Global Journal of Computer Science and Technology: F
Graphics & vision
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Novel Search Technique of Motion Estimation for Video Compression

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Abstract- Video Compression is highly demanded now a days as due to the fact that in the field of entertainment, medicine and communication there is high demand for digital video technology. For the effective removal of temporal redundancy between the frames for better video compression Motion estimation techniques plays a major role. Block based motion estimation has been widely used for video coding. One such method is the Hierarchical Search Technique for BMA. By amalgamating the three different search algorithms like New three step search, New Full search and New Cross diamond search a novel hierarchical search methodology is proposed. Subsampling the original image into additional two levels is done and thereby the New Diamond search algorithm and a new three-step search algorithm are used in the bottom two levels and the Full Search is performed on the highest level where the complexity is relatively low. In terms of PSNR with reduced complexity this new proposed algorithm showed better performance.

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GJCST-F Classification: I.4.2, H.3.3

ANOVELSEARCHTECHNIQUEOFMOTIONESTIMATIONFORVIDEOCOMPRESSION

A Novel Search Technique of Motion Estimation for Video Compression

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Abstract- Video Compression is highly demanded now a days as due to the fact that in the field of entertainment, medicine and communication there is high demand for digital video technology. For the effective removal of temporal redundancy between the frames for better video compression Motion estimation techniques plays a major role. Block based motion estimation has been widely used for video coding. One such method is the Hierarchical Search Technique for BMA. By amalgamating the three different search algorithms like New three step search, New Full search and New Cross diamond search a novel hierarchical search methodology is proposed. Subsampling the original image into additional two levels is done and thereby the New Diamond search algorithm and a new three-step search algorithm are used in the bottom two levels and the Full Search is performed on the highest level where the complexity is relatively low. In terms of PSNR with reduced complexity this new proposed algorithm showed better performance.

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I. Introduction

Video compression is the process of representing the video data using fewer bits than the original representation. Motion estimation plays a major role in Video Compression. As video requires much more space to store than still image, video compression is very much useful in reducing the storage space and which will eventually lead to lesser cost. It is carried out mainly by using BMA. In BMA both the reference frame and current frame are divided into blocks and for each block in the current frame the algorithm searches for a best match block in the reference frame. The search in the reference frame is conducted within a search window defined by parameter p. The displacement of the macro block in the reference frame with respect to macro block in the current frame is represented by a vector known as motion vector. The most suitable matching criteria that are used are mean square error (MSE), sum of absolute difference (SAD) etc.

Several BMA's have been developed over the years. The most basic is the FSA [1], where all the blocks are searched for a best match (255 comparisons). It is the best algorithm in terms of efficiency but the most computationally expensive and it is very time consuming. The TSS in comparison to FSA requires only 25 comparisons. Since it follows a fixed pattern, it works inefficiently on slow motion video sequences. The NTSS [2] enhances the TSS by using a half way stop technique. NTSS is more complex than TSS. The FSS [3] uses a centre biased checking point pattern with a half way stop technique being more complex. The CDS [4] uses a cross and diamond shape pattern. They are very complex. In Neighborhood Elimination approach [5] we use a spatial correlation property and a half way stop technique. This approach however has low PSNR for medium and fast motion sequences. The ABC Algorithm [6] has a low PSNR compared to FSA. The Modified PSO [7] offers reduced number of computations and high PSNR for large motion, but not for slow and medium motion sequences. The Octagon Square BMA [8] uses an octagon and square shape pattern and can identify both large and small motion. It has the disadvantage of being a fixed pattern algorithm. The BBGDS [9] Algorithm works better in small motion but it has very large motion vector for large motion video sequences.

Most of these BMA perform well in terms of estimating slow, medium and fast motion video sequences. The performance of the proposed hierarchical search technique unlike the other algorithms is close to the Full Search with reduction in complexity.

II. Motion Estimation Algorithms for Hierarchichal Search

a) Full Search Algorithm (FS)

FS Algorithm searches all the search points within the search window for a best match. Therefore it is very simple to implement and is highly efficient but it has very high computational time.

b) New Cross Diamond Search Algorithm (NCDS)

The NCDS [10] Algorithm follows a pattern. The first step stop involves a search of only 5 search points while the second step stop required 8 search points. An unrestricted large diamond search (DS) pattern was employed in the subsequent steps followed by a final small diamond search.

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c) New Three Step Search Algorithm (NTSS)

The NTSS Algorithm is an improvement on the TSS Algorithm so as to find small motions. It has a half way stop for first and second steps.

III. Proposed Method

In the proposed hierarchical search technique, an input and reference frame are subsampled into three levels. Level 1 is subsampled both horizontally and vertically by a factor of 2 to get Level 2. This level in turn is subsampled both horizontally and vertically by a factor of 2 to get Level 3 as shown in Fig 1.The three different algorithms such as Full Search Algorithm, New Cross Diamond Search Algorithm and New Three Step Search Algorithm are applied to the various Levels .The best match motion vector obtained from Level 3 is passed on to Level 2 and the best match motion vector obtained from Level 2 is passed on to Level 1.The motion vector so obtained from Level 1 is considered the final motion vector of the motion estimation process.

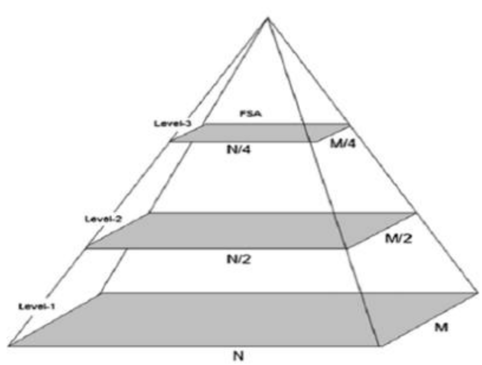


Fig.1: Different Levels in a HS algorithm

IV. Proposed HSBMA Algorithm

Step 1: Level-1 is the lowest level and consists of the original frame at its full resolution. This level is subsampled by a factor of 2 in vertical and horizontal directions to produce Level-2.

Step 2: This step involves sub -sampling Level-2 in the same way to produce Level-3 (highest level).The sub-sampling process ends, by getting Level-1, Level-2 and Level-3.

Step 3: In this step, the search starts from the highest level (Level-3) using 4 X 4 block sizes, where a FS algorithm will be performed to get the initial coarse motion vector and the best match position will be passed to the lower level (Level-2).

Step 4: This step involves searching Level-2 by using the new proposed cross-diamond search pattern (using 8 X 8 block sizes) to get a new motion vector, and the best match position will be passed to Level-1 (Lowest level).

Step 5: In this step, the New Three-Step-Search algorithm is used on Level-1 utilizing 16 X 16 block sizes. Hence the final motion vector is obtained and that will be added to the previous image to get the next predicted image frame.

V. Implementation and Results

The section presents the results of applying the various algorithms included in the proposed Hierarchical Search Motion Estimation technique. Simulations have been performed over the standard Video Sequence “Sample Video.avi” has moderately complex motion getting medium content regarding its motion content. By using the matlab the The video is extracted into frames. Here the video is initially run in MATLAB using the “VideoReader” command. It is then extracted into frames as shown in Fig 2.

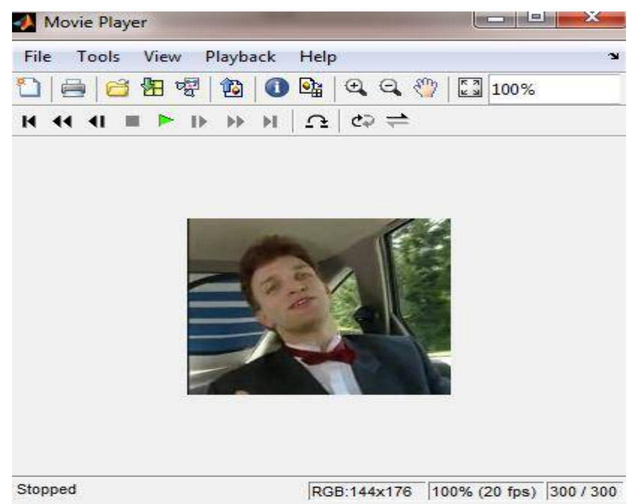


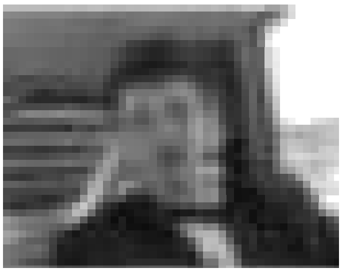
Fig. 2: Video Played in MATLAB

Fig 3 shows the lowest level (Level-1) consists of the original frame at its full resolution. The next Level-2 consists of Level-1 image sub-sampled by a factor of 2 in vertical and horizontal directions as in Fig (b).And again sub-sampling Level-2 in the same way produces Level-3 image (highest level) as in Fig (c).

Fig. 3: Input image subsampled into three Levels of different resolutions

The Input frame and Reference frame are as shown in Fig 5,6,7. Motion estimation is performed using the three above mentioned algorithms on the three levels. The Compensated Image at the end of HSBA is shown in Fig 8.

(a)



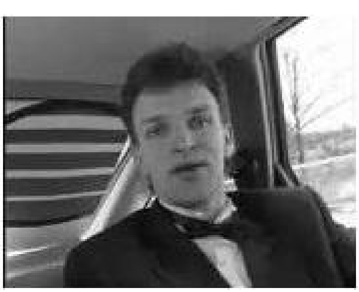
(b)

Fig. 4: Input (a) and Reference Frame (b) for Full Search Algorithm

(a)

(b)

Fig. 5: Input (a) and Reference Frame (b) for New Cross Diamond Search Algorithm



(a)

Fig. 6: Input (a) and Reference Frame (b) for New Three Step Search Algorithm

Fig. 7: Compensated Image of Input and Reference for Carphone using HS Algorithm

VI. Performance

The PSNR plot and the plot for No of Search Points per MacroBlock vs Frame Number for the Carphone sequence with the FS different algorithms are as shown below:

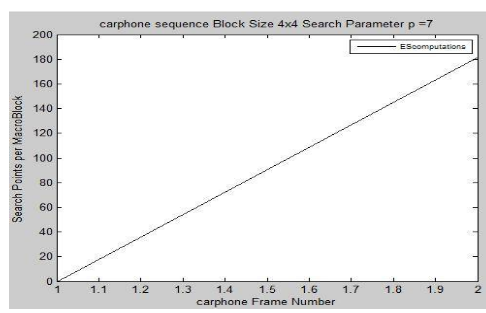


Fig. 8: Search Points per MacroBlock vs Frame Number in FS Algorithm

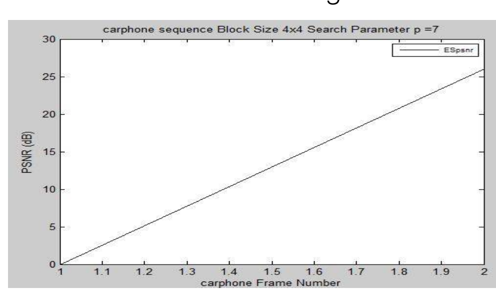


Fig. 9: PSNR of the motion compensated image w.r.t. original image vs Frame Number in FS Algorithm

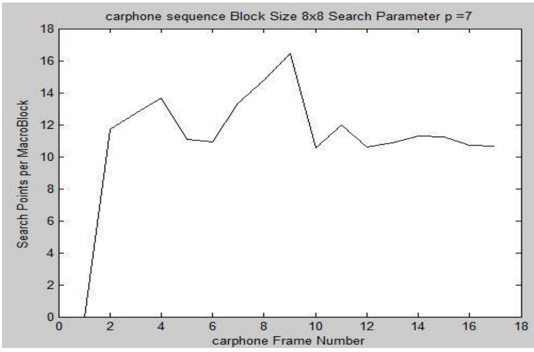


Fig.10: Search Points per Macro Block vs Frame Number in NCDS Algorithm

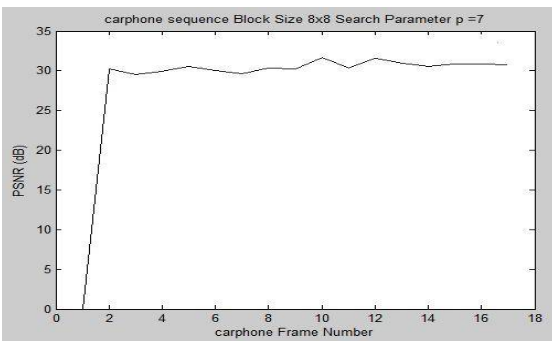


Fig. 11: PSNR of the motion compensated image w.r.t. original image vs Frame Number in NCDS Algorithm

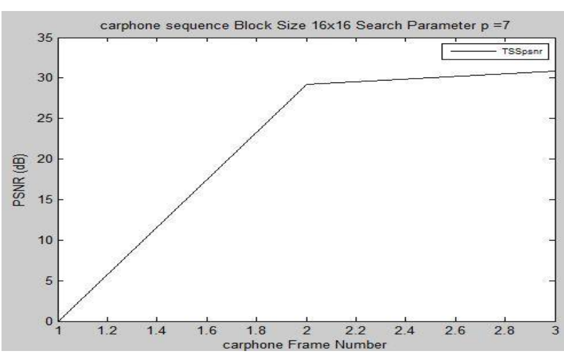


Fig.12: PSNR of the motion compensated image w.r.t. original image vs Frame Number in TSS Algorithm

The value of No of computations for the Full Search Algorithm is shown as below:

Table I: No of Computations

Algorithm	No of Computations
FULL SEARCH	213.38

The value of the No of computations for the HS Technique which is the sum of all the computations by the three algorithms in the three levels of the frame is lesser than that of the Full Search algorithm.

Table II: No of Computations

HIERARCHICHAL SEARCH	
Algorithm	No of Computations
FULL SEARCH	181.444
NEW CROSS DIAMOND	5.1708
NEW THREE STEP SEARCH	22.3485

Also the value of PSNR for the HS Technique is approaching that of the most efficient FS Algorithm.

Table III: PSNR and MSE of the FS and HS Technique

ALGORITHM	PSNR	MSE
FULL SEARCH	32.3436	37.9074
HIERARCHICHAL SEARCH TECHNIQUE	29.2417	22.3485

VII. Conclusion

Motion estimation algorithms intend to construct the current frame as accurately as possible while keeping the computational complexity acceptable. Full Search Algorithm is the most efficient for Motion Estimation. But its highly expensive. Hierarchical Fast Search motion estimation is in order to reduce the Full Search complexity. Therefore, a new Hierarchal Search technique is developed that achieves a performance much better than the existing hierarchical techniques with reduction in complexity.

Acknowledgment

The author would like to thank Dr. Habibulla Khan and Dr. K.S.Rao for their valuable suggestions and thorough checking the paper with necessary enhancements incorporated where ever required.

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