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A Review on Video Stabilization Using Block Matching Algorithm and Motion Estimation

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ABSTRACT: As the telecommunication technology grows in the modern era from internet to video conferencing, Video stabilization has become an avoidable feature in information broadcast and also in the entertainment media. In this thesis we compared a different block matching motion estimation algorithms to find the motion estimation with a rapid growth of multimedia information; when transmitting a large amount of data video coding standards have become crucial. Motion estimation ascertain to be the key to splendid performance in video coding by recover the temporal redundancy effectively between adjacent frames.So Based on the study of motion vector distribution from several commonly used test image sequences algorithm for EBMA block matching motion estimation is proposed. The performance of this algorithm is compared with other existing algorithms of basic full search [FS] by means of error metrics and no of search points in this the simulation results shows that the proposed search algorithm achieves close performance uses less no of search points When compared with previous work, this algorithm requires less computation time and gives an improved performance.

KEYWORDS: Block matching algorithm ,Motion estimation, Motion vector Search pattern

I. INTRODUCTION

Video stabilization is a key problem in producing high quality video sequence, especially when we are in self-media age and much more videos are shot with smart phones, which meansvideo stabilization is in great demand.
Typically, there are three steps in video stabilization workflow:

i. motion estimation shaking recognition
ii. motion compensation

Among all three steps, the most computationally expensive and resource consumed one is motion estimation. Some mature models are discussed in [1]: based on optical flow, based on pixel, based on block, based on mesh, etc.

BLOCK MATCHING

In all video coding standards motion compensation and estimation carried out on 8x8 or 16X16 blocks in the current frame. Motion Estimation of complete blocks is known as block matching. Each block of luminance samples in the current frame, the motion estimation algorithms searches a neighbouring area of the reference frame 16x16 areas the best match is the one with minimises the energy of the difference between the current 16X16 block and the matching 16x16 area. The area in which the search is carried out may be centred around the position of the current 16X16 block because.

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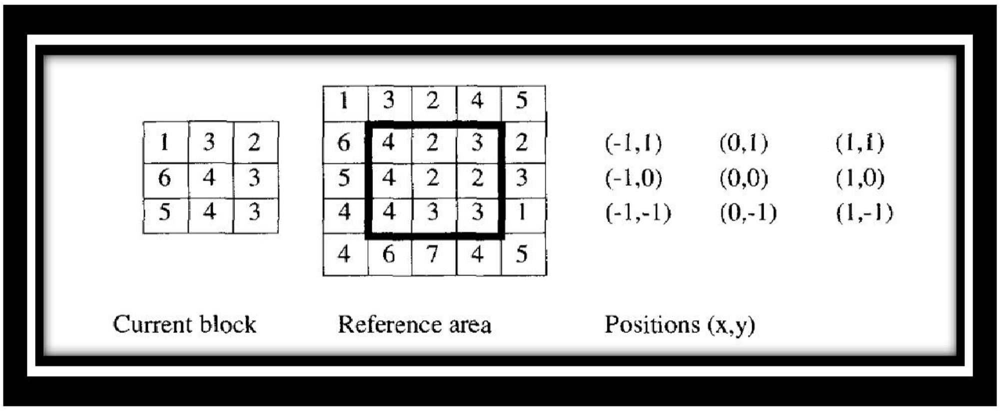

Figure 1.1 The current Frame and reference frame

MOTION ESTIMATION

A video sequence can be considered to be a discredited three dimensional projection of the real four-dimensional continuous space time. The objects in the real world may move, rotate, or deform. The movements cannot be observed directly, but instead the light reflected from the object surfaces and projected onto an image.. The current frame and reference frame difference can observe in the figure 1.2 diagram.

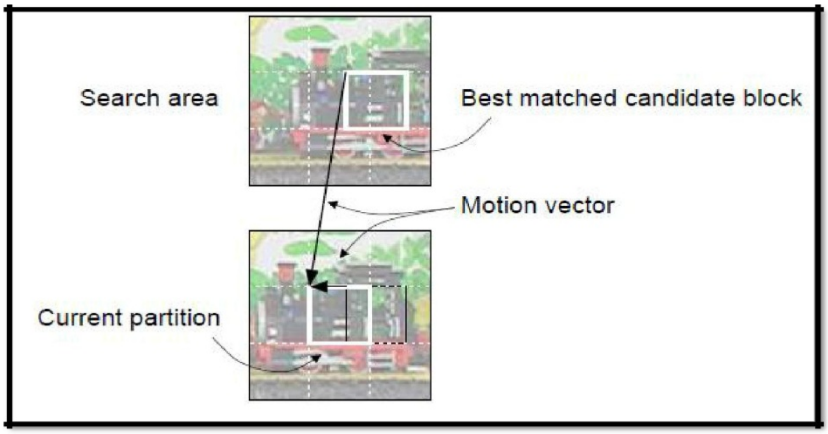

Figure 1.2 motion estimation detector

Changes between frames are mainly due to the movement of objects. Using a model of the motion of objects between frames, the encoder estimates the motion that occurred between the reference frame and the current frame. This process is called motion estimation (ME) [12]. The encoder then uses this motion model and information to move the contents of the reference frame to provide a better prediction of the current frame.

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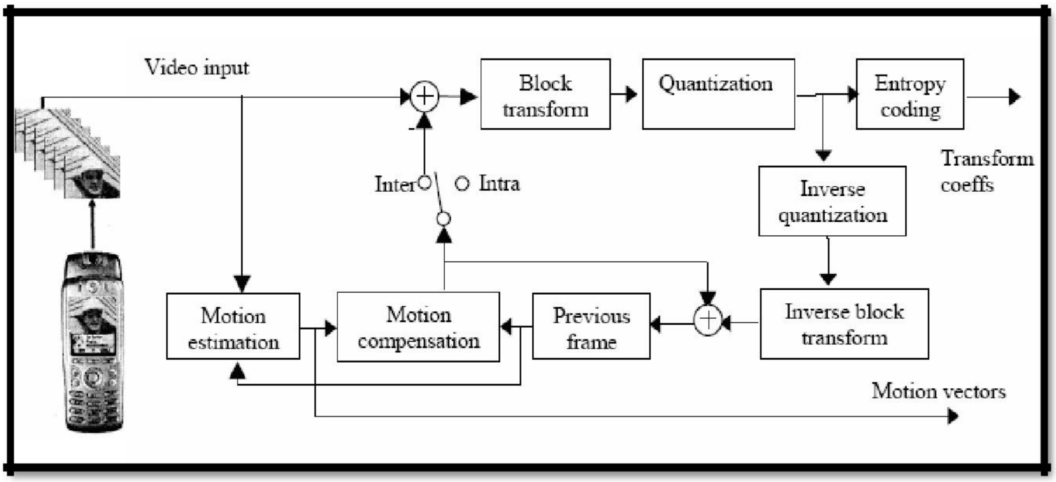

Figure 1.3 Motion compensated video coding

This process is known as motion compensation (MC), and the prediction so produced is called the motion-compensated prediction (MCP) or the displaced-frame (DF) [13]. In this case, the coded prediction error signal is called the displaced-frame difference (DFD).A block diagram of a motion compensated coding system is illustrated in Figure 1.3 This is the most commonly used inter frame coding method. The reference frame employed for ME can occur temporally before or after the current frame. The two cases are known as forward prediction and backward prediction, respectively. The prediction can be observed in figure 1.

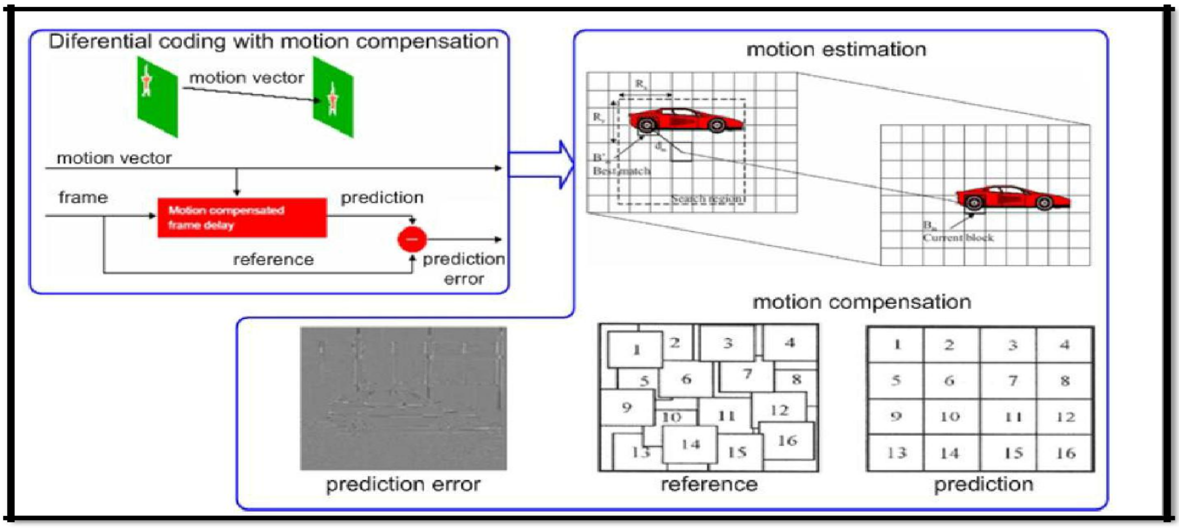

Figure 1.4 Predictive sources coding with motion compensation

II. LITERARURE REVIEW

Enock T. Chekure et.al(1) This paper gives the results of an investigation on the use of exhaustive block matching techniques in detecting railwayline tracks in a video sequence with the view of implementing the outcome in a real-time system.

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RazaliYaakob et.al(2) In this paper, four different block matching algorithms using motion estimation are evaluated where the effects of the macro block size used will be reviewed to find the best algorithm among them is scrutinized to determine the most optimal algorithm.
Sonam T. Khawase1 (3) In video compression technique, motion estimation is one of the key components because of its high computation complexity involves in finding the motion vectors (MV) between the frames
WissalHassen et.al (4)he Block Matching is a temporal compression technique used in the video encoding. The main purpose of this method is to determine the displacements of each block of pixels between two successive frames
Maria Santamaria et.al (5) Block-matching motion estimation is an efficient algorithm for reducing the temporal redundancy in video coding and is adopted by video coding standards. Many fast blockmatching algorithms have been devised to reduce the computational complexity without degrading the estimation quality.
K. W. Cheng et.al (6) Motion compensation is an effective method for reducing temporal redundancy found in video sequence compression. However, the complexity of the full-search block matching algorithm (BMA) is extremely high and a number of fast algorithms have been proposed to reduce the computational complexity of the BMA
Hussain Ahmed Choudhury et.al (7) in video both temporal redundancies as well as spatial redundancy occurs. So to remove the both type of redundancies we need combination of systems that can remove both type of redundancies and hence we use Hybrid Video Codec for video compression.
Manisha Pal et.al (8) the fundamental of motion estimation is that the objects in a frame of video sequence should only move within the original frame to form corresponding objects on the next frame.

III PROBLEM STATEMENT

Assume a camera rigidly mounted on a vehicle in motion. If the motion of the vehicle is smooth, so will be the corresponding image sequence taken from the camera. In the case of small unmanned aerial imaging system, and off road navigating ground vehicles, the on-board cameras experience sever jitter and vibration. Consequently, the video images acquired from these platforms have to be pre-processed to eliminate the jitter induced variations before human analysis.

There are some cost functions which are considered as criteria for matching blocks, these are given below:

a) The Mean Absolute Difference (MAD) is a criterion used to determine which block should be used. Typically, the lower the MAD the better the match and block with the minimum MAD is chosen. MSE is the old quality standard which calculates Mean squared Error as follows:

$$\text{MSE} = \frac{1}{N^2}\sum_{i=0}^{N-1}(C_{ij} - R_{ij})^2$$

$$\text{MAD} = \frac{1}{N^2}\sum_{i=0}^{N-1}|C_{ij} - R_{ij}|$$

Where N= width or height of macroblock
Cij = Pixels compared in current macroblock
Rij = Pixels compared in previous macroblock

b) Sum of Absolute Difference (SAD) is given by:

$$\text{SAD} = \sum_{i=0}^{N-1}\sum_{j=0}^{M-1}|fcurrent(j,i) - fref(j + V_{x,i} + V_y)|$$

Where, N= height of block.
M= width of block.
i= index of horizontal direct.
j= index of vertical direction.

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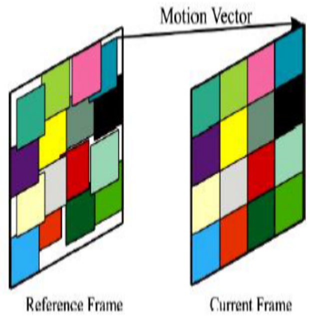
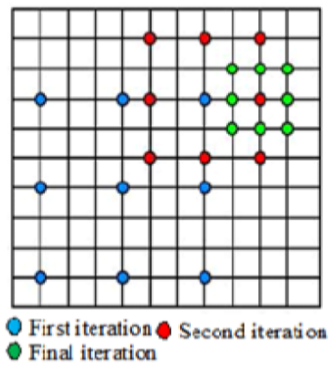
IV. BLOCK MATCHING ALGORITHMS FOR MOTION ESTIMATION

There are various methods related to block matching algorithms:

Serial No.	Techniques	Methodology	Reference Figure
1.	FULL SEARCH METHOD OR EXHAUSTIVE BLOCK MATCHING SEARCH (FSA / EBMA)	Full search algorithm (FSA) or Exhaustive Block Matching Search is a very common block matching algorithm. In this, macroblocks are matched from top to bottom, left to right. This method gives best PSNR to evaluate Interframe fidelity (ITF). ITF is the PSNR between two consecutive stabilized video frames. By plotting PSNR & ITF we can prove the efficiency of block based method for video stabilization. FSA is simple in implementation, robust and accurate but the computations are more since it evaluates every possible pixel. Refer Fig. 3.1 **Application:** To obtain best picture quality and highest PSNR	 **Fig 3.1: Full Search Method[18]**
2.	THREE STEP SEARCH	Three step search is said to be one of the fast search algorithm. In TSS, the first iteration evaluates nine points considering one at centre and other in all direction equidistant at step size 4 from central point. SAD is calculated for these points and the smallest SAD point is chosen as a new centre. The process continues by reducing step size into half. TSS is simpler but less efficient than FSA. Fig 3.2 shows the TSS method and iterations. **Application:** Recommended in MPEG2	 **Fig 3.2: Three Step search[17]**

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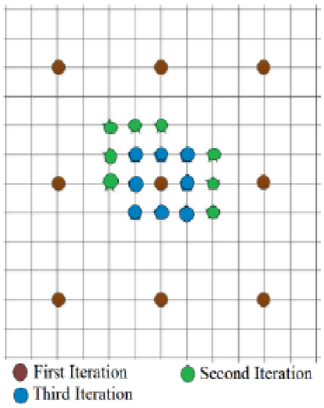
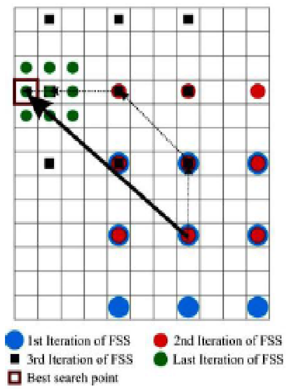
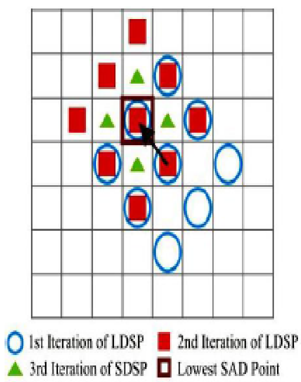
3.	NEW THREE STEP SEARCH (NTSS)	New three step search uses center biased checking point scheme in which a center point is selected in particular search region. In NTSS, the first iteration it evaluates 8 points considering step size 4 and other 8 points are equidistant at the step size 1 from search origin. In second iteration, if the minimum cost function value is found at the center of the search window, the search is stop, otherwise change the search origin with min. cost function and repeat first iteration procedure. This algorithm has the best case of 17 checking points and worst case of 33 checking points. Refer Fig. 3.3. **Application:** More efficient than TSS for small motion.	 **Fig 3.3: NTSS Search method**
4.	FOUR STEP SEARCH (FSS)	In first iteration,4SS algorithm uses a search pattern with nine checking points in window size of 5x5 pixel. If min. cost function is available in this window size then the search procedure moves to 4th step and stop the search after finding min. cost function by using small nine point search pattern, which is known as halfway stop. In second iteration min. cost function is set as center of 5x5 search window. If the point is at center of 5x5 window in second step then stop search by performing fourth step otherwise third step is performed exactly the same as 2nd step. In the fourth step the pattern size decreases from 2 to 1 which reduces the window size up to 3x3. At the end of fourth step search the min. cost function is best matching point. Significance of 4SS algorithm is its robustness & reduction in computation. **Application:** Initial small step size so more efficient for small MV.	 **Fig 3.4: Four Step Search[18]**
5.	DIAMOND SEARCH (DS)	DS algorithm considers two patterns for searching. One is Small Diamond Search Pattern (SDSP) and other is Large Diamond Search Pattern (LDSP). SDSP consists of five checking points while LDSP consists of nine checking points with one point at centre and others being around that centre point. At nine points of LDSP, min.cost function is calculated. If that point is other than centre point then new LDSP is formed. i.e. other new eight points with previous min. cost function point as centre is considered. This procedure repeats until the min. cost function point is at achieved at centre point. Once that point is found at centre, LDSP is switched to SDSP at which min. cost function is found. The block with min. cost function is achieved is the best matching block. Refer Fig 3.5. **Application:** Adopted and incorporated in MPEG-4 verification model.	 **Fig 3.5: DS method[18]**

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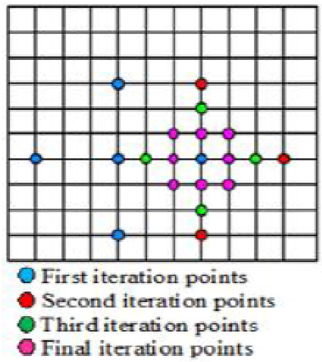
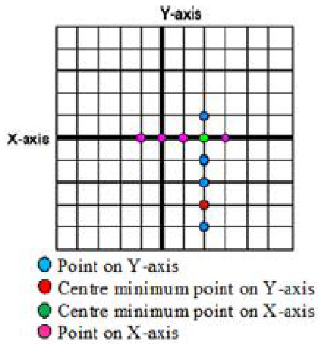
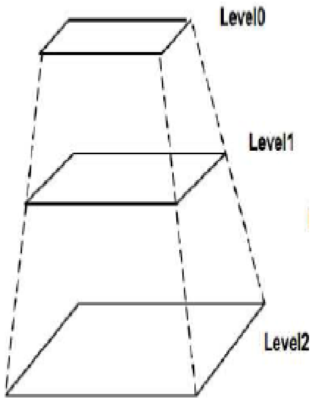
6.	LOGARITHMIC SEARCH METHOD	In this search, a point is centred at the search region while other four points are placed diagonally to the centre as diamond shape. The step size for first iteration is half of the search range and the cost function in the centre of search region and four neighbouring points are taken. During second iteration, the centre of the diamond is shifted to the least valued cost function, if it is not a center, the cost functions in two corresponding diagonal points are drawn. The step size reduces till it becomes one pixel. This search is more accurate for estimating motion vectors for a large search window size. **Application:** Suitable for Fast Motion sequences	 **Fig3.6:2D Logarithmic search[17]**
7.	ONE AT A TIME SEARCH	One at a time search is another type of fast search algorithm, in which motion vectors are calculated along X-axis and Y-axis independently. Firstly the point search is done along the X-axis, then the next three points along same axis are matched. The process ends when the best matching point has selected a centre.The location of this point on the x-axis is used as the x-component of the motion vector. Same process is carried out along the Y-axis for the estimation. It requires less number of points than other fast algorithms. However, the motion vector accuracy is poor. Refer Fig. 3.7. **Application:** Used in real time videos for optimal estimation solutions.	 **Fig3.7:one at a time search[17]**
8.	HIERARCHICAL BLOCK MATCHING ALGORITHM (HBMA)	HBMA is simple which successively refines motion vectors at different resolutions. Initially a pyramid of reduced resolution video motion vector is formed from video sequence. The highest resolution image is extracted from the original video frame and the other images in the pyramid are formed by down sampling the original image. Down sampling is of bi-linear type. At the highest resolution the block size of N x N is reduced to (N/2) x (N/2) in the next resolution level. The search range is also reduced. At the lowest resolution the process of motion estimation starts. The full search motion estimation is performed for each block at the lowest resolution. HBMA does not need large computations. The motion vectors from lowest resolution are scaled and passed on to each block to next level. As the level increases, the motion vectors are refined with a smaller search area. Refer Fig 3.8 **Application:** Suitable for videos with different resolutions	 **Fig 3.8: Multi Resolution Pyramid for Hierarchical Block Matching [17]**

Table 1:Summary of Techniques, methodology, reference figures for different Block Matching Algorithms.

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V. EXPECTED OUTCOME

Predict a new frame from a previous frame and only code the prediction error .Prediction error will be coded using an image coding method. Prediction errors have smaller energy than the original pixel values and can be coded with fewer bits .Those regions that cannot be predicted well will be coded directly.
Use motion-compensated prediction to account for object motion .Work on each macroblock (MB) (16x16 pixels) independently for reduced complexity .Motion compensation done at the MB level.
Blocking effect (discontinuity across block boundary) in the predicted image .Because the block-wise translation model is not accurate – Fix: Deformable BMA (next lecture).
Motion field somewhat chaotic, because MVs are estimated independently from block to block
Fix 1: Mesh-based motion estimation.
Fix 2: Imposing smoothness constraint explicitly.
The video is stabilizes using EBMA algorithm. We calculate motion vector,compute motion vector entropy,calaculate mean square error, compute frame difference entropy

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