



Video Image Compression Using Absolute Moment Block Truncation Method with Orthogonal Search Motion Estimation Technique

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Abstract:

Image compression has become one of the most important applications of the image processing field because of the rapid growth in computer power. The corresponding growth in the multimedia market, and the advent of the World Wide Web, which makes the internet easily accessible for everyone. Since the early 1980, digital image sequence processing has been an attractive research area because an image sequence, as a collection of images, may provide much compression than a single image frame. The increased computational complexity and memory space required for image sequence processing, has in fact, becoming more attainable. This research absolute Moment Block Truncation compression technique which is depend on adopting the good points of other techniques. As well as algorithm of efficient block's position has been adopted to achieve this research. Also in this paper was introduce A modify of the orthogonal search algorithm (OSA) for searching scheme has been introduced which is contributed in decreasing the motion searching time of the successive inter frames.

Keywords: Absolute Moment Block Truncation, AMBTC, Orthogonal Search algorithm, Video compression, Motion estimation.

ضغط الصور الفيدوية باستخدام طريقة عزم البلوك المستقطع مع تقنية البحث المتعامد لتخمين الحركة.

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الخلاصة:

مؤخرا اصبح ضغط الصور الرقمية في مقدمة حقل معالجة الصور الرقمية وهذه كانت نتيجة التطور السريع في قدرة الحاسوب وما يقابله من تطور في تسويق هذه الاجهزة كذلك قدوم شبكة المعلومات العالمية وهذا جعل الانترنت في متناول كل شخص وبسهولة. منذ بداية عام 1980 حقل معالجة الصور الرقمية المتلاحقة جذب الكثير من البحوث بسبب ما يعطيه من نسبة ضغط في بيانات الصور المتلاحقة اكثر مما هو عليه من الصورة الواحدة. في هذا البحث قدمت تقنية الضغط الصورة بحساب العزم المطلق للبلوك المستقطع. وهذه الطريقة تعتمد على تحسين النقاط الجيدة في الطرق الأخرى. هدف البحث هو تحديد البلوك الفعال الذي تم تشفيره بالاضافة الى تقديم طريقة مطورة من البحث المتعامد للبحث المختصر والتي ساهمت كثيرا في تقليل زمن ايجاد اللقطات المتتابعه.

1. Introduction:

The demand for communications with moving video picture is rapidly increasing. Video is required in many remote video conferencing systems, and it is expected that in near future cellular telephone systems will send and receive real-time video. A major problem in a video is the high requirement for bandwidth. A typical system needs to send dozens of individual frames per second to create an illusion of a moving picture. For this reason, several standards for compression of the video have been developed. Digital video coding has gradually increased in importance since the 90s when MPEG-1 first emerged [1]. Figure 1- represent video compression flow.

The degree of data reduction achieved by a compression process or algorithm is called compression ratio, given by:

$$\text{compression ratio} = \frac{\text{Uncompressed File Size}}{\text{Compressed File Size}} \dots \quad (1)$$

Therefore, measuring compression ratio as a function of the reproduced image quality define the efficiency characteristics of the adopted lossy compression technique, rather than a signal compression ratio in the decompressed pictures.

The equivalent definition to the mean square (SNR)_{ms} is the Peak Signal-to-Noise Ratio (PSNR) defined as [2,3]

$$\text{PSNR} = \frac{[\text{Peak to Peak of } x_i]^2}{\text{MSE}} \dots \quad (2)$$

The PSNR can be represented in decible (dB) unit as:

$$\text{PSNR} = 10 \log_{10} \left[\frac{\text{gray scale of image}}{\text{MSE}} \right]^2 \dots \quad (3)$$

Interframe predictive coding is often used to eliminate the large amount of temporal and spatial redundancy that exists in video sequences. It is also helps in achieving compression purposes. In conventional predictive coding the difference between the current frame and the predicted frame, which is based on the previous frame, is coded and transmitted. The better prediction, smaller error, and hence the lowest transmission bit rate. However, when there is motion in a sequence, then a pel on the same part of the moving object is a better prediction for the current pel. the use of the knowledge of the displacement of an object in successive frames is called Motion Compensation [4]. This called Block Matching Algorithm (BMA), this algorithm estimates the amount of motion as blocks basis, i.e., for each block in the current frame, a block from the previous frame is found, that is said to match this block, based on a certain criterion. Two of them are:

The Mean Absolute Difference (MAD), defined as :

$$\text{MAD}(dx, dy) = \frac{1}{mn} \sum_{i=-n/2}^{n/2} \sum_{j=-m/2}^{m/2} F(i, j) - G(i + dx, j + dy) \dots \quad (4)$$

Where $F(i, j)$ represents an $(m \times n)$ macro block within the current frame, $G(i, j)$ represent the corresponding macro block within reference frame (past or future), (dx, dy) a vector representing the search location.

The Mean-Squared Difference (MSD) cost function is defined as :

$$\text{MSD}(dx, dy) = \frac{1}{mn} \sum_{i=-n/2}^{n/2} \sum_{j=-m/2}^{m/2} [F(i, j) - G(i + dx, j + dy)]^2 \dots \quad (5)$$

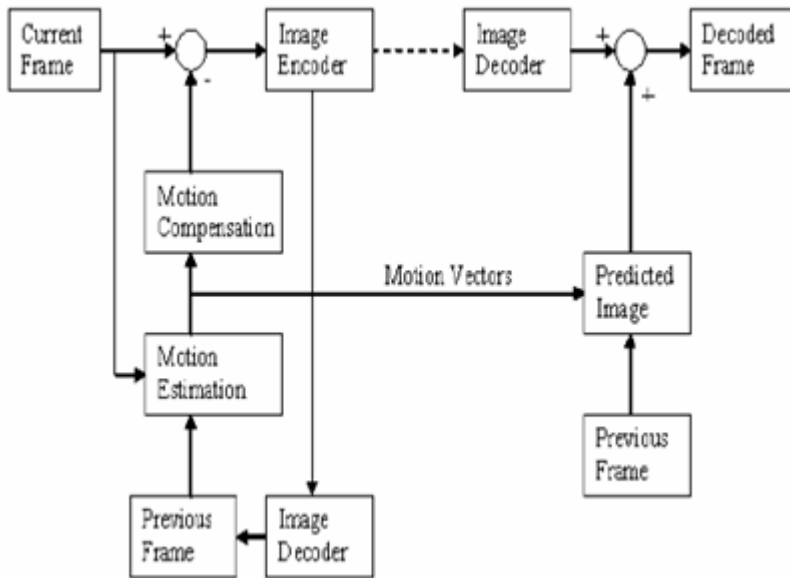


Figure 1- show the video compression process flow.

2. Absolute Moment Block Truncation method:(AMBTM)

Most image data compression techniques achieve high data compression ratio. The trade off between data compression remains one of the difficult problems. Maintaining high compression ratios with good image quality is possible at a more or less high computational cost. One of the main goals for image data compression is to reduce redundancy in the image block.

3. Algorithm of AMBTC

A simple and fast variant of BTC, named Absolute Moment BTC (AMBTC) [6] that preserves the higher mean and lower mean of a block. The AMBTC algorithm involves the following steps:

Step 1: An image is divided into non-overlapping blocks. The size of a block could be (4 x 4) or (8 x 8), etc.

Step 2: Calculate the average gray level of the block (4x4) as equations (6):

$$x = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x}_i) \dots \dots \dots (6)$$

$$\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \bar{x}_i)^2} \dots \dots \dots (7)$$

Where: x_i represent image pixel values, and \bar{x}_i represent the mean value.

Step3: Pixels in the image block are then classified into two ranges of values. The upper range is those gray levels which are greater than the block average gray level (x) and the remaining brought into the lower range. The mean of higher range X_H and the lower range X_L are calculated as :

$$x_H = \frac{1}{K} \sum_{x_i > x} x_i \dots \dots \dots (9)$$

$$x_L = \frac{1}{16 - K} \sum_{x_i < x} x_i \dots \dots \dots (10)$$

Here K is the number of pixels whose gray level is greater than x .

Step 4: Binary block, denoted by B, is also used to represent the pixels. Where it can be used “1” to represent a pixel whose gray level is greater than or equal to x and “0” to represent a pixel whose gray level is less than x . The encoder writes X_H , X_L . Then the total number of bits required for a block is $8+8+16 =32$ bits. Thus, the bit rate for the MBTC algorithm is 2 bpp.

$$B = \begin{cases} 1 & x_i \geq \bar{x} \\ 0 & x_i < \bar{x} \end{cases} \dots\dots\dots(11)$$

Step 5: In the decoder, an image block is reconstructed by replacing the "1" s with XH and the "0"s by XL In the AMBTC, we need 16 bits to code the bit plane which is same as in the BTC. But, AMBTC requires less computation than BTC AMBTC has several advantages over BTC one advantage is in the case that the quantization is used to transmit an image from transmitter to a receiver, it is necessary to compute at the transmitter the two quantities, the sample mean and the sample standard deviation for BTC and sample first absolute central moment for AMBTC. When we compare the necessary computation for deviation information, we will see that in case of standard BTC it is necessary to compute a sum of m values and each of them will be squared while in case of AMBTC it is only necessary to compute the sum of these m values. Since the multiplication time is several times greater than the addition time in most digital processors, thus using AMBTC the total calculation time at the transmitter is significantly reduced.

$$x = \begin{cases} x_L & B = 0 \\ x_H & B = 1 \end{cases} \dots\dots\dots(12)$$

4. Motion Estimation

The goal of video compression is to remove the redundancy in the video signal. In still image coding, the main task is to improve the transform and entropy coding efficiency. However, the optimal performance of an individual video frame in video coding is upper bounded by the entropy of its residual frame. Motion estimation plays an important role in video coding by taking advantage of the temporal Redundancy across the sequence. The general goals of motion estimation methods are to improve the prediction accuracy, or to reduce the implementation complexity,

5. Orthogonal Search Algorithm

The orthogonal search algorithm (OSA) is proposed by A. Puri et. al. in 1987 [7]. It consists of pairs of horizontal and vertical steps with a logarithmic decrease in step size. Two search paths of OSA are shown in figure 2. Starting from the horizontal searching step, three checking points in the horizontal direction are searched. The minimum checking point then becomes the center of the vertical search step that also consists of three checking points. Then step size is decreased to half and same search strategy is used. The algorithm ends with step size equal to one. For d=7, the (OSA) algorithm requires a total of (3+2+2+2+2+2)=13 checking points. For general case, the OSA algorithm requires [1+4{log2(d+1)}] checking points.

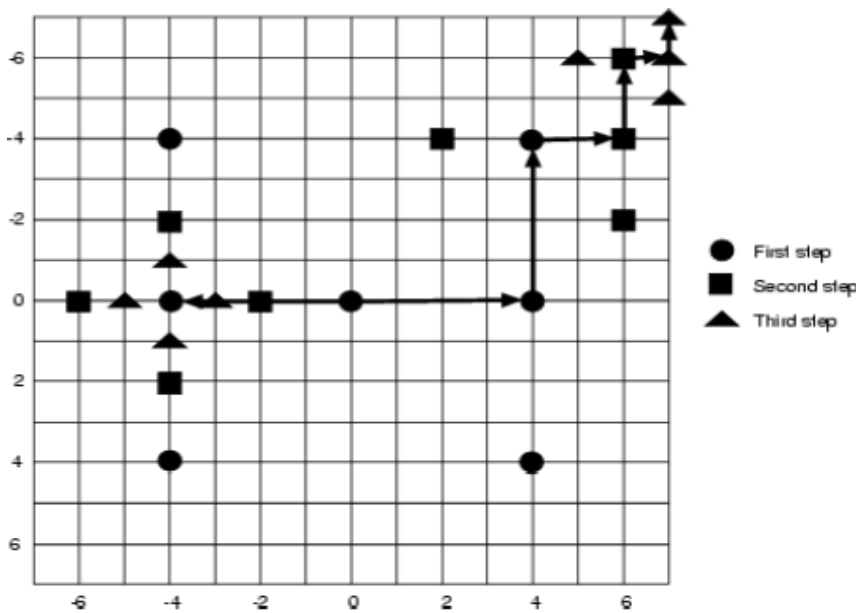


Figure 2- The two search path of orthogonal search algorithm.

6. Interpolation (IBBP):

Interpolation is a simple yet efficient and important method in image and video compression . In image compression, we may only transmit, say, every row. We then try to interpolate these missing rows from the other half of the transmitted rows in the receiver . In this way, compress the data to half . since the interpolation is carried out within a frame, it is referred to as spatial interpolation . In video compression the receiver may try to interpolate the dropped frames from the transmitted frames . This strategy immediately drops the transmitted data to one third. 1st or basic concepts of zero – order interpolation, bilinear interpolation, and polynomial interpolation ,readers are referred to signal processing texts . In temporal interpolation, the zero – order interpolation means creation of a frame by copying its nearest frame along the time dimension. The conversion of a 24 – frame –per –second motion picture to a 60 –frame –per – second.The IBBP frame model is a new feature of video coding which consists of three pictures (one p-picture and two BB-pictures). The P-pictures are predicted from previous decoded (I). The BB-pictures are bidirectional predicted both from the previous decoded (I) and P-picture . This model has been used in this work see eq.(13).

$$f(x, y, t) = \frac{I_2}{I_1 + I_2} f(x, y, t_1) + \frac{I_1}{I_1 + I_2} f(x, y, t_2) \dots\dots\dots(13)$$

7. Experimental results.

Producing a compression unit for digital security video cameras poses a unique challenge; ideally the encoder should be small and inexpensive, yet powerful enough to compress and transmit live video. In this paper a absolute moment block truncation method with orthogonal search motion estimation based video compression algorithm that solves this problem will be presented. Which consider to be low computational complexity. The new efficient video image compression using block truncation with different block size is applied to Man with image size (128x128) and reference block size is (4x4),(8x8) and (16x16) pixel. Also was applied adaptive search for motion Estimation technique and reference block size is(8x8) pixel .We will show the usefulness of the motion estimation in interframe compression. The compression and motion estimation are performed using the package of visual basic programming. In performance tests of the proposed algorithm the absolute moment block truncation (AMBTC) and (OSA) was applied. figure 3- shows the original (Man) images (I) and (P). Figure 4- shows the reconstruction images (I) and (P) with block different using (OSA) method 4(MAD)threshold. Figure 5- present reconstruction images (I) and (P) with block different using (OSA) with 12(MAD) threshold criteria. Figure 6- presented the frames (I), (B1),(B2) and (P) respectively Where BB-pictures are bidirectional predicted both from the previous decoded (I) and P-picture . Table (1,2, and 3) shows the numerical result using absolute moment block truncation coding (AMBTC) with block size [(4x4), (8X8), and (16X16)] respectively.

8. Conclusions:

From the result we were found the best image reconstruction at block size (4x4) with good value of compression ratio but lowest C.R than block size (8x8)and (16x16). We have presented motion estimation technique, New Three Step Search (OSA), The experimental results show that this new method can significantly reduce the computational complexity and low search time while achieving comparable performance for many video sequences . Also we have found the criteria (MAD) was gave higher number of block different than criteria(MSD) then low C.R when we used(MAD) than (MSD).Threshold (4) was gave highest number of block different than other thresholds.



Figure 3- The origin (Man) image(I),(P).



Figure 4- The Reconstruction image (I) and (P) when block truncation applied for man
The number of block difference 90 if select thr. 4 using MAD



Figure 5- Reconstruction image (I), and (P) when we apply block truncation applied for man
The number of block difference 55 if select thr. 12 using MAD



Figure 6- Frames (I), (B1),(B2) and (P) respectively
Where BB-pictures are bidirectional predicted both from the previous decoded (I) and P-picture.

Table 1- show the motion estimation (OSA) with different criteria (MAD) and (MSD) with block size (4x4) Comp. ratio (I)= 5.81 PSNR=25.6

threshold	Tim of search(sec)	No. of block change	Over all comp. ratio	PSNR (B1)	PSNR (B2)	PSNR (P)
4 (MAD)	0.411	90	19.5	24.7	24.4	25.5
8 (MAD)	0.232	85	22.5	24.7	24.4	25.5
12 (MAD)	0.161	55	29.2	24.7	24.4	25.5
4 (MSD)	0.411	75	21.9	24.1	23.5	24.7
8 (MSD)	0.232	54	34.8	24.1	23.5	24.7
12 (MSD)	0.161	42	38.7	24.1	23.5	24.7

Table 2- show the motion estimation (OSA) with different criteria (MAD) and (MSD) with block size (8x8) Comp. ratio (I)=9.57 5.2 PSNR=23.8

threshold	Tim of search(sec)	No. of block change	Over all comp. ratio	PSNR (B1)	PSNR (B2)	PSNR (P)
4 (MAD)	0.411	90	19.5	22.7	22.4	23.2
8 (MAD)	0.232	85	22.5	22.7	22.4	23.2
12 (MAD)	0.161	62	29.2	22.7	22.4	23.2
4 (MSD)	0.411	55	21.9	22.1	22.1	22.6
8 (MSD)	0.232	54	34.8	22.1	22.1	22.6
12 (MSD)	0.161	42	38.7	22.1	22.1	22.6

Table 3- shows the motion estimation (OSA) with different criteria (MAD) and (MSD) block size (16x16) Comp. ratio (I)=13.2 PSNR=21.3.

threshold	Tim of search(sec)	No. of block change	Over all comp. ratio	PSNR (B1)	PSNR (B2)	PSNR (P)
4 (MAD)	0.411	90	19.5	20.7	20.4	21.2
8 (MAD)	0.232	85	22.5	20.7	20.4	21.2
12 (MAD)	0.161	62	29.2	20.7	20.4	21.2
4 (MSD)	0.411	55	21.9	20.3	20.1	20.9
8 (MSD)	0.232	54	34.8	20.3	20.1	20.9
12 (MSD)	0.161	42	38.7	20.3	20.1	20.9

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