Fast vector quantization algorithm - based on Absolute Moment Block Truncation coding (AMBTC)

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ABSTRACT

An development will be used to improve the compressibility of the AMBTC using the VQ method to represent the binary form of the coded image produced from the AMBTC. The encoding of a VQ image coding requires a full codebook search for each input vector to find out the best-matched codeword. It is a time consuming process. In our presence work, a fast algorithm for vector quantizing image data is proposed. The algorithm is proved powerful.

Keywords: The Absolute Moment Block Truncation coding (AMBTC) algorithm, Vector Quantization method, Triangular Inequality Elimination (TIE).

1.INTRODUCTION

The Absolute Moment Block Truncation coding (AMBTC) algorithm preserves spatial details in the image content with low computation of complexity but it has a medium compression ratio), i.e. 8:1 maximum compression could be achieved [1,2]. Therefore, an adaptation is required to improve the compressibility of the AMBTC using the vector-quantization method to represent the binary form of the coded image produced from the AMBTC [2]. The VQ is a widely used technique in many data compression applications. This is because The encoding process is computationally intensive procedure. This limits the applicability of VQ in practical considerations [3]. In this paper, we present a new fast vector quantization algorithm for coding image data. An elimination rule which based on Triangular Inequality Elimination (TIE) is adopted to perform the coding procedures [4]. the introduce algorithm produce the same decoded image quality which may be obtained by the full – search technique, but greatly decreasing the matching searching time and, consequently, simplify the computational complexity [3].

Absolute Moment Block Truncation coding (AMBTC)

The Absolute Moment Block Truncation coding algorithm subdivides an image into uniform blocks, typically (*m*n*) pixels in size. For each block, the mean (*M*) and a bit map are created then the high and low mean of block (the two reconstruction levels H&L) can be calculate as [3];

$$M = \frac{1}{k}\sum x_i \text{ ......(1)}$$

$$H = \frac{1}{q}\sum x_i , \quad x_i \geq M \text{ .....(2)}$$

$$L = \frac{1}{k-q}\sum x_i , \quad x_i < M \text{ .....(3)}$$

Where k is ($m*n$) and q is the number of pixels whose values are greater than or equal threshold value (M). The bit map results from a two- level quantization of the block, where pixels with values greater than or equal to the block mean are represented by 1 and pixels with values less than the block mean are represented by 0. Computing two reconstruction values for each block, based on the encoded moments of same block eq. 2&3, where, in decoding ,one value (low mean L) is assigned to the 0- valued pixels in the bit map, the orders (high mean H) is assigned to the 1- valued pixels [3].

The Vector Quantization technique (VQ)

There are two types of quantization - Scalar Quantization and Vector Quantization. In scalar quantization, each input symbol is treated separately in producing the output, while in vector quantization the input symbols are clubbed together in groups called vectors, and processed to give the output. This clubbing of data and treating them as a single unit increases the optimality of the vector quantizer, but at the cost of increased computational complexity and coding time [3-6].

VQ is defined as a mapping of k-dimensional vectors in the vector space R^k into a finite set of vectors Y = {y_i, i=1, 2,..., N}, where N is size of the codebook. Each vector y_i= (y_0,..., y_{k-1}) is called a code vector or codeword. Only index i of the resulting code vector is sent to the decoder. At the decoder, identical copy of the codebook is retrieved as the encoder by a simple table-lookup operation, see Figure 1. The encoder assigns each input vector $\mathbf{x} =(x_0,...,x_{k-1})$ in the vector space $\mathbf{R}^k$, then input vector is compared with all the code words in the codebook to find the best match in terms of the chosen cost function, (i.e. The representative codeword is determined to be the closest in Euclidean distance from the input vector [2]). The Euclidean distance is defined by:

$$d(x,y_i)=\sqrt{\sum_{j=1}^{k}(x_j-y_{ij})^2} ------(4)$$

Where x_j is the jth component of the input vector, and y_{ij} is the jth component of the codeword y_i.

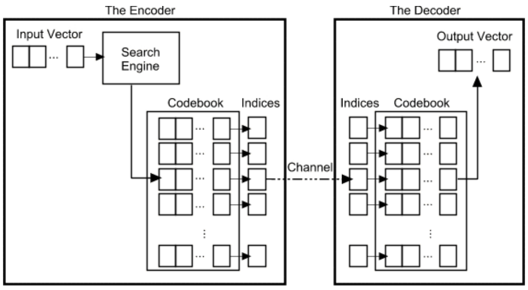


Figure 1: The Encoder and decoder in a vector quantize technique. Given an input vector, the closest codeword is found and the index of the codeword is sent through the channel. The decoder receives the index of the codeword, and outputs the codeword.

A major advantage of VQ is that hardware of the decoder is very simple. However the encoding process is, in fact, computationally intensive procedure and, therefore, limits the applicability of the VQ compression method [3,4]. The method proposed in this paper enables a sensible decrease of coding time with little deterioration of performance; also, it can be used to improve coding efficiency even further.

Triangle Inequality Theorem (TIE)

Triangle Inequality Theorem states that "the addition of the lengths of any two sides of a triangle is always greater than the length of the third side" [4,6], see fig. 2.

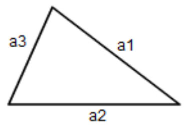


Figure 2: Illustration of the Triangle Inequality Theorem, a1+a2 > a3, a1+a3 > a2, a2+a3 > a1.

In this paper, the elimination rule based on Triangular Inequality criteria very efficient, it can described as follows; Let $Dis_{(x,ci)}$ be squared error distortion between the input vector x and the code vector c_i, if the $Dis_{(c1,c2)}> 4Dis_{(x,c1)}$, (where $Dis_{(c1,c2)}$ represents the distortion of matching the code word C_1 with C_2 but $Dis_{(x,c1)}$ represents the distortion of matching the encoding vector x with the code word C_1), then eliminate the computation of the distortion of matching the encoding vector x with the code word C_2 (i.e. $Dis_{(x,c2)}$), this process leads to greatly decreasing the matching searching time, consequently simplify the computational complexity with fast in codebook searching.

Fast VQ algorithm

A fast VQ algorithm can be obtained by using the elimination rule, based on triangular inequality elimination (TIE) method [4]. The procedure is as follows.

Step1. Initialization, calculate the distortion D_{ij} of matching the code word C_i with C_j, where (i=1, …, N-1, j=i+1….N), and N is the number of the code-word in the code-book (codebook size), see fig 3.

Step2. calculate the distortion of matching the input vector x with the first code word in the codebook C_1 let $D_{(x,c1)}$ or D_{x1} is the distortion between the encoding vector x and the code- word C_1, set i=1 and j=2

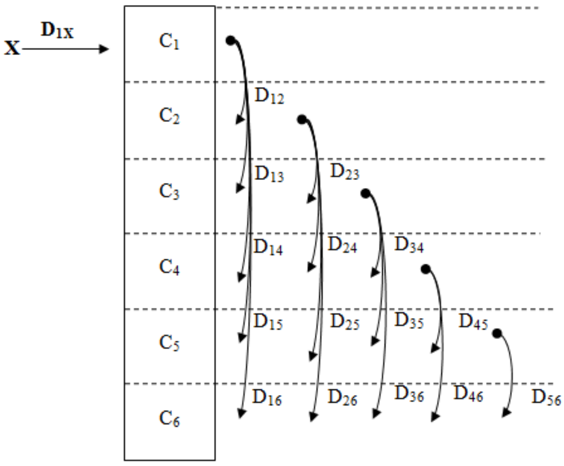
Step3. if $D_{Lj} > 4D_{x1}$, then eliminate the computation of D_{xj}, (j) should be incremented by one (i.e. j=j+1), and repeat the process of step 3 again. Otherwise, continue.

Step4. If j>N then give the input vector x a label (i).

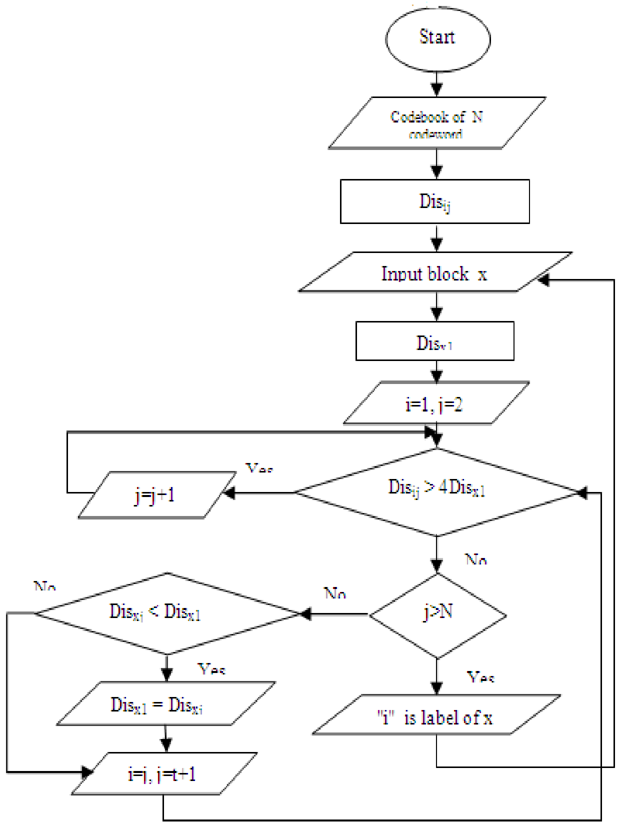
Step5. Calculate the distortion of matching the x with the (j) code word (i.e D_{xj}).

If $D_{xj}<D_{x1}$ then $D_{x1}=D_{xj}$, i=j,j=j+1, and go to steep3.

Step6. Take the next input vector x to code it, and go to step 2. This method will be very efficient if we can initially find a code word, which has small distortion to the encoding vector. This is because many distortion computations (step5) can therefore be eliminated.



a)



(b)

Figure 3: Demonstration of the TIE method
(a) Proposed Fast Vector Quantization method, when codebook size = 6 code word.
(b) Flowchart of proposed Fast VQ algorithm.

2.EXPERIMENTAL

The efficiency of the proposed fast encoding algorithm for adaptive Absolute Moment Block Truncation coding algorithm using Vector Quantization method is examined by simulation. The image is first divided into 4*4 sub images. The AMBTC is implemented, where for each block, high and low mean of block(the two reconstruction levels H&L) and bit plan are determined. A binary codebook containing 256 code words is then generated from these vectors using the well-known LBG algorithm.

3.CONCLUSION

The effectiveness of applying the Triangle Inequality Theorem method in the fast encoding algorithm is tested using this codebook. The elimination efficiencies of applying TIE in adaptive Absolute Moment Block Truncation coding algorithm using VQ algorithm is listed in table 1. It can be seen from the table that 61.32% codeword matching are eliminated by TIE.

Table 1. Elimination efficiencies for encoding "RMB1" image.

Block size	**TIE**
4*4	61.32%
8*8	71.16%

The TIE rule will be very efficient if we can initially find a code word which has small distortion to the encoding vector. This is because many distortion computations can therefore be eliminated.

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