Low bit rate efficient video compression based on Quantized motion vector

Poorva Waingankar, Prajakta Pawar

Abstract— Motion compensation it is an algorithmic technique used in the encoding of video data for an efficient video compression. Motion compensation uses the realization of motion of object in order to achieve best compression. This paper introduced a modified coding technique based on the Quantized motion vector. The key tool of modified technique is the lossless coding of motion vectors. The experimental results show an efficient video compression based on Quantized motion vector by carried out comparison of bit rate, PSNR, MSE values of respective videos. The Bit rate, PSNR and MSE comparison of these videos is carried out using Block matching algorithm& Huffman coding. Huffman's algorithm derives the table for encoding a source symbol such as a character in a file and that are based on the determining probability or frequency of occurrence for each possible value of the source symbol. H.264/AVC which is block oriented motion compensation based video coding standard offers many coding tools for achieving high compression gains than other standards. Several problems are faced in order to get an efficient implementation of the coding technique & prediction of the quantized motion vectors.

Index Terms— Motion vector, Quantization, video coding, DCT, IDCT, H.264/AVC, Block matching, Huffman coding, motion estimation and compensation, video coding, Motion vector quantization.

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1. INTRODUCTION

Data compression it is an art of representing information in a compact manner. Compression is nothing but the development of a compact representation of information [1].and the task of compression consist of two components that is first is an encoding algorithm that takes a message and generate a compressed representation and second is decoding algorithm that reconstruct the original message. Video compression is a technique that is used for reducing and removing redundant video data, so that digital video data can be more effectively sent over a network and stored on computer disk.H.264/AVC is one of the video coding standards used for the recording, compresses and distribution of video content. This coding provide a good video quality at low bit rates than the previous standards. This coding standard achieves excellent compression performance at many different bit rates. However it has been concluded that high efficiency video coding used to double data compression ratio as compared to H.264 standard with same level of video quality [2].

In video compression motion vector are the main key element in the motion estimation process. For an efficient

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video coding (Motion vector quantization) algorithm developed. The difference between current frame and the actual frame is quantized by motion vector quantizer. And block matching algorithm is the process of locating matching blocks in a sequence of digital video frames for the purposes of motion estimation process.

2. BACKGROUND AND RELATED WORK

The following research papers incorporated different methods to carry out project work related to efficient video compression simulation in MALTAB environment. The brief explanation and important results about this is discussed below.

2.1 Basic motion compensation process

Motion compensation is the process used to describe frame in transformation of a reference frame to the current frame or in a video by giving the previous frame or future frames. And that are depends on calculation of the motion of the camera or motion of the objects in the given video. And for video transmission predictive coding has been used. Motion compensation technique is used in the encoding of video data for video compression. Motion compensation process used for low bit rate coding. the facts behind the motion compensation process is that ,it employs for many frames of a movie and in this process the only difference between one frame and another is the result of either the camera moving or an object in the frame is

moving. In reference to a video stream much of the information that represents one frame will be the same as the information used in the next frame. And using this motion compensation technique a video format will contain reference frames as well as the information stored for the frames and that would be the information needed to transform the previous frame into the next frame.
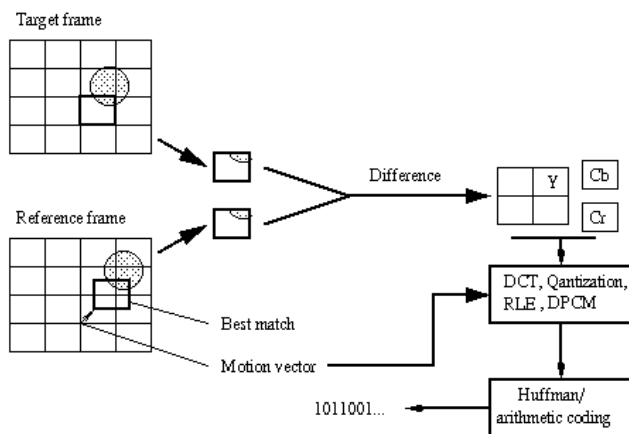

Figure 1: Motion compensation process

The temporal redundancy between frames is reducing by using Motion compensated prediction. The concept of motion compensation contains the motion estimation between video frames is explained in Figure 1. In which the motion is described by a small number of motion vectors which gives the translation of a block of pixels between frames. And the motion vectors and compressed prediction errors are then transmitted. Huffman coding a method of compressing a given set of data based on the relative frequency of the individual elements. The more often a given element occurs, the shorter in bit length its corresponding code. This method is used for text, with the coding based on letter frequency. The Huffman code was one of the earliest data compression codes and, with modifications, remains one of the most widely used for a large group of message types [3].

The conversion of a media files or object from one format to another is the process of Transco ding. Which is used to convert different video formats but it is also used to fit hyper text markup language files and graphics files to the unique constraints of mobile devices .These devices usually have smaller screen sizes and slower bandwidth rates. The process of Transco ding is performed by a Transco ding proxy server, which receives the document or file which requested and uses a specified annotation to adapt it to the client. This Video Trans coding is a technique of converting a compressed video stream into another compressed video stream. The video Trans coding is determined by the difference in original stream and

transcoded stream. And that deals with converting a previously compressed video signal into another one with different Format with consideration, such as different bit rate, frame rate, frame size, as well as even compression standard [4].
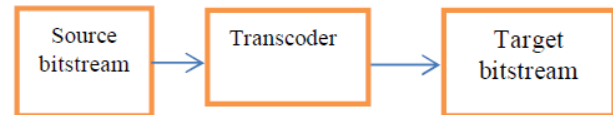

Figure 2: video transcoding

In video transcoding process transcoder code the video stream from one format to another for multimedia application that is used of digital video broadcasting, teleconferencing etc.

2.2 Fast motion estimation system

Motion estimation is the process of finding the motion vectors that describe the transformation from one 2D image to another; usually from adjacent frames in a video sequences. It is the major problem as the motion is in three dimensions but the images are a projection of the 3D scene onto a 2D plane. Motion estimation is the process of determining the motion vectors that described the transformation from one 2D image to another image usually from adjacent frames in a video sequence. The motion vectors used to represent a translational model or many other models that can approximate the motion of a video. A fast ME algorithm is proposed to reduce the computational complexity. H.264/AVC provides many coding tools for achieving high compression gains of up to 50% more than other video coding standards. These all video coding tools dramatically increase the computational complexity of the block based motion estimation (BB-ME) which consumes up to 80% of the entire encoder's computations. Fast motion estimation based on the distribution of motion field and the correlation which happened inside in macro blocks (MB).Fast motion estimation is multistep process which includes motion starting process, motion search pattern etc. the collective properties these technique makes the motion estimation more efficient. And this fast motion estimation will provide good predicted image quality as well as it's also reducing the computational burden by keeping good quality of video.
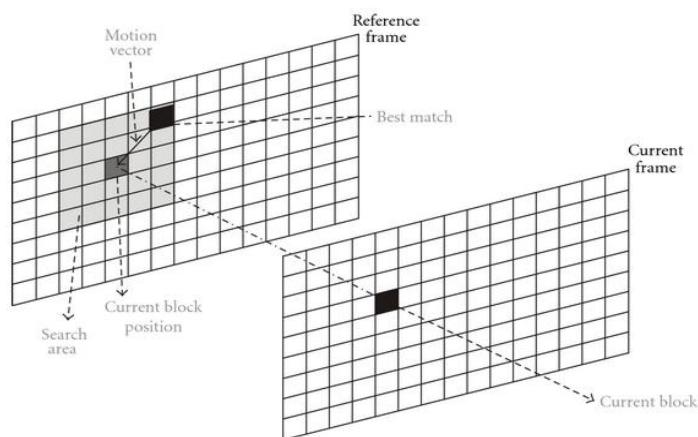
Figure 3: Fast Motion estimation

Motion Estimation (ME) is an important part of any video compression as this can achieve significant compression by exploiting the temporal redundancy existing in a video sequence. But probably it is also the most computationally intensive function of the entire encoding process. In motion estimation process the current image is divided into Macro Blocks (MB) [5]. There are some algorithms those have been proposed for motion estimation use from BMA is based Block Matching Algorithms methods. In this estimation methods, motion estimation is performed for a N×M blocks of current frame, It is done with checking entire N×M blocks from search area situated in the reference frame(s) and calculating the difference between the current block and other reference blocks and finally choosing the block that has the most similarity to the early block in current frame. And the difference of two blocks as residual (motion compensated residual) and the distance of them as motion vector, is coded and transmitted [6].

The use of motion estimation is to find the optimal motion vector that are representing the displacement between the current block in the reference frame and its best matching block in the adjacent frame . Figure 4 shows., a block of size M × N and a search window of size (2dm + 1) × (2dm + 1), where dm is the maximum value of search range in pixels & for the vertical and horizontal coordinates of the block, the motion vector is defined the displacement between such a block and a similar block in the next frame which is the best match in terms of its intensity contents. To find the best match between two blocks one can use the mean absolute deviation (MAD), defined by:

Equation 1

$$MAD(i, j) = \frac{1}{MN} \sum_{m=1}^{M} \sum_{n=1}^{N} |s_k(m, n) - s_{k-1}(m + i, n + j)|$$

As the $s_k(m, n)$ the luminance value of the pixel in the reference block, $s_{k-1}(m + i, n + j)$ is the luminance value of the pixel in the block from the previous frame (m, n) gives the local coordinates of the upper left corner of the reference block in the current frame and i and j are the coordinates offsets in the search window.

2.3 Sub sampled Block-Matching for Zoom Motion Compensated Prediction

Motion compensated prediction is very important process in achieving enormous video compression efficiency in advanced video coding technology. As In practical point of view motion compensated prediction techniques implicitly assume pure translational motions in the video contents for effective operation. Some attempts aiming that general motion models are usually too complex requiring parameter estimation in practical implementation. The zoom motion compensation is investigated to extend the assumed model to support both zoom and translation motions.
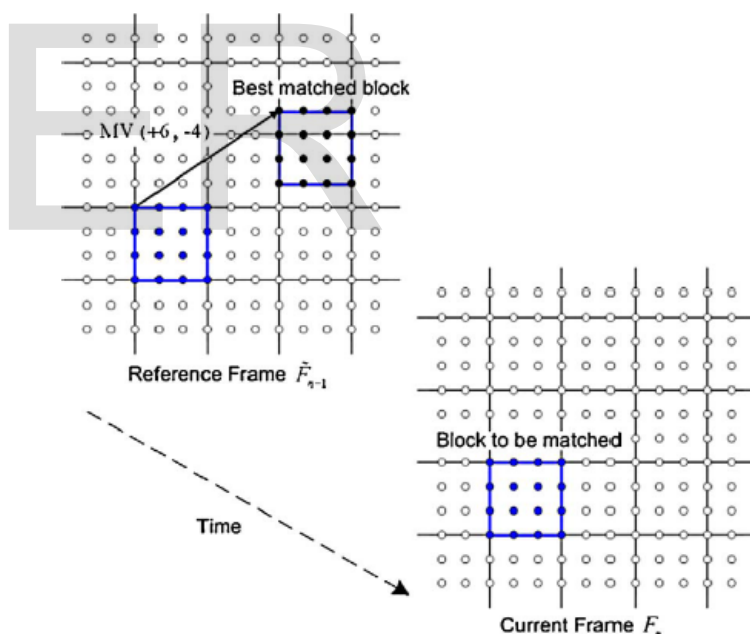

Figure 4: block matching motion estimation

This section reviews the block-matching-based pure translation MCP techniques used in conventional hybrid video coding standards. Basically, this section forms a foundation for describing the details of the proposed translation and zoom motion compensation techniques. In block matching-based translation MCP process frame is segmented into K non-overlapping blocks, $\_Bi, n\_Ki=1$. In single reference frame MCP, each block is predicted from

previous reconstructed frame ˜F*n*−1 by block-matching motion estimation process is shown in Fig. 4. The motion vector (MV), **v***i, n* = (*u, v*) *i, n*, specifying a spatial displacement for motion compensation of *i*th block in **F***n*, is determined by block-matching process. [7]

2.4 Block-Matching Translation and Zoom Motion Compensated Prediction

Motion compensation Predictive coding based on block matching translation and zoom process is widely used in video transmission, specifically for low bit-rate coding. Typically some fraction of an image changes from frame to frame allowing straight forward prediction from previous frames. That is the idea of multiple reference frames (MRF) motion compensation to provide additional candidates for prediction over longer period of time. The weakness of single reference frame in cases of temporary occlusion and periodic Deformation may be resolved by selecting another reference frames. That is the idea of multiple reference frames (MRF) [8] and motion compensation is used to provide additional candidates for prediction over longer period of time. Fig.5 shows an example of MRF motion estimation in case of temporary occlusion, where two good matching blocks cannot be found in the previous reference frame. Since MRF uses frames with different time delays, the reference frame for generating the prediction is not limited to the previous frame.
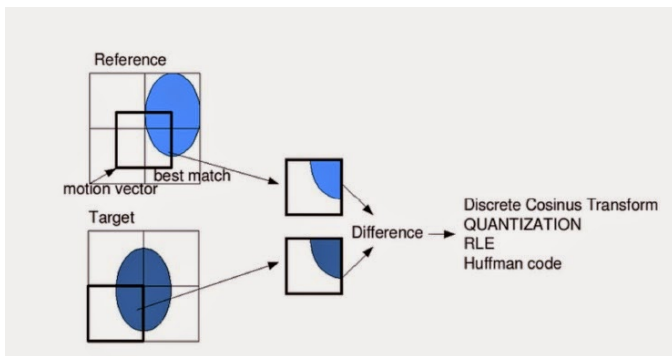

Figure 5: Example Multiple Reference Frames

The reference picture can be from past or future the prediction happens on a block by block basis and there can be multiple reference frames.

3. RESULTS AND DISCUSSION

3.1 Introduction
The following results shows the output of the project which are simulated in MATLAB, Simulink along with the practical outputs. The equations were derived and

simulated to get expected outputs. The results were found out to be satisfactorily matched with the practical results.

3.2 Experimental Results and discussion
The following section gives the graphical representation obtained by various video taken and by using Huffman coding and block matching algorithm. By using this techniques Bit rate, PSNR and MSE calculations carried out. According to that the graphical representation take placed as shown in below sections. Let us discuses before that what is Bit rate, PSNR, MSE.

3.2.1. BIT RATE
The bit rate is the number of bits that pass a given point in telecommunication network in a given time of period usually a second. Bitrates describes the rate at which bits are transferred from one location to another. Bit rates used to measures how much data is transmitted in a given amount of time. Bitrates is measured in bits per second (bps), kilobits per second (Kbps), or megabits per second (Mbps) [9].

3.2.2. PSNR & MSE
The PSNR computes the peak signal-to-noise ratio, in decibels, between two images. PSNR used as a quality measurement between the original and a compressed image. The higher the PSNR the better will be the quality of the compressed or reconstructed image. PSNR is most easily defined by understanding the mean squared error (MSE).

Equation 2

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

The PSNR (in dB) is defined as:

Equation 3

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned}$$

By using the techniques Huffman coding and block matching algorithm the Bit rate, PSNR and MSE calculations are carried out. As we know The Block Matching Algorithm is the process of finding matching blocks in a sequence of digital video frames for the

purposes of motion estimation. And the idea behind motion estimation is that the patterns which corresponding to objects and background which present in a frame of video sequence move within the frame to form corresponding objects on the subsequent frame. Huffman coding is the process that uses a specific method for choosing the representation for each symbol. And gives results in a prefix code it means that, the bit string representing some particular symbol is never a prefix of the bit string representing any other symbol. Huffman coding is such a universal method for creating prefix codes that the term "Huffman code" is widely used as a "prefix code".

As the efficient video compression based on quantized motion vector, the comparison of video clips results are held by according to change in Bit rate, PSNR and MSE.As well as change in motion vectors which is present in all video clips. All video clips are having same Fame width as well as same frame height. And same frame rate, same video sizes respectively. Among these 5 video clips, clip 4 is having VBR bit rates. Variable bit rate encoding will generally give you higher quality for a smaller file size. And the video clip 4 is faster than other video clips. Results are tabulated according to video clips with their video sizes.
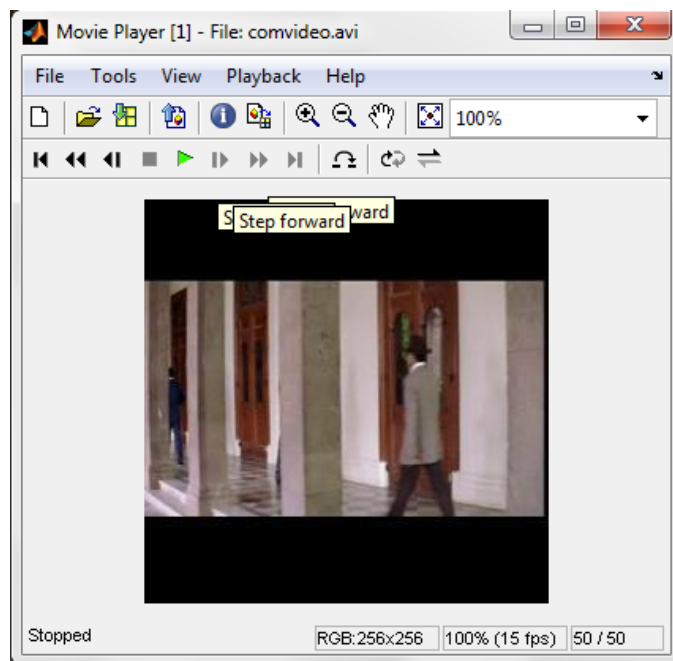

Fig 6: Before compression video.

Fig 7: compressed video.

Table1: Comparison of frame per second (FPS) rate from all video clips.

Video clips	Video size(MB)	Time(S)	Frame width	Frame height	Frame rate	Decoded frames	FPS
Clip 1	13.6	3s	352	288	15f/s	45	15
Clip 2	13.9	3s	352	288	15f/s	46	15.33
Clip 3	14.5	3s	352	288	15f/s	50	17
Clip 4	17.5	3s	352	288	15f/s	50	17
Clip 5	31.5	3s	352	288	15f/s	50	17

Table 2: Comparison of Bit rate, PSNR and MSE values from video clip 2

Video Size (MB)	Time (seconds)	Original video size(MB)	Compressed video size(MB)	Compression ratio	Bit rate (MBPS)	PSNR	MSE
8×8	3s	13.9	7.89	1.76	3.6573	47.478	1.162
16×16	3s	13.9	8.77	1.58	3.7521	47.487	1.282
32×32	3s	13.9	8.82	1.58	3.7824	46.9634	1.299
64×64	3s	13.9	8.87	1.57	3.8124	46.9432	1.304
128×128	3s	13.9	9.26	1.5	3.8553	47.9395	1.328

Table 3: Comparison of Bit rate, PSNR and MSE values from video clip 4

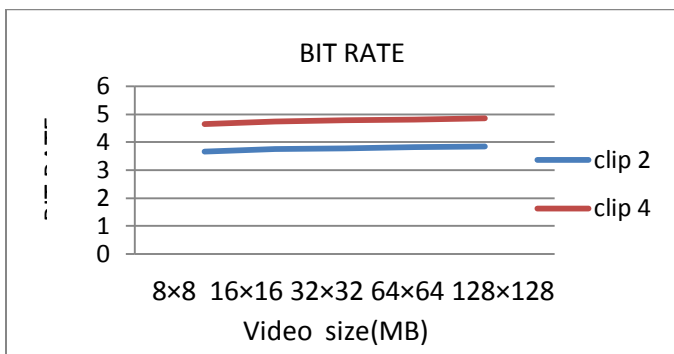| Video size (MB)	Time (S)	Original video (MB)	Compressed video (MB)	Compression ratio	Bit rate (MBPS)	PSNR	MSE
8×8	3s	17.5	11.49	1.52	4.6552	47.45	1.17
16×16	3s	17.5	12.37	1.41	4.7321	47.49	1.28
32×32	3s	17.5	12.42	1.41	4.7824	46.96	1.29
64×64	3s	17.5	12.48	1.4	4.8121	46.95	1.3
128×128	3s	17.5	12.86	1.36	4.8534	46.96	1.33

Fig 8: Plot for Bit rate obtained for two different video clips.
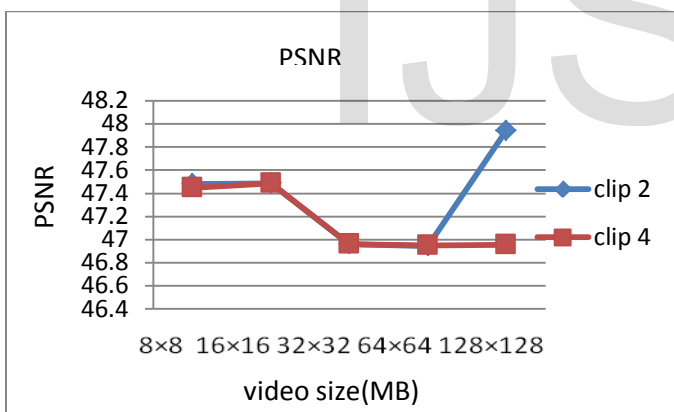

Fig 9: Plot for PSNR obtained for two different video clips.
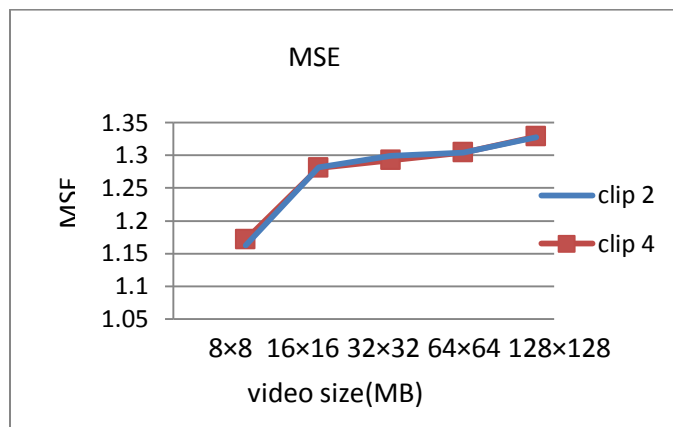

Fig 10: Plot for MSE obtained for two different video clips.

4. Conclusion

It has been observed that an efficient video compression based on Quantized motion vector is achieved. The comparison of Bit rate, PSNR &MSE values of respective videos is presented in this paper. The results for Clip2 shows better results compared to Clip 4 as clip 4 is having fast motion than clip 2 & clip 4 is having variable bit rates than clip 2 respectively.H.264/AVC used at low bit rate for an efficient video compression based on Quantized motion vector.

5. References

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