A Robust Digital Image Stabilisation Using LS Algorithm

Dr.Ch.Ravi Kumar, and Dr.S.K Srivatsa

Abstract— A video is nothing but a continuous number of successive images. The cams and robots are a portion of the implanted frameworks which are outfitted with a computerized picture sensor which delivers picture arrangements from a feature with two separate sorts of developments: the smooth movement (purposeful or needed) and the undesirable movement (jitter) of the cam. The strategy for the evaluation of the jitter with a specific end goal to acquire the settled picture is called Digital Image Stabilization (DIS). Block Matching Method (BMM) is used to find about the pixels displacement between two continuous images in a video which helps in effective and efficient encoding of a video. Movement estimation was carried out on the sender side to get the Motion Vectors (MV) which helps in acquiring the needed and the undesirable movement. The Motion Estimation is done by using Logarithmic Search (LS) which is a Fast search algorithm in which two motion estimations are obtained which helps in compensation of the image to get the stabilized output. Basing on the fundamental features of the shaking patterns which is unwanted with low power contents and high frequencies, both the jitter and wanted motions are determined, and then, in order to remove the possible fluctuations and to produce a stabilized image with smoother transitions, motion compensation is applied.

Keywords—— Digital Image Stabilization (DIS), Block Matching Methods (BMM), Block Matching Algorithm (BMA), Motion Vectors (MV), Jitter, Jitter Estimation, Logarithmic Search (LS)..

I. Introduction

IMAGE stabilization mainly deals with removal of the unwanted motion from a sequence of images in such a way that to obtain the sequence which is called as compensated image sequence. In stereo image analysis to achieve maximum performance, vehicles are equipped with vision systems [1]. To improve the efficiency of video communication, image stabilization is integrated with compression codecs, [2]. In [3], an image is stabilized with the help of the solar optical telescope by using displacements of the images to remove jitter motion from the obtained image sequence from satellite. These Image Stabilization framework are divided into four parts: Optical, Electronic stabilizers, Charge-Coupled devices (CCD) and Digital stabilizers in [4]. Optical picture settling systems are utilized as a part of cams that settle the recorded picture by fluctuating the optical way by the sensor [5]. An image stabilization process was applied after the image acquisition which contains three stages [6], [7] and [8]. They are global motion estimation, jitter movement determination, and image warping. Stabilized image only contains the Smooth camera movements. Typically a video sequence contains temporal redundancy i.e., two consecutive frames are similar except for the changes due to object and camera movements, illumination and so on. The motion estimation has the process of video compression which has inter-frame and intra-frame coding, [9].

The Efficient motion estimation is the one which improves compression performance by reducing the energy in the motion-compensated residual frame, [10]. To decrease the redundancy in moving pictures, Block matching methods are used. Block matching algorithm (BMA) has two stages. They are image Estimation and Compensation. It contains Block Determination, Matching criteria and Search Method. BMA takes a reference frame block in a current frame and it searches in the window size of (2MD+Q) x (2MD+Q) in the last frame to obtain the best Block match, where MD stands for Maximum Displacement allowed and Q x Q is the number of pixels in the block. The motion vector of the reference block is obtained as by calculating the relative positions between the best matched block and the reference block. The Block Matching Method is shown in Fig 1.

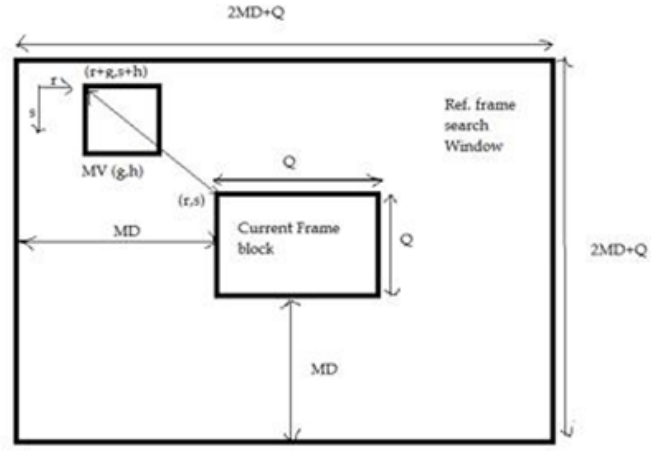

Fig 1: Block Matching

Block matching criteria and search method is depend on the type of search used. Mostly the matching criteria used is SAD (Sum of Absolute Difference) and PSNR (Peak Signal to Noise Ratio). The Search method used in LS i.e. Logarithmic Search. The steps involved in this are firstly the initial frame is coded and secondly traversing of the trajectories for different objects. With the help of the obtained motion vectors

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the jitter motion is determined. It was estimated by considering the directions and velocities of the vectors obtained at every pixel of the image. The elimination of the jitter motion with the help of the motion vectors is called as image compensation or image warping.

Due to its efficiency in bit rate and quality, many video encoders uses BMA. The Brute force attack method of searching is the Full Search Algorithm (FSA) which is of highly time competitive and for some image frames it is NP complete. Hence various fast algorithms are used. In this paper, Logarithmic search algorithm is used which belongs to fast Search algorithm. It was introduced by Jain and Jain, [10] where the search window confines to a particular step size.

Finally, the image compensation is done with the help of the inversion of the defined jitter motion. The remaining paper is organized as follows: In section II, Digital Image Stabilization is discussed, in section III simulation analysis of the proposed method. Finally, conclusions are drawn on section IV

II. Digital Image Stabilisation

The Digital image stabilization (DIS) has mainly three stages. They are Motion estimation, Jitter Motion estimation and Image Compensation. Each of the three parts plays an important role in obtaining the stabilized output. The Motion Estimation helps in finding the motion vectors. With the help of the obtained motion vectors, we can estimate the amount of jitter present in the image that is Jitter estimation. Image compensation deals with the removal of that jitter motion which is unwanted. Fig 2 shows the block diagram of the digital image stabilization.

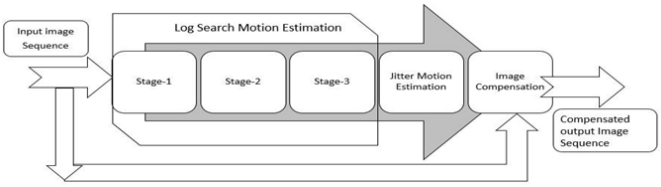

Fig 2: Block Diagram

A. LS Algorithm

LS Stand for Logarithmic Search where we are using the two dimensional Logarithmic search in which block matching was done by monotonic quadrant model. The motion vector is obtained from this LS algorithm. The searching was done in Multiple stages by successive reduction of the search area in each stage up to a small area is obtained. SAD is calculated for getting best match.

1) Methodology:

We take 5 positions to form a similar pattern to the 5 points like cross. If the center of the area to be searched is (r, s) then (r, s+SS1), (r, s-SS1), (r+SS1, s), (r-SS1, s) are examined with step size as SS1. Fig 3 shows the pattern of search for LS algorithm. Now the step size is divided by two only when the best match is found at the center i.e. SAD is less among the obtained ones, else step size is SS1. When SS1=1, all 8 blocks around (r, s) are examined. If the step size is not one, the above procedure for the best match coordinate is done. Then the algorithm halts.

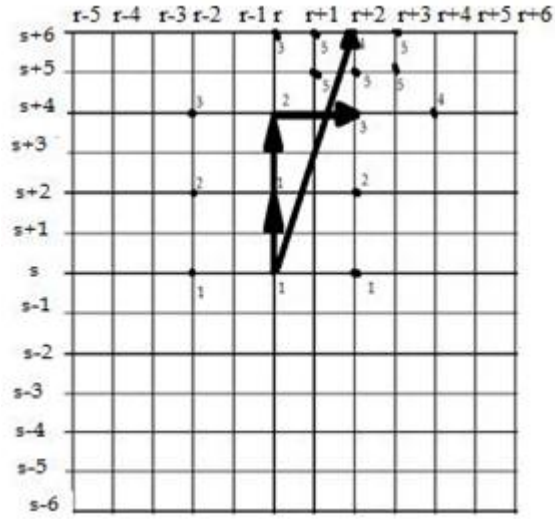

Fig 3: LS Methodology

Step1: If the displacement allowed for minimum is MD, step size SS equals to $2^{[\log MD]-1}$.Let an initial step size be SS1 and take the block at the center of the area to be searched and consider four blocks around it. Let

2) Algorithm:

The Logarithmic Search algorithm is as follows:

- the center be (r,s) then the four points will be (r, s+SS1), (r, s-SS1), (r+SS1, s), (r-SS1, s) which are examined.
- Step2: At the center, if the best match is found at (r, s) reduce the step size SS1 to half. If the best match is found at other four points, make it as center and repeat step 1 that is (r, s) = (r1, s1) where (r1, s1) is the best match position coordinates. Perform the step 2 until the step size becomes one.
- Step3: On continuously obtaining the best match, the step size will become unity. Consider all the nine blocks around the center and the best match is selected from the reference block. They are (r-1,s-1), (r-1,s), (r-1,s+1), (r,s-1), (r,s), (r,s+1), (r+1,s-1), (r+1,s), (r+1,s+1).

3) The Flow Chart of the LS:

As the LS is a continuous search process, the flow chart gives the flow of steps from the start to the end of the search process. The cost function used for determining the best match is to add the difference values of the pixels in the reference frame and the current frame sequence and the minimum is take out of it.

B. Jitter Motion Estimation

By obtaining the best matched blocks from the LS, We can find the Motion vectors. By drawing the Motion vectors, the vectors which are in zigzag manner are treated as the Jitter. As they are Low power Components with high frequencies, their determination becomes easy. The jitter is determined all over the image but not on a single block of the image. The Perfect estimation of the Jitter helps in complete removal of the jitter which plays another important role in DIS. Jitter in between two sequential frames are calculated and the image compensation is performed.

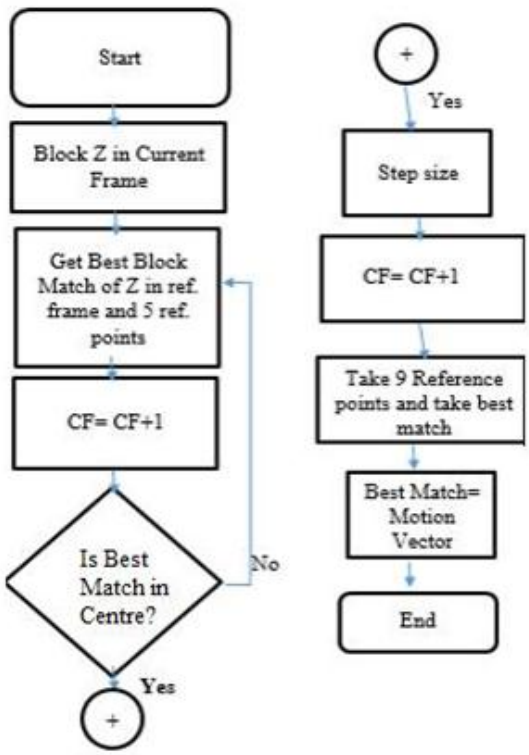

Fig 4: Flow Chart

C. Image Compensation

The image compensation deals with the removal of the obtained Jitter. This was done by taking the forward and the backward motion vectors which gives the exact information about the jitter and the orientation of the jitter. On determining the both motion vectors, with the help of MATLAB tools, image reconstruction is done.

III. Simulation Results

The Simulations are done on the Intel Core i5 processor. Various search windows and Macro-size blocks are used for testing the Motion Estimation. Cost for the computation in terms of time and their PSNR's are calculated for the frames in the video.

The Motion Vectors are obtained with the help of the motion estimation. First the video is converted into frames and named as image I where I is from 0 to the number of frames in the video. The shaky car video is taken from the MATLAB library. The first two images, image 0 and 1 are shown in Fig 5 and 6 respectively. By applying the LS algorithm on the two images, the Motion Vector of the image 0 with respect to image 1 is shown in Fig 7.

Fig 5: image 0

Fig 6: image 1

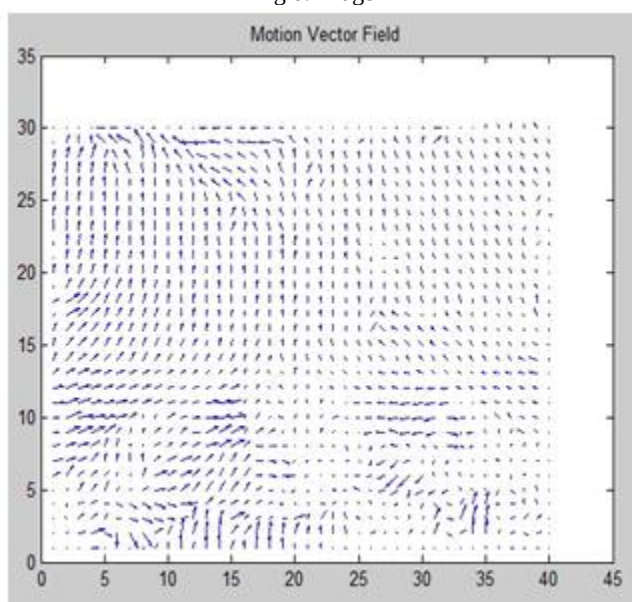

Fig 7: Motion Vector field

The above Figure shows the motion vectors which are oriented in different directions. The place where there is randomly ordered motion vectors are called as Jitter. The Fig 8 shows the jitter present in motion vector field.

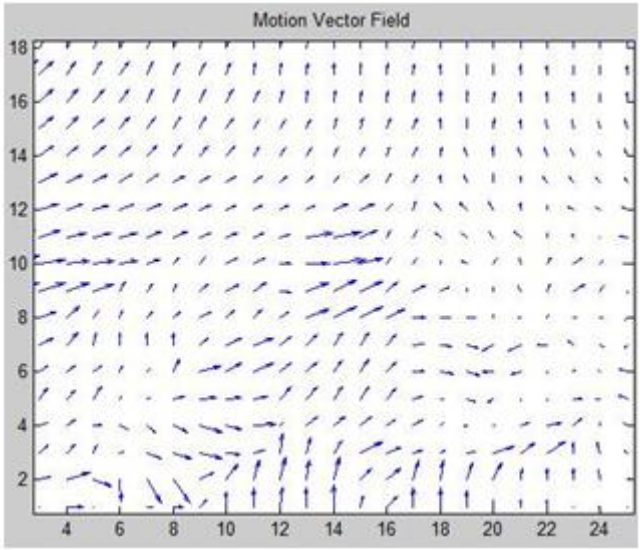

Fig 8: Zoomed version of jitter in Motion Vector Field

The motion compensated image is obtained by removing the jitter with the help of the motion vectors. Both forward and backward motion vectors are calculated. With the help of the both vectors, the jitter removed by rounding them. In that way we obtained the Digitally Stabilized Image. Finally the compensated image is shown in Fig 9.

Fig 9: Motion Compensated image

TABLE I
COMPARISION OF BLOCK SIZE, PSNR, ELAPSED TIME FOR SEARCH LIMIT =10

Block Size	PSNR(dB)	Elapsed time (S)
8	27.5496	11.522152
10	27.8623	6.822918
12	28.0552	5.138473

TABLE II
COMPARISION OF SEARCH LIMIT, PSNR, ELAPSED TIME FOR BLOCK SIZE =8

Search Limit	PSNR(DB)	Elapsed time(S)
8	27.5241	8.984770
10	27.5496	9.545821
12	27.8672	11.057860

IV. CONCLUSIONS

The Digitally stabilized image is obtained with the help of the Logarithmic Search algorithm effectively and within in seconds of time. To perform the Digital Image Stabilization on hardware, the software running time should be less. If the software running time is more, the hardware runtime will be much more than that of the software run-time. Hence in order to get DIS in hardware, the software run-time should be less which makes the hardware run-time less. As LS algorithm is of less runtime when compared to other search algorithms, it was implemented in MATLAB and as a result digitally stabilized image is obtained.

REFERENCES

[1] C. Carafe, S. Catani, and P. Grislier, "Off-road path and obstacle detection using decision networks and stereo vision," IEEE Trans. Intell.Transp. Syst., vol. 8, no. 4, pp. 607–618, Dec. 2007.

[2] H. Chen, C. Liang, Y. Peng, and H. Chang, "Integration of digital stabilizer with video codec for digital video cameras," IEEE Trans. Circuits Syst. Video Technol., vol. 17, no. 7, pp. 801–813, Jul. 2007.

[3] Ichimoto, and Y. Suematsu, "Image stabilization system for Hinode (Solar-B) solar optical telescope", Solar Phys., vol. 249, no. 2, pp. 221– 232, Oct. 2008.

[4] Konstantinos Ioannidis and Ioannis Andreadis, "A Digital Image Stabilization Method Based on the Hilbert–Huang Transform, " IEEE Trans. Instrumentation and Measurement, Vol. 61, no. 9, Sept 2012.

[5] B . Cardani, "Optical image stabilization for digital cameras," IEEE Control Syst. Mag., vol. 26, no. 2, pp. 21– 22, Apr. 2006.

[6] C.Wang, J.-H. Kim, K.-Y. Byun, J. Ni, and S.-J. Ko, "Robust digital image stabilization using the Kalman filter," IEEE *Trans. Consum. Electron*, vol. 55, no. 1, pp. 6–14, Feb. 2009.

[7] S.-C. Hsu, S.-F. Liang, and C.-T. Lin, "A robust digital image stabilization technique based on inverse triangle method and background detection," *IEEE Trans. Consum. Electron*, vol. 51, no. 2, pp. 335–345, May 2005.

[8] A . A. Amanatiadis and I. Andreadis, "Digital image stabilization by independent component analysis," *IEEE Trans. Instrum. Meas.*, vol. 59, no. 7, pp. 1755–1763, Jul. 2010.

[9] Motion Estimation (2010) The IEEE website. [Online].Available on: http://www.ieee.org/. Browsed on Sept 2014.

[10] J.R. Jain and A.K. Jain, "Displacement measurement and its application in interframe image coding," IEEE Trans. Commun., Vol.- 29, pp. , 1799-1808, Dec. 1981.

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