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International Journal of Advanced Research in Computer Science Engineering and Information Technology

Volume: 4, Issue: 3,Special Issue: 3 ,Apr,2016 ,ISSN_NO: 2321-3337

Adaptive Block Matching In Video Compression Using H.264 Standard

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Abstract:

Video Compression is about reducing and removing redundant video data so that a digital video file can be effectively sent and stored. The MVCWT deals with video compression in an efficient manner. It focuses on performance, time as well as the compression ratio using effective transforms and coding techniques. In Motion Estimation, Block matching algorithm is being used to determine the moving vector of each block. We have analyzed various block matching algorithms. Adaptive Block Matching Algorithm method is used for finding the moving vectors. Motion compensation is done for reconstructing the video from the moving vector. Both the Motion Estimation and Motion Compensation will be done using Wavelet Transform. Huffman variable length coding is being used for encoding and decoding process. Compression rate depends on two factors such as PSNR value and the bit rate. The bit rate should be less and the PSNR value should be high.

1.Introduction:

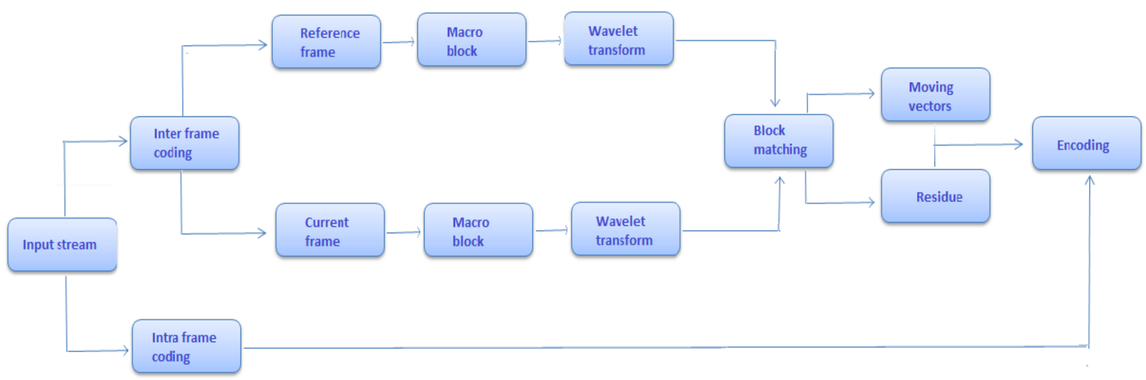
Digital video techniques have been used for a number of years, for example in the television broadcasting industry. However, until recently a number of factors have prevented the widespread use of digital video. An analog video signal typically occupies a bandwidth of a few megahertz. However, when it is converted into digital form, at an equivalent quality, the digital version typically has a bit rate well over 100 Mbps. This bit rate is too high for most networks or processors to handle. Therefore, the digital video information has to be compressed before it can be stored or transmitted. Over the last couple of decades, digital video compression techniques have been constantly improving.

All video coding standards make use of the redundancy inherent within digital video information in order to substantially reduce its bit rate. In a moving video sequence, successive frames of video are usually very similar. This is called temporal redundancy. Removing temporal redundancy can result in further compression. To do this, only parts of the new frame that have changed from the previous frame are sent.

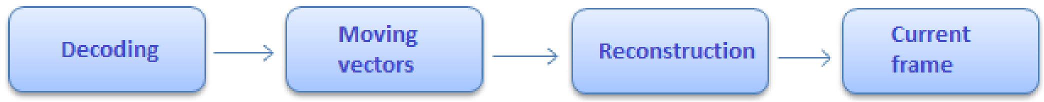
The H.261 standard supports motion video coding for videoconferencing and video telephony applications. It is optimized for video communications at the bit rates supported by ISDNs. The recent development of the H.263 draft standard specializes in very low bit rate videoconferencing (less than 64 Kbps). Motion Picture Experts Group (MPEG) standards addresses the issues of video coding for entertainment and broadcast purposes. MPEG1 is optimized for coding of video and associated audio for digital storage media such as CD-ROM. MPEG2 enhances the techniques of MPEG1 to support video coding for a range of video communication applications, including broadcast digital television (at an equivalent resolution and quality to analog television and also at higher resolutions). The MPEG4 initiative is addressing generic, integrated video communications.

2.MVCWT

Encoding:



Decoding :



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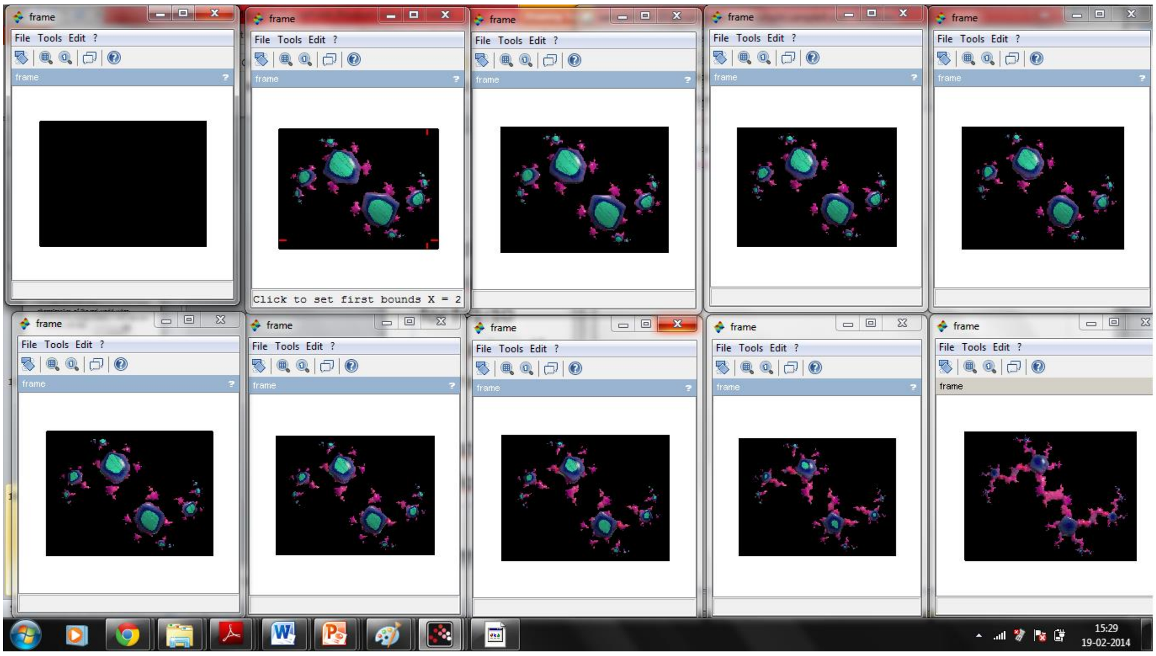
3. Conversion of video to frame

An video is the sequence of images. Hence, the video is initially converted into frames.



4. Motion Estimation:

It is the process of calculating motion vectors by finding match blocks in the future frame to the blocks in the current frame which is shown in fig 1. Motion estimation helps in detecting the temporal redundancy. Initially the video is being divided into sub frames. Using block matching algorithm the current frame and the reference frames are compared. It is known to be the most crucial and computationally intensive process.

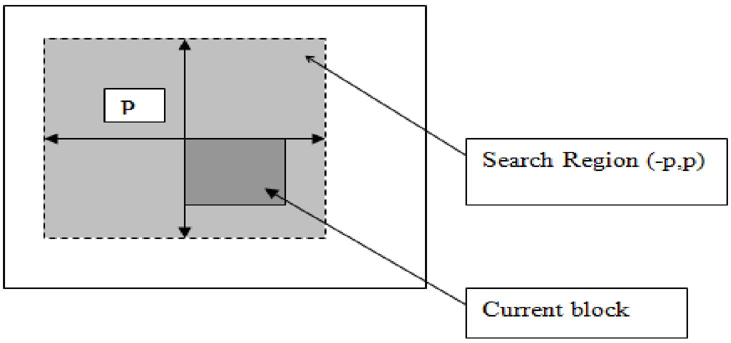


Fig1

4.1 Block matching Algorithm:

The idea behind block matching is to divide the current frame into a matrix of 'macro blocks' that are then compared with corresponding block and its adjacent neighbors in the previous frame to create a vector that stipulates the movement of a macro block from one location to another in the previous frame. The size of the macro blocks(MB) can be either 8x8 , 16x16 or 32x32.The search area for a good macro block match is constrained up to *p* pixels on all fours sides of the corresponding macro block in previous frame. This '*p*' is called as the search parameter.

4.2Full Search Algorithm:

Full search is an exhaustive search algorithm. Full search is the simplest method to find the motion vector for each block. Thus a search for the match block is made in the complete (-p, +p) range in the future frames for every block of the current frame which is shown in fig 2. CPU time for full search is the highest of all the algorithms. This algorithm calculates the cost function at each possible location in the search window. As a result of which it finds the best possible match and gives the highest PSNR amongst any block matching algorithm.

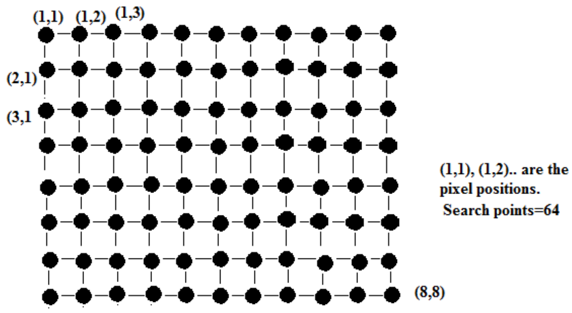


Fig 2

4.2 Three Step Search Algorithm:

Three Step Search Algorithm became very popular because of its simplicity, robust and near optimal performance. One problem that occurs with the Three Step Search is that it uses a uniformly allocated checking point pattern in the first step, which becomes inefficient for small motion estimation.

Step 1: An initial step size is picked. Eight blocks at a distance of step size from the centre (around the centre block) are picked for comparison.

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Step 2: The step size is halved. The centre is moved to the point with the minimum distortion.

Steps 1 and 2 are repeated till the step size becomes smaller than 1. A particular path for the convergence of this algorithm is shown below (fig3):

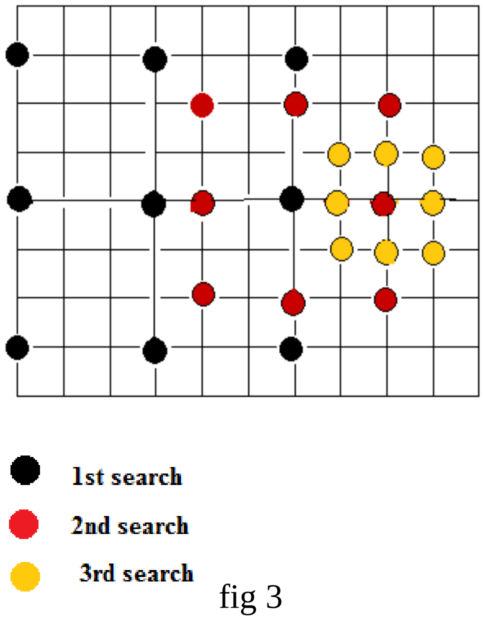

fig 3

4.3 Cross search Algorithm:

The reference point for a block is taken at its upper left hand comer. The block in the previous frame which corresponds to a block in the current frame is referred to as the block at (0,0). The current block and the block at (O,O), are compared and if the value of the distortion function is less than a predefined threshold T then the current block is classified as a nonmoving block and the search stops which is shown(fig 4)

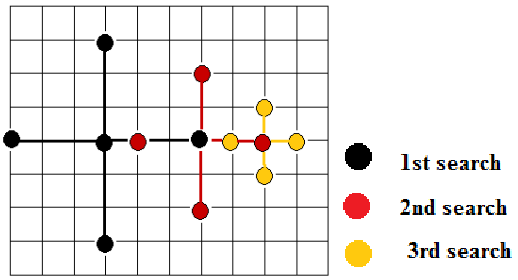

Fig 4

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4.4 Diamond Search Algorithm

Start with 9 points creating a *large diamond* with center of search window in center. Find best match, repeat with this best match as center. The search point pattern is changed from a square to a diamond, and there is no limit on the number of steps that the algorithm can take which is shown in fig 5.

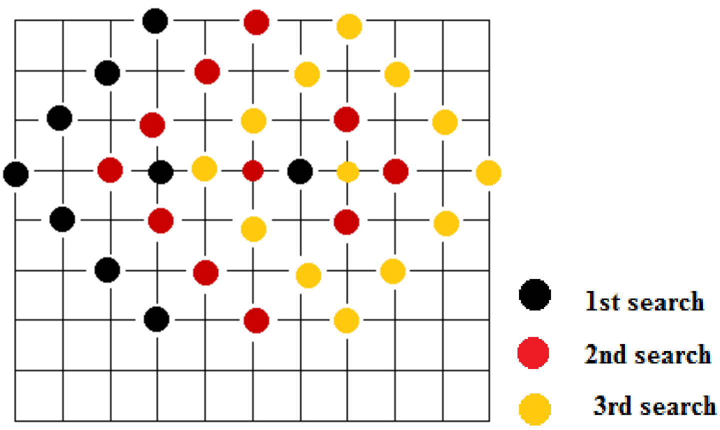

Fig 5

4.5 Four Step Search Algorithm

Four Step Search is the most efficient block matching algorithm. This algorithm also exploits the center-biased characteristics of the real world video sequences by using a smaller initial step size compared with 3SS. 4SS [6] also employs center biased searching and has a halfway stop provision. 4SS sets a fixed pattern size of S = 2 for the first step, no matter what the search parameter *p* value is. Thus it looks at 9 locations in a 15x15 window. If the least weight is found at the center of search window the search jumps to fourth step. If the least weight is at one of the eight locations except the center, then we make it the search origin and move to the second step. The search window is still maintained 15x15 which is shown in fig 6.MVCWT uses Four Step Search Algorithm for motion estimation.

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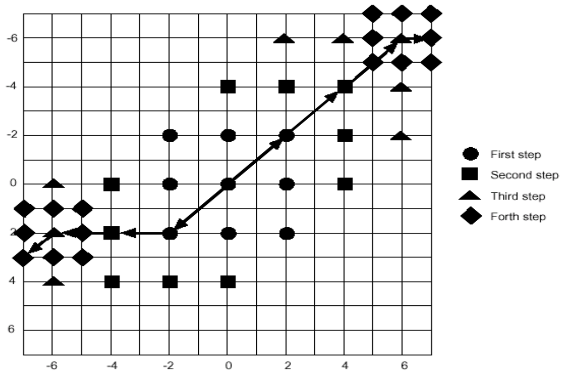
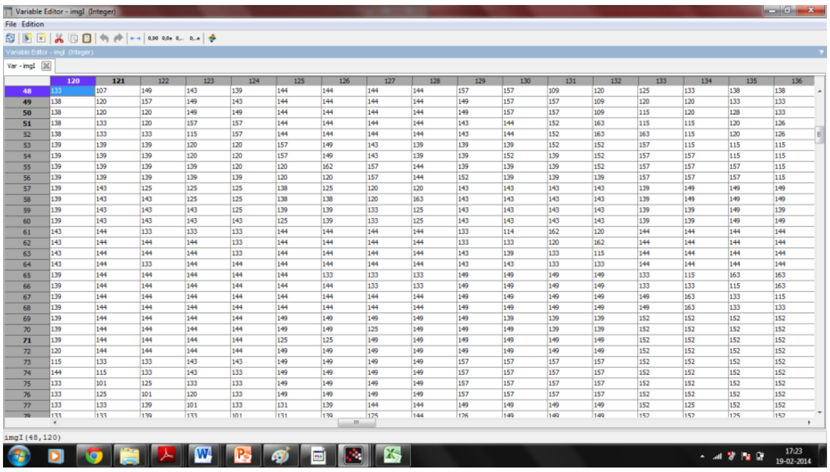


Fig 6



Original image matrix format

Fig7

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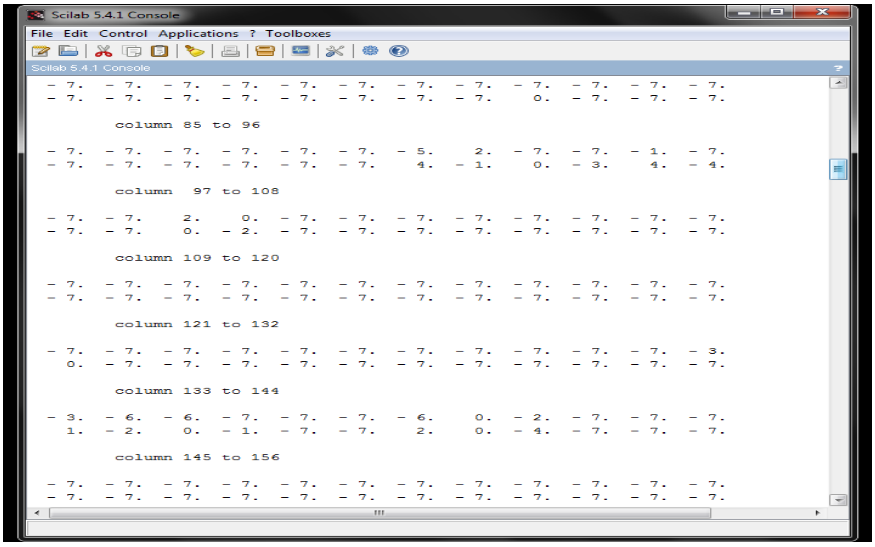
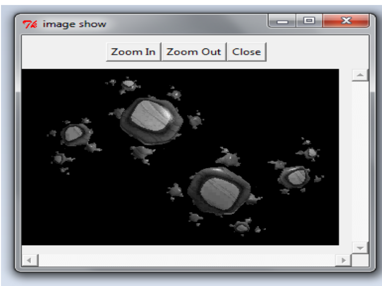


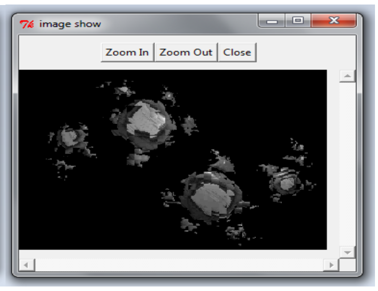
Moving vectors obtained for the corresponding image

Fig 8

5. Motion Compensation

The idea is to reduce the bandwidth required for the video by sending only the difference frames instead of the actual frames.The motion vectors produced during Motion Estimation are utilized in the Motion Compensation process in order to produce the predicted image. The two images (current frame and the motion compensated frame) are now subtracted and the difference is sent to the receiver along with the motion vectors. Thus the decoder can produce the exact copy of the future frame by first motion compensating the current frame using the motion vectors and then adding the difference image.





Original image Reconstructed image

6. Wavelet Transformation:

Wavelet transforms are based on small waves, called *wavelets*. It can be shown that we can both have frequency and temporal information by this kind of transform using wavelets. Due to the fact that human vision is much more sensitive to small variations in color or brightness, that is, human vision is more sensitive to low frequency signals. Therefore, high frequency components in images can be compressed without distortion. Wavelet transform is one of a best tool for us to determine where the low frequency area and high frequency area is.

7. Quantization

The human eye is not sensitive to the high frequency content in an image. Therefore removal of these spatial frequencies does not lead to any perceptible loss in image quality. This is the basic principle behind quantization. The spatial frequency content of the image is obtained by using the Wavelet transformation, which is followed by a removal of the high frequency content that is the quantization process. Quantization is a lossy process and some data is lost during quantization. This loss of information is irreversible.

8. Huffman Coding:

Huffman encoding is a form of entropy encoding and it is based on Shannon's Information theory. The fundamental idea behind Huffman encoding is that symbols, which occur more frequently, should be represented by fewer bits, while those occurring less frequently should be represented by more number of bits. This scheme is similar to the one utilized in Morse code. Shannon has proved that the entropy of the total message gives the most efficient code, with minimum average code length, for sending a message. Given n symbols S1 to Sn-1 with probabilities of occurrence P1 to Pn-1 in a certain message, the entropy of the message will be given by Huffman encoding attempts to minimize the average number of bits per symbol and try to get a value close to entropy.

9. Conclusion:

In MVCWT, We have analyzed various block matching algorithm for motion estimation for determining the moving vector.

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