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Motion Estimation in Video Coding & SSIM and CIR Comparison between Adaptive Search Algorithms

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Abstract

An adaptive search order calculations are introduced to accelerate the square or hexagon movement estimation in advanced video coding. As indicated by the movement incline, a table of the versatile inquiry request is characterized. For each seeking emphasis, a superior pursuit request is determined and after that the best coordinated square can be found in the early hunt stage. Some test results exhibit the computational point of interest of the proposed enhanced calculation when contrasted with past calculations. Block motion estimation and compensation are played a major role in the video compression to reduce the temporal redundancies of the input videos. Assortment of square pursuit example is created in the writing to coordinate the pieces with decreased calculation multifaceted nature however without influencing the visual quality. In this paper, we have talked about the precious stone, square and hexagon look design with versatile request to discover the piece movement estimation. These inquiry examples are created as adaptive order square hexagon (AOSH) look calculation to locate the best coordinating piece without much considering vast number of hunt focuses. Likewise, the seeking capacity is defined as exchange off standard where, digression weighted capacity is recently created to assess the coordinating point. The AOSH seek calculation and digression weighted exchange off paradigm is successfully connected to piece estimation process with the point of enhancing the visual quality and compressive execution. The goal of video pressure is accepted for the proposed strategy utilizing three recordings to be specific, football, garden and tennis. The quantitative execution of the proposed technique and existing strategies are broke down utilizing Structural Similarity Index (SSIM) and Compression Improvement Ratio (CIR). The outcomes demonstrate that the AOSH technique got the great visual quality and compressive execution than the past strategies.

Keywords: *Motion Estimation, Adaptive Order Square Hexagon Search Algorithm, Structural Similarity Index*

1. Introduction

Propels in the versatile correspondence advances have empowered convenient gadgets to run complex interactive media applications including video handling. Because of the fast development of the media benefit, the video pressure gets to be crucial for diminishing the required transfer speed for transmission and capacity in numerous applications [1-13]. Video pressure alludes to lessening the amount of information used to speak to video outlines. A video is a grouping of edges (or pictures) that are connected along the fleeting and spatial measurements: two back to back edges may be comparable, and the main watched changes should be because of the relocations of articles or the

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camera, or to the commotion. To diminish the measure of information in the casings to be transmitted, it is then important to decide this excess and to endeavour it by characterizing unsurprising properties. Considering the genuine information to be transmitted, these properties are utilized to make forecasts of this information, and just the mistakes amongst genuine and anticipated information are transmitted [8].

Among the diverse video pressure calculations, H.264/AVC (Advance Video Coding) is an industry video coding standard [19-20]. Contrasted with past video coding measures [10-11], H.264/AVC accomplishes fundamentally better coding execution by receiving an arrangement of cutting edge coding instruments, for example, spatial-space intra forecast, variable piece size Motion Estimation (ME) [21-22], a Motion Vector (MV) with quarter pixel exactness, various reference outlines, a de-blocking channel, Rate-Distortion (R-D) enhancement [23-16], and a novel entropy coding. Be that as it may, the better coding execution comes at the expense of high computational many-sided quality. The ME process contributes most of the computational multifaceted nature, since the variable size pieces and the various reference casings are utilized. In movement estimation procedures, every casing is apportioned into pieces and anticipated utilizing the best match from a reference outline.

The fundamental presumption is that every piece experiences autonomous movement from the reference square. The execution of coordinating procedure depends on three components: 1) the square size and shape; 2) coordinating exactness; and 3) the movement model.

Research endeavours gave to address these issues is entirely various. In prior principles, for example, H.264 [12] has embraced a propelled tree-organized square apportioning strategy down to a piece size of 4 × 4. Be that as it may, in the H.264 standard, this issue is considerably more extreme, since i) this standard can utilize multi-reference outlines, ii) there are a few movement estimation modes and iii) a sub-hinder in a square can have a movement vector. In this manner, the computational intricacy of the piece movement estimation process in H.264 is a few times that of different principles. In the full-scan calculation [15] for the square movement estimation process, it checks every hopeful movement vector and in this way is a savage power calculation and has the most measures of the computational intricacy and the most astounding precision. Consequently, scientists attempt to discover a moderately low many-sided quality square movement estimation calculation with a high precision [6]. A few analysts have investigated the likelihood of movement helped combining or leaf-consolidating [9] after quad tree-based division [14] with a mean to diminish the quantity of sections/squares which can be anticipated utilizing the same movement vector. In [17-18], it has been demonstrated that the ME procedure can expend 70 % (one reference casing) to 90 % (five reference edges) of aggregate encoding time of a standard H.264/AVC encoder.

2. Related Work

All printed material, including text, illustrations, and charts, must be kept within the parameters of the 8 15/16-inch (53.75 picas) column length and 5 15/16-inch (36 picas) column width. Please do not write or print outside of the column parameters. Margins are 3.3cm on the left side, 3.65cm on the right, 2.03cm on the top, and 3.05cm on the bottom. Paper orientation in all pages should be in portrait style. Reviews of the recent works related to the block motion estimation are deliberated in the Table 1. Accordingly 13 research papers are reviewed in this section. The papers under the literature works [1- 13] are based on the block motion estimation scheme. The motion estimation intention is to attain motion blocks without compromising the visual quality and the compression. The complexity over head of the motion estimation is the other norm for the best motion estimation algorithm.

Table 1. Literature Review

Author	Contributions	Issues
Xiaolin Chen *et al.*, [1]	Adaptive pixel-based motion estimation	Refining search classification affect the motion vectors severely
Pengyu Liu *et al.*, [2]	unsymmetrical-cross multi hexagon-grid search-based motion estimation	Required more Computational effort to search over the partitions.
Zhaoqing Pan *et al.*, [3]	Direction based unsymmetrical-cross multi hexagon-grid search-based motion estimation	Recursive search process which takes too long time to find the search patterns
Abdullah A. Muhit *et al.*, [4]	elastic motion model with larger blocks	Small level motion preservation is tough with larger blocks
Abdullah A. Muhit *et al.*, [5]	Geometry-adaptive partitioning-based elastic motion model	Limited number of searches over the partitions
Chunjiang Duanmu and Yu Zhang *et al.*, [6]	Octagon and Triangle Search-based motion estimation	Finding difficult to handle tricky motions such as, zoom and rotation
Marc Bosch *et al.*, [7]	visual motion perception-based motion model	Chance of missing the small level motions due to visual motion perception model
Jonathan Fabrizio *et al.*, [8]	Tangent Distance prediction-based motion compensation	Fails to preserve the motion discontinuities
Zhou Wei *et al.*, [9]	Fractional pixel motion estimation algorithm	Lower prediction quality
P. Thambidurai *et al.*, [10]	Hexagonal search algorithm	Increased search point
Alexander A. Sawchuk *et al.*, [11]	2-D Motion estimation algorithm	Computation time with improper initialization of motion parameters
Saeed Ranjbar Alvar *et al.*, [12]	Fast search algorithm	In accurate since it uses MSE
Jong Nam Kim *et al.*, [13]	Fast full search motion estimation algorithm	Computation time

3. Problem Statement and Motivating Scenario

3.1. Problem Statement

Due to the significant application of H.264 or MPEG for video compression, researchers have tried different variants of video compression model based on this standard. Here, the most of the research are in motion estimation part in finding the motion vector through different search algorithms. Accordingly, literature [1-8] presents different algorithms for movement search and estimation. While investigating these calculations, those algorithms still faces the following challenges in video compression.

i. Facing big challenge to preserve the motion discontinuities for the difficult motions especially, zooming, rotation, fast moving objects and so on

ii. Search calculation for the most part requires much computational time to locate the motional pieces

iii. Mathematical formulation of Rate-distortion trade off played a big role in selecting the blocks for further partitioning or encoding.

iv. Considering the high resolution blocks for motion vectors by neglecting low resolution blocks affect the visual quality greatly.

3.2. Motivation

This obviously means the shape and the extent of the hunt designs mutually are the main considerations in video quality (mistake execution) additionally the computational multifaceted nature of the movement estimation. The intrinsic goal here is to find matching point. If more search points are used to find the best matching point, the complexity would be high but the increasing the search points will further enable the gain in video compression. Hence, finding of better matching point to estimate motion field is a reasonable progression in video coding research. In searching algorithm, selecting the better search points is always evaluated by an objective function. Here, rate and distortion parameters are taken to evaluate the search points based on the fuzzy tangent weighted function which play a big role in further partitioning and encoding of the blocks.

4. Motion Estimation in Video Coding

4.1. Modified Pixel-Based Motion Estimation (MPME) Using Diamond Search Algorithm

We proposed a video compression technique based on Modified Pixel-Based Motion Estimation (MPME). Efficiently compressing the video is the main objective of this research. Here motion estimation technique is conducted on a pixel-by-pixel basis. The proposed technique will comprised of four stages namely, Displacement Calculation, Motion Estimation, Encoding and Decoding. A video is a compilation of an enormous amount of still frames which exhibits a motion like feature when the frames are changed in quick sequence. In this process, to compress the entire video, each frame of the video is compressed [5].

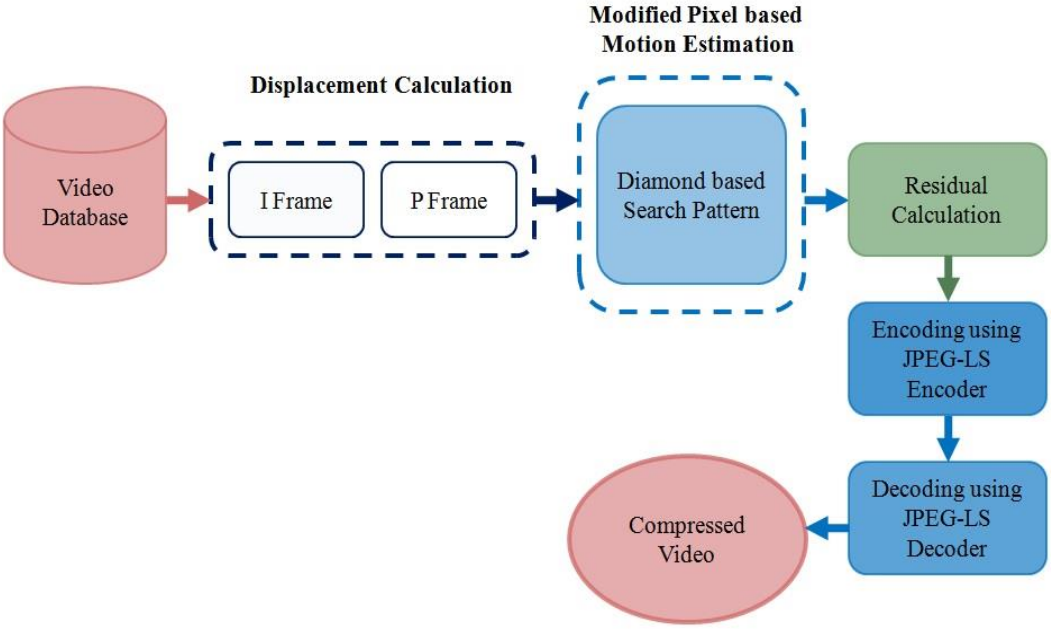


Figure 1. The Architecture of Modified Pixel Based Motion Estimation (MPME) Technique

Let $v_i : i = 1,2,\cdots,n$ be a database video,

Where n is the total number of videos present in the database.

The video is a set of frames of size $H \times B$ that can be represented as $f_j\ (x,y) : j = 1,2,\cdots,N_f$, $x = 0,1,2,\cdots,H-1$ and $y = 0,1,2,\cdots,B-1$, where, N_f is the total number of frames present in the ith database video.

The motion estimation scheme is conducted on a pixel-by-pixel basis. Pixel based approach cares for each individual pixel and possibly achieves better motion estimation accuracy and it is more prediction based. The Architecture of Modified pixel based Motion Estimation (MPME) technique is shown in Figure 1.

Our Modified Pixel-Based Motion Estimation (MPME) technique will comprise four stages namely: Displacement Calculation, Motion Estimation using diamond search pattern, Encoding and Decoding using JPEG-LS method.

4.2. Adaptive Order Square Hexagon Search and Tangent Weighted Trade Off for H.264 Motion Estimation

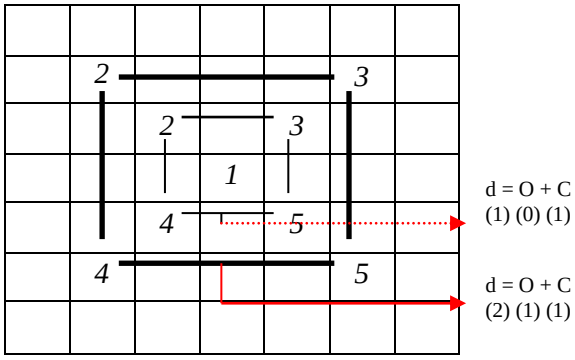
The flow of the AOSH algorithm is discussed with four steps and is shown in Figure 2(a) and Figure 2(b) and also the flow chart of AOSH and tangent weight trade-off criterion is shown in Figure 3.

Step 1: Starting: In the current frame, the centre point (x, y) is located in the same location of the reference frame and a block of size BxB is formed by fixing the centre point as centre pixel.

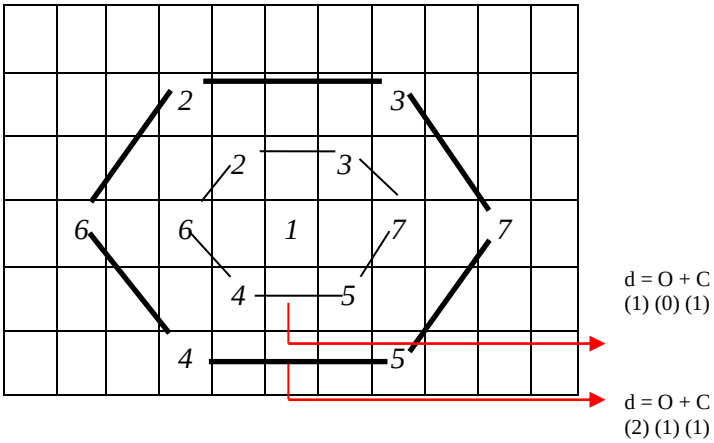
Step 2: Adaptive order square search: The adaptive square search is performed for the given S value with respect to the depth and order by traversing through the four corner points towards right, left, top and bottom direction. For all the five points visited in the square shape for order 0, the block is formed by fixing the current point as centre pixel. Similarly, for the order 1, again five points will be searched to find the best matching block.

Step 3: Adaptive order hexagonal search: Once the adaptive order square search is finished, hexagonal search is performed to find the best matching block by traversing through the six corner points. For all the six corer points of order 0, block is formed by fixing the current point as centre pixel to find the best matching block. Similarly, for the order 1, again six points will be searched to find the best matching block.

Step 4: For all the pixels visited through the adaptive square search and hexagonal search, the trade-off criterion is found and the block which is having the maximum value is taken as the best matching block.



(a)



(b)

Figure 2. Search Sattern: (a) Adaptive Order Square Search, (b) Adaptive Order Hexagon Search

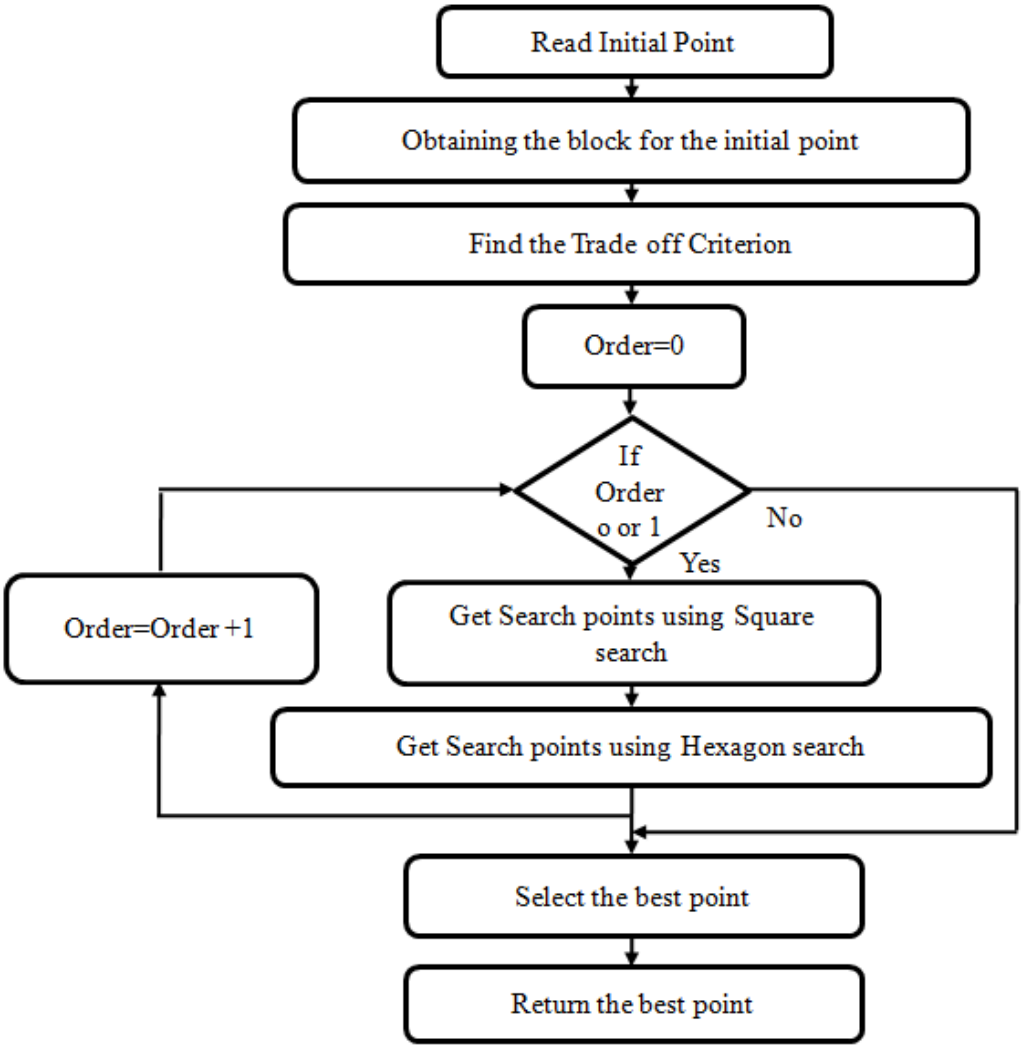


Figure 3. Flowchart of AOSH Algorithm

5. Results and Discussions

5.1. Experimental Set Up

The above methods are implemented using MATLAB (R2014a). The experimentation has been achieved with a system of having i3 processor and main memory of 2 GB RAM with windows 8 as operation system. The validations of the above methods are done using three videos namely, football, garden and tennis taken from [24]. The characteristics of video taken for the experimentation are given in Table 2.

Table 2. Characteristics of Input Videos

	Time	Frame rate	Number of frames	Scalar value for quantization	Macro block size
Football	2sec	30	60	27	16*16
garden	2sec	30	60	27	16*16
Tennis	2sec	30	60	27	16*16

The performance of the AOSH, Diamond Search, H.264 and Elastic methods are analysed using SSIM (structural similarity index) [9] and CIR (Compression improvement ratio). SSIM is used to evaluate the visual quality of the video after the decompression. CIR is used to evaluate the compressive performance after compression of the video.

5.2. Discussion

From Table 3, AOSH technique has higher SSIM and CIR when compared to the other existing JPEG-LS, H.264 and Elastic Methods for the 3 different kinds of dataset videos. Hence from the Performance Analysis AOSH tangent weight trade-off method gives better motion estimation than any other existing techniques.

Table 3. PSNR Values, Compression Improvement Ratios for the AOSH, Diamond Search Method, H.264, and Elastic Model

Video Database	AOSH tangent weight trade-off Method		Diamond search method		H. 264		Elastic Model	
	SSIM	CIR	SSIM / PSNR	CIR	SSIM	CIR	SSIM	CIR
Foot ball	92	0.778	54.2276	0.5169	64	0.733	64	0.732
Garden	97	0.601	59.5004	0.6256	74	0.578	74	0.578
Tennis	93	0.86	65.0337	0.8627	85	0.786	85	0.785

6. Conclusion and Future Scope

This paper displayed a diamond search, adaptive order square-hexagon search and digression weighted exchange off for motion estimation in H.264. Here, AOSH calculation was produced by joining the square and hexagon look for a versatile request of profundity. This enhances the looking capacity of motion estimation forms with less calculation multifaceted nature. Additionally, digression weighted exchange offs was condescended to assess the inquiry focuses utilizing two parameters called, rate and distortion. These two upgrades are connected to square estimation procedure of H.264 to

enhance the visual quality and also compressive execution. The experimentation is performed utilizing three recordings to be specific, football, garden and tennis and the execution of the AOSH, Diamond search, H.264 and Elastic model utilizing two quantitative parameters, as SSIM and CIR. The AOSH tangent weighted trade-off technique got great change than the past strategies for these two quantitative parameters which guaranteed the visual quality and compressive execution of the AOSH strategy. In future, the AOSH calculation can be further enhanced by including the different compel than the rate, bending or by utilizing Adaptive Cross Square Hexagon (AOCSH) search algorithm.

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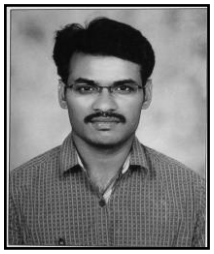

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