Movement Evaluation Algorithm for video coding in Video Compression

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Abstract-The increase demand to incorporate video data into telecommunications services, the corporate environment, the entertainment industry, and even at home has made digital video technology a necessity. A problem, however, is that still image and digital video data rates are very large, typically in the range of 150Mbits/sec. Data rates of this magnitude would consume a lot of the bandwidth, storage and computing resources in the typical personal computer. For this reason, video compression standards have been developed to eliminate picture redundancy allowing video information to be transmitted and stored in a compact and efficient manner.

Key Words - Frame, Pixel, Searching, Algorithm, Compression.

I. INTRODUCTION

Basic of Motion

Successive video frames may contain the same objects (still or moving). Motion estimation examines the movement of objects in an image sequence to try to obtain vectors representing the estimated motion [1]. Motion compensation uses the knowledge of object motion so obtained to achieve data compression. In inter-frame coding, motion estimation and compensation have become powerful technique to eliminate the temporal redundancy due to high correlation between consecutive frames.

Basics of Video Coding

For any inter frame video coding standards, the basic functional modules are motion estimation and compensation, quantization and entropy encoder. The temporal redundancies exists in successive frames are minimized or reduced by motion estimation and compensated fame is applied into the sequence of transformation and quantization modules. The spatial redundancy exists in neighbouring pixels in the image or inter- frame is minimized by these modules. The transformation module converts the residue symbols from time domain into frequency domain. This is so appropriate for quantization. Quantized transform coefficients and motion displacement vectors obtained from motion estimation and compensation module are applied into entropy encoding module. Where it removes the statistical redundancy. The most time consuming part of video coder is motion estimation block. Motion estimation technique is classified into four types. There are gradient technique, pel-recursive technique, block matching technique and frequency domain techniques [1]. Block matching technique are commonly used in video sequence coding.

Algorithm for Motion Estimation

Motion estimation is the process by which element in a picture are best correlated to elements in other pictures (ahead or behind) by the estimated amount of motion. The amount of motion is encapsulated in the motion vector. Forward motion vector refer to correlation with previous pictures [2]. Backward motion vectors refer to correlation with future pictures.

II. RELATED WORK

H.264/Video Coding

It is the newest international video coding standard [8]. By the time of this publication, it is expected to have been approved by ITU-T as recommendation H.264 and by ISO/IEC as international standard 14496-10. The main goal of H.264 standardization effort has been enhanced compression performance and provision of a network friendly video representation addressing conversational and non-conversational applications. H.264 does not explicitly define a CODEC (encoder/DECoder pair) but rather defines the syntax of an encoded video bit stream together with the method of decoding this bit stream.

Block Matching Algorithm

It is a standard technique for encoding motion in video sequence [2]. It aims at detecting the motion between two images in a block wise sense. The blocks are usually defined by dividing the image frame into non-overlapping sequence parts. Each block from the current frame is matched into a block in the destination frame by shifting the current block over a predefined neighbourhood of pixels in the destination frame. Some of the most often used matching criteria based on pixel dereferencing are Mean Absolute Distance (MAD), Mean Squared Distance (MSD) and normalized cross-correlation. In the popular video coding standards (H.261, H.263, MPEG-1, MPEG-2 and MPEG-4), motion estimation and compensation are carried out 8 X 8 0r 16 X 16 blocks in the current frame.

Full Search

This is the first block matching algorithm for video encoder. The full search algorithm provides the best result by matching all possible blocks within the search window of reference frame from the current frame. Hence, the full search algorithm acts as a benchmark for evaluating the efficiency of other algorithm.

2-D Logarithmic Search

This algorithm was introduced by jain and jain. This is the one of the old fast block matching algorithm. These techniques for estimating inter-frame displacement of small blocks with minimum mean square error [3]. First, we approximate the interframe motion by piecewise translation of one or more areas of a frame relative to a reference frame. The segmentation of image into areas, each of which is undergoing approximately the same translation, and the measurement of the magnitude and the direction of the translation of each area is a difficult task. A simpler method is to segment an image into fixed size, small rectangular blocks and to assume that each of these areas is undergoing independent translation.

Three Step Search

The three step search (TSS) algorithm was introduced by Koga et al in 1981. This is the most popularly used in last decade. It became very popular because of its simplicity and also robust and near optimal performance [4]. It searches for the best motion vectors in a course to fine search pattern. This TSS reduces the search point than the previous technique. So the three step search algorithm gives more compression than existing algorithm. So these techniques widely used in many video coding applications.

Predictive Search

This algorithm developed by R. Srinivasan and K.R. Rao in 1985. The main objective of this technique is to develop a much more efficient BMA called the Conjugate Direction Search and its modified version called one at a Time Search which involves considerably simpler arithmetic [5]. These motion estimation technique gives superior performance compared to the existing techniques is illustrated based on histograms of the prediction error.

New Three Step Search

This algorithm developed by R. Li, B. Zeng, and M. L. Liou on August 1994. The three step search (TSS) algorithm has been widely used as the motion estimation technique [6] in some low bit rate video compression applications, owing to its simplicity and effectiveness However, TSS uses a uniformly allocated checking point pattern in its first step, which becomes inefficient for the estimation of small motions. The features of new Three Step Search are that it employs a center-biased checking point pattern in the first step, which is derived by making the search adaptive to the motion vector distribution, and a halfway-to stop technique to reduce the computation cost. The search pattern in each step is fixed and no threshold operations are involved in this algorithm. In low bit-rate video application, the search is usually performed for an area of size 15*15, so widow size is 7. In full search will check 225 points, while TSS checks 25 points, thus leading to a speed-up ratio of 9.

A Novel Four Step Search

This algorithm is developed by L. M. Po. And W. C. Ma June 1996. A new four step search algorithm with center biased checking point pattern for fast block motion is proposed in this paper [7]. Halfway-stop technique is employed in the new algorithm with searching steps 2 to 4 and the total number of checking points is varied from 17 to 27. The 4SS algorithm is stimulated using the luminance component of the first 90 frames of the

"Football" and "Tennis" sequences. These two sequences consist of large displacement and fast motion. In the "Tennis" sequence, camera zooming and panning are also involved. The size of each individual frame is 352 X 240 pixels quantized uniformly to 8 bits. The mean absolute error (MAE) distoration function is used as the BDM. The maximum displacement in the search area is 7 pixels in both the horizontal and the vertical direction for 16 x16 block size. Average MSE of 90 frames from three different sequences result shown in table 1.

In addition, 4SS is more robust as compared with 3SS and N3SS. It is because the performance of 4SS is maintained for image sequence that contains complex movement such as camera zooming and fast motion. On the other hand, the 4SS also possess the regularity and simplicity of hardware-oriented features.

Searching Algorithm	Football	Tennis
FS	175.74	143.99
3SS	219.26	221.97
N3SS	206.72	203.05
4SS	205.99	189.39

Table 1 Average MSE of the first 90 frames

Block Based Gradient Descend Search

This algorithm developed by L. K. Liu and E. Feig in 1996. This technique provides competitive with reduced computational complexity compared with FS, TSS, OTS and NTSS. This algorithm evaluates the values of a given objective function starting from small centralized checking block. In this algorithm the search block consists of 3 x 3 pixels. At the time of starting center point of the search block in the origin. The objective function of all nine points in check block will be evaluated. If minimum BDM occur at center, then stop. It means motion vector should be at the center. Otherwise reset the checking block. Finally the winning pixel will be in center.

Novel Cross Diamond Hexagonal Search

This algorithm is developed by Chun-Ho Cheung and Lai-Man Po in Feb 2005. The algorithm basically employs two cross-shaped search patterns consecutively in the very beginning steps and switch using diamond shaped patterns. To further reduce the checking points, two pairs of hexagonal search patterns are developed in conjuction with candidates found located at diamond corners [9].

III. CONCLUSION

Video coding is the process of compressing and decompressing a digital video signal. Digital video representation of a natural visual scence, sampled spatially and temporally. A scene is sampled at a point in time to produce a frame or a field. The accuracy of a reproduction of a visual scene must be measured to determine the performance of a visual communication system, a notoriously difficult and inexact process. Motion Estimation is the most time consuming module in any video CODEC. The time complexity of Motion Estimation module is approximately 80 to 90% of total computational time of video coder.

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