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MATLAB SIMULATION OF HYBRID MOTION ESTIMATION ALGORITHM FOR H.264/AVC

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ABSTRACT

The virtual role of science and technology in modern life demands compression in multimedia applications, as it involves transfer a large amount of data. Motion estimation is one of the most important and complex block of all the existing video coding standards. In the new video coding standard H.264/AVC, motion estimation is allowed to search multiple reference frames. In H.264/AVC video coding standard ME process is much more complex due to variable block size with quarter pixel accuracy. therefore, efficient motion estimation algorithm are required to reduce the computational complexity. In H.264/AVC video coding standard are required computation is highly increased, but frequently a lot of computation is wasted without achieving any better coding performance. the New Modified Small Cross Diamond Search algorithm is suitable for stationary, quasi-stationary and fast moving video sequences and computationally less complex. The results show that the proposed algorithm requires very few number of search points for finding the best matched block with almost negligible loss in video quality. As compared to the fastest existing ME algorithm. the proposed algorithm achieved 9.02% less number of search computations with less time and also be calculated in 0.007dB PSNR. Simulation Motion Estimation Algorithm is done by using MATLAB.

Key words: Motion estimation; H.264; search pattern; Modified small-cross diamond Search; ME time.

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1. INTRODUCTION

H.264/AVC is one of the most usable video coding standard used in various video processing applications. It has been jointly developed by ITU-T Video Coding Expert Group (VCEG) and ISO/IEC 14496-10 AVC Moving Picture Expert Group (MPEG) in 2003. It reduces the bit-rate 39%, 49% and 64% as compared to MPEG-4, H.263 and MPEG-2 respectively. The improvement in coding performance is due to variable block size motion estimation with quarter-pixel accuracy, multiple reference frame and improved prediction mode. But these features make the video encoder very complex, for example the complexity of encoder in H.264/AVC is increased by a factor of 9 as compared to MPEG-2. H.264/MPEG-4 Advanced Video Coding (AVC) standards, which are widely used in variety of product in our daily life. Block based motion estimation is used in all the existing MPEG-X and H.26X video coding standards due to ease in implementation and good trade-offs between complexity and accuracy. It is used for removal of the temporal redundancy between the current frame and reference frames. Full search block based motion estimation is the best motion estimation (ME) algorithm for finding the best possible matched block in the search window of the reference frame because it searches each and every possible blocks in the search window, but it consumes more time. Variable block size and multiple reference frames in H.264/AVC video coding standard add more complexity in ME process.

Further, variable block size with quarter pixel accuracy ME consumes more than 90% time of the H.264/AVC baseline encoder. Several techniques such as, reduction of bit width, MV prediction, successive elimination, hierarchical search and reduction of the checking points were proposed by researchers to accelerate the ME process. Nowadays, the traffic caused by video applications in network high due to the growing popularity of High Definition (HD) Video and beyond HD videos. Personal computers, Tablets and even mobile devices .need to receive and display HD videos, and this become a severe challenge on today's network. Network traffic can be minimized by increasing video compression. essentially all existing applications and issues of H.264/AVC. It particularly focuses on two key issues (1) increased video resolution (2) improve the coding performance. The most essential part in video coding standards like MPEG-2, H.264/AVC. But Motion estimation it consumes more than 50% of coding complexity or time to encode. To reduce the computational complexity, the time required for Motion Estimation should be reduced.

MPEG-4 (ISO/IEC 14496) is a collection of standards defining the coding of audiovisual objects. The collection is divided into a number of parts describing video compression and audio compression standards, as well as system level parts, describing features such as the MPEG-4 file format. The video compression standard found in many products today, such as in the Indigo Vision 8000 product series, is the traditional DCT-based MPEG-4 Part 2 (ISO/IEC 14496-2) standard.

The H.264 video compression standard has been incorporated into MPEG-4 as MPEG-4 Part 10 (ISO/IEC 14496-10). This means MPEG-4 now has two video compression standards available. However, these two video compression standards are non-interoperable, with each standard using different methods in fig 1 to compress and represent the data i.e. an MPEG-4 Part 10 (H.264) decoder cannot decode an MPEG-4 Part 2 bit stream and vice versa.

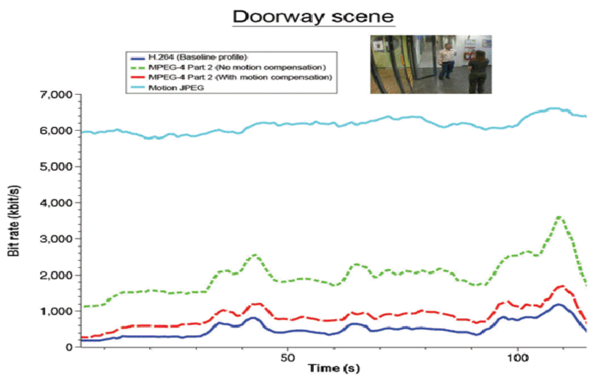

Figure 1 Comparison between different standards

H.264/MPEG-4 (AVC) standard. Table I shows some of the key improvements of HEVC/H.265 standard related to H.264/MPEG-4 (AVC).

Table 1 Key Improvements in H.264 standards

Category	H.264
Bit rate	40-50% bit rate reduction quality compared to MPEG-2
Specification	Supports up to 4k (4096x2304) Supports up to 59.9 fps
Compression Model	Hybrid Spatial-temporal prediction Model
Block structure	Macro block structure with maximum block size supporting of 16x16
Intra prediction Directional Modes	9 directional modes
Improvements	Led growth HD content for broadcast and online
Other Names	MPEG 4 part 10 AVC

Chapter two gives the existing for further work. Chapter three Analysis of proposed Motion Estimation Algorithm and Searching patterns for motion estimation have been analysed for its performance. Chapter four gives Simulation of motion estimation and various search patterns and system design results using MATLAB. The last chapter will summarise the concluded with future work to be done.

2. EXISTING SEARCH METHODOLOGIES

DS algorithm is one of the most popular fast ME algorithm. It gives good PSNR value with less number of search points as compared to other fast ME algorithms like TSS, NTSS,HEXBS etc. DS algorithm has two types of diamond search patterns: Large diamond-search pattern (LDSP) and Small diamond search pattern (SDSP) as shown in Fig. 3 and Fig. 2 respectively [10]. LDSP searches nine points while SDSP searches only five points. In [10] the first step is the LDSP and it continues until either the motion search reaches the boundary of the search range or best matched block is found on the center of the LDSP. After finding best matched block using LDSP, SDSP is used for further refinement and it executes only once.

In [11], Ho *et al*. performed experiments on various types of video sequences using full search ME algorithm and found 74.76% motion vector lie on the cross-center-biased portion. So, instead of using LDSP as the initial step, they used cross-search pattern (CSP) as the initial step. The CSP searches total nine positions, one at origin and eight ((0,±1), (0,±2), (±1, 0) and (±2, 0)) positions around the origin of the search window, as shown in Fig. 4. Using this technique, CDS algorithm saves four search points for stationary blocks and two search points for quasi-stationary blocks unlike the DS algorithm.

In [14] and [15] small cross search pattern such as the one shown in Fig. 5 is used as the initial step for further speeding up the CDS algorithm with negligible loss in visual quality. But these algorithms are complex because they use more number of search patterns like small cross search, CSP at origin and LDSP at the origin.

2.1. Diamond Search Pattern

The existing methods number of search pattern algorithm are used. Diamond Search algorithm is one of the most popular fast ME algorithm. It gives good PSNR value with less number of search points as compared to other fast ME algorithms like TSS, NTSS, HEXBS etc. DS algorithm has two types of diamond search patterns: Large diamond-search pattern (LDSP) and Small diamond search pattern (SDSP). LDSP searches nine points while SDSP searches only five points. the first step is the LDSP and it continues until either the motion search reaches the boundary of the search range or best matched block is found on the center of the LDSP.SCDS and NCDS are suitable for both type of video sequences but architectural complexity of these algorithms is large. As the video sequences are naturally the combination of stationary, slow moving and fast moving blocks, so there is a need to develop a single algorithm which is suitable for all types of video sequences. In Diamond search pattern as shown in figure 2.

2.2. Hexagon Search Pattern

In Hexagon pattern save around 23% of search window when compared to diamond pattern. There are two basic hexagon search pattern. Horizontal hexagons is good for horizontal motion and have poor performance for vertically moving objects, whereas Vertical hexagons is good for vertical motion and have poor performance for horizontally moving objects. In order to cope with these patterns without loss of performance we consider rotating hexagon patterns. as it incorporates both vertical and horizontal motion. Hexagon pattern helps reducing the computational complexity to a great extent, but there is still complexity in coding. . In Hexagon search pattern as shown in figure 3.

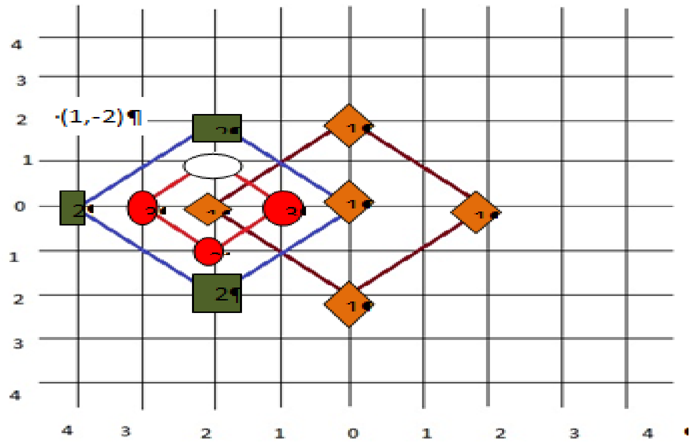

Figure 2 Diamond search pattern

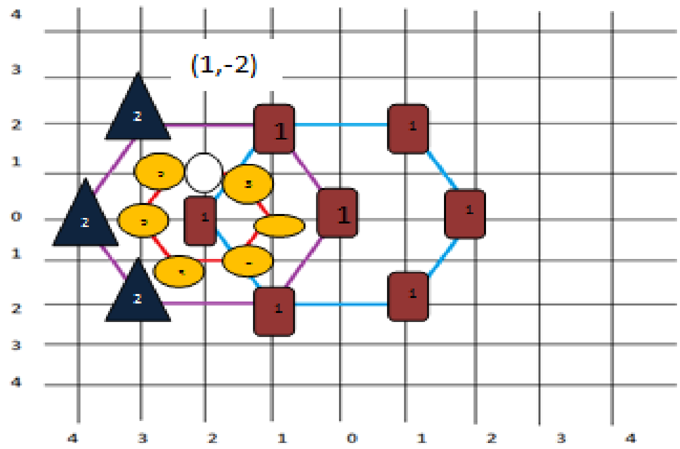

Figure 3 Hexagon Search Pattern

3. PROPOSED MOTION ESTIMATION ALGORITHM

The search patterns are used to find the global minimum points. The search patterns comes in different forms such as small cross, diamond grids. These patterns are used so as to reduce the computational complexity for finding motion vectors. The modified small-cross diamond search became very popular because of its simplicity and also robust and near optimal performance. It searches for the best motion vectors in a coarse to fine search pattern.

In this paper, we have proposed a new fast ME algorithm called modified small cross search diamond search (MSCDS), which is the combination of small cross search pattern and diamond search pattern (DSP). The proposed algorithm is suitable for all types of video sequences. It uses two half way stop techniques: one after initial step and the other after second step. In MSCDS small cross pattern is used as the initial step, which is good for stationary and quasi-stationary blocks. If block is neither stationary nor quasi-stationary, LDSP is used for further refinement which gives better performance for fast moving objects. So, we conclude that, MSCDS is suitable for all types of video sequences.We have performed experiments on various video sequences full search ME algorithm and found that 75% of the blocks are either stationary or quasi-stationary. Hence, by using small cross in initial step, we gain the advantage of speed up in the algorithm. The proposed modified small cross search diamond search (MSCDS) ME algorithm used only two search pattern: small cross and DS pattern.

The step by step procedure of the proposed MSCDS algorithm can given by:

Step (1) Initial: The first step of the proposed MSCDS algorithm is Small cross search pattern It checks all the five points of the small cross-search pattern and find minimum block distortion. If minimum block distortion is found at the center of the small cross-search pattern, the best matched block is the block at the center of the search window and search stops immediately else go to step 2.

Step (2) Small Cross Search: The point with minimum block distortion is the new center and again use the small cross-search pattern. In this step, only three near by point of the new center are evaluated, If the minimum block distortion found at the center, then the search stop. Otherwise search will go to the 3rd step.

Step (3) Large Diamond Search: If the minimum block distortion is found other than center point in the previous step, the point with minimum block distortion is the new center and used LDS pattern. It will repeated until either the search reached to the boundary of the search window or the best matched block lies at the center of the LDS pattern and go to step 4.

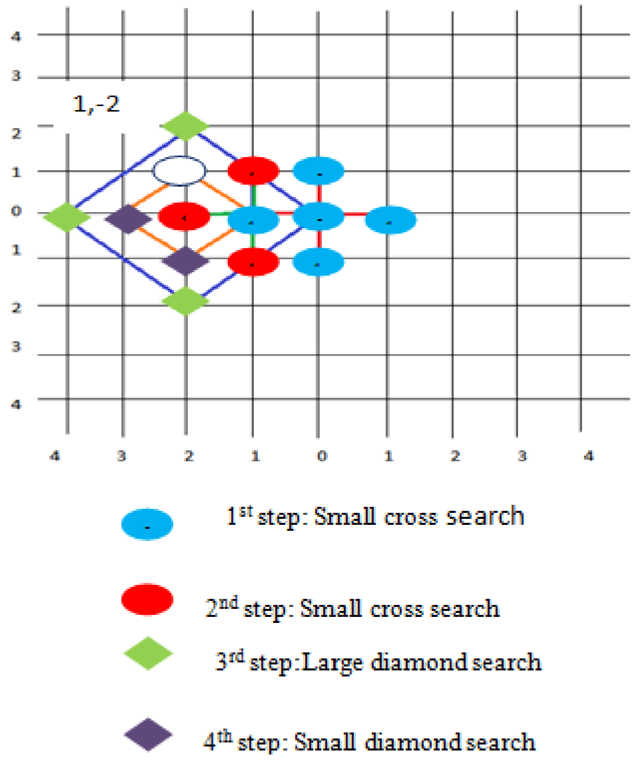

Figure 4 Search path analysis of proposed MSCDS

Step (4) Small Diamond Search: The point with the minimum block distortion in the previous step is the new center and use SDSP pattern. It will execute only once and identify the minimum block distortion point, which is the final best matched block for the current block with in the search window of the reference frame.

The Modified Small-Cross Diamond Search pattern are above shown in figure 4.

This can be understood through the motion vector translational model which gives better performance for fast moving objects. So, we conclude that, Proposed MSCDS is suitable for all types of video sequences and it able to finding the motion estimation.

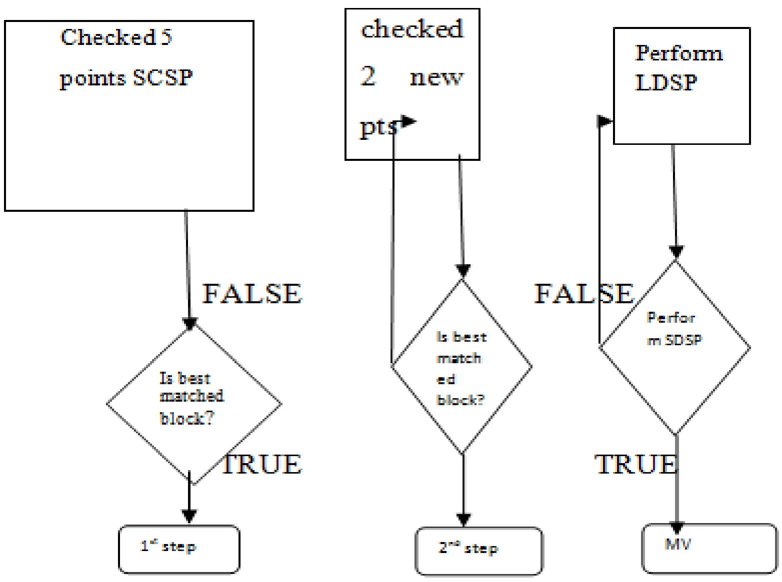

Figure 5 Flow chart of proposed MSCDS Algorithm

4. PERFORMANCE MEASURE

The results of motion estimation and compensation is produced in the MATLAB environment. Peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR is usually expressed in terms of logrithamic decibel scale The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. PSNR is most easily defined via the mean squared error (MSE). Given a noise free monochrome image I and its noisy approximation K, MSE is defined by Equation.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2 \quad (1)$$

knowing the Mean Squared Error, the Peak Signal to Noise Ratio is given by a Equation [1]

$$PSNR = 10\,log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

Here MAXI is maximum possible pixel value of the image When the pixels are represented using 8 bits per sample then MAXI is 255. YUV test sequence named ‘Mobile’ of resolution 832x480 is used for analysis. The YUV sequence is converted to sequence of frames and is read from storage location using MATLAB. Motion Estimation is done for a total of 10 frames and the average time, PSNR and computations is calculated with different search patterns for the compensated and original frame. The algorithms were implemented with different sequence with a distance of two between the frames. H.264 has a high complexity in computational time. So as to reduce the computational complexity, the number of computations should be reduced. This is achieved by limiting the search points of search patterns. The proposed MSCDS pattern proposed in H.264 has minimum search points and so thus provide low computation than other search patterns. The time and PSNR is calculated for each frame of the sequence and the PSNR compensated frame and current frame of distance for different patterns. The different search pattern algorithm used to measure the average time, PSNR, and computations by using different block size

Table 2 shows the results of PSNR value

Sequence	Depth	PSNR Improvement (db) compared to MSCDS		
		DS	**HS**	**MSCDS**
BQMALL	1	-0.23276	0.27705	0.04092
	2	0.13086	0.08098	0.23582
MOBISODE	1	1.1086	0.82732	0.9011
	2	-0.60223	0.51061	0.68056
PEOPLE ON	1	0.31395	0.02099	0.13663
2560x1600	2	0.31346	0.25937	0.30735
TRAFFIC	1	-0.43395	0.19148	0.24657
	2	-0.07319	0.11079	0.17016
Average improvement in quality (db)		**0.06559**	**0.28482**	**0.33989**

Table 3 Simulation Results of ME System

	Dept	**ME Time (sec)**			
		TSS	**DS**	**HS**	**NCTSS**
BQMALL 832x480	1	25.47689	16.40981	13.21377	13.00017
	2	32.54606	23.97998	18.80197	18.40985
MOBISO DE 832x480	1	24.74718	18.19181	12.91023	12.32081
	2	32.80111	28.66917	19.79492	19.34664
PEOPLE ON STREET 2560x160 0	1	303.02874	223.3282	136.1478	135.6764
	2	370.8152	311.356	186.7926	185.6142
TRAFFIC 2560x160 0	1	289.8494	188.7696	139.6987	139.9564
	2	374.7651	269.2973	201.2912	201.5436
Average		**181.75371**	**135.0002**	**91.08139**	**90.73384**
Average Time Saving Compared with TSS			**25.72%**	**49.88%**	**50.07%**

The motion estimation time is calculated for “MOBILE” sequence each frame of the sequence and the motion estimation time compared with different patterns. The proposed MSCDS algorithm is simulated in MATLAB using the luminance of the test video sequences We consider the previous frame as the reference frame with block size 16×16. In motion estimation time are measured the number of search point for each block for different search pattern with compared on proposed search methods as shown in figure (5.1) it shows the MSCDS pattern used in H.264 has lower time at all points compared to other search patterns. Motion Estimation is done for a total of ten frames and the average PSNR is calculated with different search patterns for the compensated and original frame and is given in Figure 6.

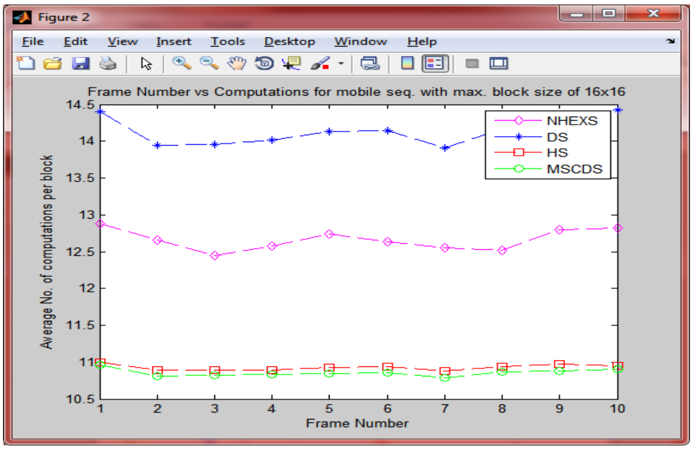

Figure 6 Computation variation in each frame in the sequence

In motion estimation time are measured the number of search point for each block for different search pattern with compared on proposed search methods as shown in figure 7, it shows the MSCDS pattern used in H.264 has lower time at all points compared to other search patterns.

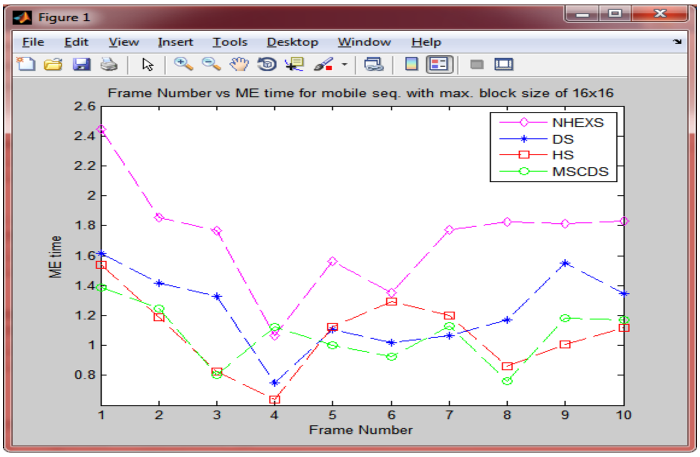

Figure 7 Time variation for each frame in the sequence

The overall MSCDS is fast motion estimation algorithm with no loss or almost negligible loss in video quality.

5. CONCLUSIONS

In this paper, we proposed a new fast MSCDS motion estimation algorithm for H.264/AVC video coding standard. The proposed algorithm reduces the number of checking points and thereby makes the motion estimation process faster. Our algorithm uses two half stop technique after first and second step, which is responsible for increase in speed of the algorithm. MSCDS outperforms other fast motion estimation algorithms like DS, HS, and NHEXS, and it takes less number of search points and Simulation results show that the proposed algorithm requires very few number of search points for finding the best matched block with almost negligible loss in video quality. Further, with less computation, there is a possibility for the architecture of the proposed algorithm to be computationally efficient. As compared to the fastest existing ME algorithm, proposed algorithm requires 9.02% less number of search points with 0.007 dB loss in PSNR. So, the overall MSCDS is 24.45% faster than other fast motion estimation algorithm.

The future work leads to the modification of the proposed algorithm for High Efficient Video Coding (HEVC) standard and its hardware implementation.

REFERENCES

[1] Karam Singh, and Shaik Rafi Ahamed, "A modified small cross-diamond search motion estimation algorithm for H.264/AVC," in 2013 Annual IEEE India

[2] Conference (2013).

[3] C.-H. Cheung and L.-M. Po, "Novel cross-diamond-hexagonal search algorithms for fast block motion estimation," IEEE Trans. Multimedia, (2005).

[4] Y.-W. Huang, B.-Y. Hsieh, S.-Y. Chien, S.-Y. Ma, and L.-G. Chen, "Analysis and complexity reduction of multiple reference frames motion estimation in h.264/avc," IEEE Trans. Circuits Syst. Video Technol.,(2006).

[5] Xing Wen, Lu Fang and Jiali Li:" Novel RD-Optimized VBSME with Matching Highly Data Re-Usable Hardware Architecture". In: IEEE Transactions on Circuits and Systems for Video Technology, Vol. 21, No. 2, (2011)

[6] Huitao Gu, Shuming Chen, Shuwei Sun, Shenggang Chen, Xiaowen Chen, The 11th International Conference on Parallel and Distributed Computing, Applications and Technologies, "Multiple Search Centers Based Fast Motion Estimation Algorithm for H.264/AVC",(2011).

[7] Haithem Chaouch, Salah Dhahri, Abdelkrim Zitouni and Rached Tourki Laboratory of Electronics and Micro-Electronics (LAB-IT06) "Low Power Architecture of Motion Estimation and Efficient Intra Prediction Based on Hardware Design for H.264",(2010).

[8] Chih-Hung Kuo, Member, IEEE, Li-Chuan Chang, Student Member, IEEE, Kuan-Wei Fan,and Bin-Da Liu, Fellow, "Hardware/Software Codesign of a Low-Cost Rate Control Scheme for H.264/AVC", (2010).

[9] Zhenyu Liu, Member, IEEE, Junwei Zhou, Dongsheng Wang, Member, IEEE, and Takeshi Ikenaga, Member, "Register Length Analysis and VLSI Optimization of VBS Hadamard Transform in H.264/AVC",(2011).

[10] Qiang Tang, Student Member, ieee, and Panos Nasiopoulos, Member," Efficient Motion Re-Estimation with Rate-Distortion Optimization for MPEG-2 to H.264/AVC Transcoding" (2010).

[11] O. Ndili and T. Ogunfunmi, "Algorithm and architecture co-design of hardware-oriented, modified diamond search for fast motion estimation in h.264/avc," IEEE Trans. Circuits Syst. Video Technol., (2011).

[12] S.N.H. Faridi, Mohammed Aslam Husain, Abu Tariq, Abul Khair, Matlab Based Modeling of a PV Array and its Comparative Study with Actual System for Different Conditions. International Journal of Electrical Engineering and Technology (IJEET), Volume 5, Issue 5, May (2014), pp. 19-27

[13] R R Mandal and U K Dewangan Finite Element Modeling of Beam with Eight Noded Brick Element Using Matlab. International Journal of Civil Engineering and Technology , 8(5), 2017, pp. 646–656

[14] Olatunji, O. M., Horsfall, I.T, Numerical Simulation of Bioremediation of Poly Aromatic Hydrocarbon Polluted Soil Using Matlab. International Journal of Advanced Research in Engineering and Technology (IJARET),Volume 5, Issue 8, August (2014), pp. 10-25