

Analysis of Motion Compensation Techniques

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Abstract—Video usage in multimedia applications are increasing heavily. The rates at which the videos are created/captured are high. We need an efficient technique to store the video data in the limited data space. Compression of videos will lead to reduced size of video. Motion Compensation techniques are used to compress the video by taking care of motion of the objects into the account. Instead of sending a raw frame which consists of difference of data between the two frames we can send the motion coordinates which leads to reduction of data required to compress the image. In this paper we are analyzing some of the different motion compensation techniques applied in Video compression streams, papers and comparing the techniques used in each of the papers.

Keywords—Video compression, Motion Compensation, Block Based Encoding, Fixed and Variable Block size Encoding.

I. INTRODUCTION

A video consists of various set of frame. Each frame constitutes a image. A second of Video may consists of more than 25 frames which are constantly showed one after the other. Considering an example of a video which consist of 30 frames per second and for each frame we may have around

1 million pixels then if we need 16 bits to represent a pixel then we need to have large disk space , bandwidth to save and transmit the data . Therefore to overcome this problem of video space we will go for video compression where a video which needs to be transmitted is compressed which is also called encoding and the compressed video is decompressed at the receiver end and the original data is recovered. Compression can be of two methods .one is lossy compression method and the other one is lossless compression method.

A lossless compression method involves no loss of the data i.e. when a data is compressed and transmitted, at the receiver end the compressed data is decompressed to get the data. The decompressed data must be same as the original data, thus there is no loss of information of data

between compression and decompression of the data. A lossy compression involves loss of data which may be occurring at the compression and the decompression.

Text file and Executable files are the some of the examples of lossless compression and video, voice are the good examples of lossy compression.

Encoding in the data compression refers to reducing the number of bits required to represent the original data and the decoding refers to extracting the original information from the encoded data.

Since a Video may consists of various set of frames we may use this frames to reduce the size of data i.e. temporal correlations between the frames can be used to reduce the size of the video. If there are 30 frames in a second of a video then we can use redundancy occurring between the frames and we can eliminate the burden of transmitting the redundant frames.

Motion compensation technique can be used to encode the frames occurring in the video and decoding it. In this paper we will discuss the Various motion compensation techniques in the section II , We will discuss the work discussion in Section III, We will discuss the some of the motion compensation techniques published in the various Papers In the Section IV .And conclusion in Section V .

II. MOTION COMPENSATION AND ITS TECHNIQUES

A. Motion compensation

Motion compensation is a algorithmic used to predict a frame occurring in the video. Given a previous frame or a future frame, by taking motion of objects in the frames we can get the current frame. Motion compensation techniques are used in various MPEG formats.

In MPEG frames can be have predicted from previous set of frame P frame or the future set of frames B frame.

To generate a B frame we need to transmit the image sequence which must be stored out of order so that future frame is available

Once the predicted frame is available, using motion coordinates we will find the error or residual which is compressed and transmitted.

B. Motion compensation Techniques

Global motion compensation-The model basically reflects camera motion such as dolly, trace, boon, tilt ,roll etc. Advantages of this techniques are the models are dominate , It does not contain artifacts in the frame and its avoid artifacts .

Block based motion compensation –The frames are divided and portioned into the block. Each block shifting/changing position is recorded with respect to the previous frame. Since a video consists of large number of frame, a very less difference exists between these set of frames, we can eliminate the redundancy occurring between the frames set.

A image needed to be encoded is divided into size of $M \times M$ block .Each $M \times M$ block is searched in previous constructed frame to find the closest match that resembles the $M \times M$ block .Then we will consider the Displacement between objects into the account

An image to be encoded is compared with best matching block with the Double image [2]. A double image can be Constructed by Interpolating the neighboring pixels .Consider the pixels h_1, h_2, v_1, v_2 a double image can be obtained from

$$\begin{aligned} h_1 &= \left\lfloor \frac{A+B}{2} + 0.5 \right\rfloor \\ h_2 &= \left\lfloor \frac{C+D}{2} + 0.5 \right\rfloor \\ v_1 &= \left\lfloor \frac{A+C}{2} + 0.5 \right\rfloor \\ v_2 &= \left\lfloor \frac{B+D}{2} + 0.5 \right\rfloor \end{aligned}$$

Variable Block size motion compensation-A

Encoder dynamically selects the size of the blocks .these blocks can be used to search in the previous frames to obtain motion coordinates .If the bocks are larger in the size then we need less number of Bits to represent the block. If small blocks are used then we need less amount of prediction residual to be sent the receiver.

MPEG1, H.261 is using fixed block size approach whereas the h.263 and higher versions are using variable block size approach.

Overlapped block motion compensation-It increases the prediction and avoids artifacts. If the blocks are usually big in the size and overlap the quadrant wise neighboring 8 blocks then each pixels can have 4 blocks.

Therefore the prediction for the pixels is summed to obtain a weighted mean. A windows function associated with each block has the property with the sum of overlapped windows equal to 1 [1].

III. WORK DISCUSSION

We referred various papers published on the Motion compensation techniques and tried to come out with the advantages and disadvantages of those techniques.

IV. ANALYSIS OF TECHNIQUES

[3] Specifies that a variable sized block using an optimal tree structure yields an improvement in the rate and the Distortion. A minimum Distortion full search MDFS is an intensive method of testing motion vectors with some search windows and choosing a lowest distortion. The problem with the BMA is that moving objects having borders does not normally coincide with the BMA blocks.

It specifies a rate allocation theory where a Lagrange multiplier >0 , can be used to find a convex haul of all possible R-D parts

A global optimization for the problem can be obtained by minimizing the objective function.

A R-D optimized V-BMA can be used to reduce the search space by choosing a quadtree data structure. A algorithm has been derived to set a optimal subtree up to $n+1$ level of tree , given the n th optimal subtree of the level n , A quad tree can be constructed by using a bottom-up approach and top down approach .

This paper specifies that the advances in rate distortion optimization to choose the motion vectors in fixed or variable block matching techniques. A variable block matching Technique is having significant better rate and optimization compared to the fixed block size

[4].It specifies that a background frame is a reference frame which improves the accuracy of motion compensation

A Background frame may appear as many as times in a video. This may not change for many of the seconds in the video. This redundancy can be used to save data required to transmit the video.

A background frame is fixed and used as the reference to the motion of the objects

A BFMC algorithm is introduced where a background frame is constructed from all the occurring set of previous frames

During the encoding process, the encoder can select the reference frame to find the motion vectors coordinates.

The blocks of the background frames are fixed to some size and are not changeable. The motion vectors of the blocks are set to zero.

The reference frame can be used by encoder to find the motion coordinates. Once the motion coordinates are sent to the receiver. The receiver can decode the frames set using the reference frame set which is sent by the encoder.

The block size of the reference frame set can be initialized to some value and can be later changed to a threshold value.

We need to optimize the both the encoder and the decoder to use the reference frame and perform encoding operations and decoding operations.

This paper specifies that having a background reference frame with the sender/encoder and with the receiver/decoder we can optimize the motion coordinates values and reduce the amount of information sent between the sender and the receiver.

It specifies the Video compression using Foreground motion compensation

This paper specifies that the increase in the surveillance systems has led to increase in content generation of the video. Transferring the video from one part to the other part requires large amount of data bandwidth and large space.

The current motion compensation techniques are such that the motion coordinates are recorded from the previously constructed frame and the coordinates are sent to the receiver along with the error residual.

This paper specifies a technique where a background is constructed using the background generation algorithms.

The paper provides an algorithm which includes Object segmentation, motion parameter extraction and encoding of the image.

Object Segmentation-In the object segmentation foreground objects are separated from the background objects. It includes the following attributes

Object pixels obtained from finding difference between current frame and background frame.

Object Edge maps can be obtained by the subtracting edge map from current frame with respect to background frame. Candy edge detector can also be used to detect the edges occurring in the frames

Difference edge map can be obtained from the equation

$$E_d = |\Phi(f_n) - \Phi(f_{n-1})|$$

Once the E_d is obtained then the algorithms performs the binary morphological operation such as dilation and erosion to remove the noise

Then the algorithm performs the foreground estimation by using the sum of the squared differences of motion estimation of objects

Then a motion vector is generated to reconstruct the encoded frame

After that the object error coding and object shape coding is done to represent the objects in the compact form

This paper specifies that the high compression is achieved using motion compensation by coding the moving objects

[6]. This paper specifies for very low bit rate video compression by clustering the motion vector based on the object movement.

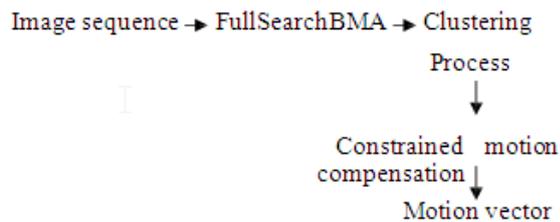
This paper species that requires high performance to achieve the bit rate target i.e. to determine the efficient motion vector for each block.

Performance enhancing for high compression is done for the inter frame coding by using reference frame. The shape and boundary of object of the frame is important.

The motion vector (MV) is displacement of object. Each block have motion vector depending on movement of objects. But Very Low Bit Rate (VLBR) is achieved with allowing frames with few object.

In this paper describes of finding MV of each block based on search BMA. And then find the object in the each frame. Next process is to clustering that tries for setting the window object. That it can cover almost all of motion vector. This is done with one algorithm called "group generation".

In this algorithm the 2-D histogram is generated for each block motion vector and list of the motion vector associated with each blocks.



Next is to generate the coverage histogram (Set of frames with selected cover motion object block) by using the original histogram and information about the location of the objects.

Then eliminate all coverage points i.e. to below the threshold in the histogram block.

Finding all the coverage MV (object MV) by using block histogram search.

To avoid the confusion of the location of each object is sent before MV of the frame. The compression cost is as follows

$$R=1/M((2 O \log S)+(B \log(W^2 O)))$$

Where,
 R-total bit rate

M & N -horizontal and vertical image size

S-search window

O-number of object

B-number of block

W-object window size

[7].This paper illustrates the improvement in algorithm for motion compensation of MPEG video compression. I.e. vector matching motion compression (VMMC).

For image and video compression the motion compensation is big role.i.e to increase the quality in MPEG standard.

MPEG-1, MPEG-2 etc are some video standard. The main thing is to estimate the displacement of moving object in the frames. And prediction error obtained from original image.

For the displacement of block by block estimation technique used in the Block Matching Algorithm (BMA).

The location in which the sub-block correlation in the adjacent frames is the motion Vector (MV)

In BMA to estimate the motion vector ie obtaining the optimal prediction error by searching all points in the given range. This is the more complex because of full search.

The VMMC is new matching technique for motion estimation.

The error in the block matching decreases the accuracy and also the reliability i.e. between edges of image .so decompressing the error into small and big error. Means the absolute frame difference called MAD.

If the big error value greater than fixed threshold then matching can't considered. Usually threshold range is to be choose between the range of 5-10.MV is used for indicate the error. Let us consider the block with $n1*n2$ pixel ie n is number of pixels. Thus to calculate the MAD the block is divided into sub-blocks like 4*4 pixel .then these are spread into the vector then calculate the inter frame difference.ie distribution of number of vectors and value of predictive error .by considering the certain threshold we can calculate value is as follows

$$N \text{ threshold} = \sum$$

N threshold absolute error in the matching blocks with pixel of less or equal to threshold.

If N threshold Value is bigger when two matching blocks are matched. If the inter frame error is small then there is more accuracy. So for optimum matching threshold value of 5-10 is better for accuracy of VMMC.

The basic thing is considered for VMMC is the object motion estimation. This is the new motion estimation to improve the traditional motion estimation method.

V. CONCLUSION

we can conclude that the variable block matching technique provide better rates and advantages over the fixed block matching technique, If we have a background reference frame then we can limit the amount of data that is needed to be sent to the receiver, We will also conclude that the coding the motion objects will lead to greater compression

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