form reference frame. Similarly ITF and SSIM are also better than beizer curve smoothing scenario. Test on different videos proves this method is efficient than previously used beizer curve for video stabilization.

The final goal of the project is to stabilize the video. We haven't tested it on real world scenario, due to limitation of computation complexity. FPGA/embedded hardware may help in it.

The initial feed for KLT features tracking is SURF features. Rather than these SURF features, a more robust feature set can be used like SIFT or SIFT in combination with others.

Further research could be performed on using this video stabilization method as part of a control loop for a pan/tilt mechanism to physically stabilize the camera. This could be a slower outer loop controller working in concert with a faster inner loop controller using a fast IMU or AHRS sensor.

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