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Fast Encoding Algorithm for Vector Quantization- Based on Block Truncation Coding Technique

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Abstract

An adaptation will be used to improve the compressibility of the BTC by utilizing the VQ method to represent the binary form of the coded image produced from the BTC. The encoding of a VQ-based 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.

الخلاصة

في هذا البحث ، تم تطوير طريقة تشفير البلوكات (الذي طبق على الصوره الثنائيــة الناتجــة مــن استخدام طريقة BTC على الصورة). حيث ان عملية التشفير للبلوكات تأخذ فترة طويلة في عملية البحث لكتاب التشفير لغرض ايجاد البلوك المقارب لكل بلوك في الصوره، في بحثنا هذا تم ايجاد طريقــة بحــث سريعة تقلص من وقت عملية التشفير في تقنية تشفير البلوكات.

Introduction

The block truncation coding (BTC) algorithm preserves spatial details in the image content and has low computation of complexity but it has only a medium compression ratio, i.e. 8:1 maximum compression could be achieved [1]. Therefore, an adaptation is required to improve the compressibility of the BTC by utilizing the vector-quantization method VQ to represent the binary form of the coded image produced from the BTC.

The VQ is a widely used technique in many data compression application. This is because a simple look-up table decoding can be used. The encoding process is computationally intensive procedure. This limits the applicability of VQ in practical considerations [2,3]. In this paper, we present a new fast vector quantization algorithm for coding-decoding image data. An elimination rule which based on triangular inequality elimination (TIE) is adopted to perform the coding decoding 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 [2].

The block truncation compression technique:

The conventional BTC algorithm subdivides an image into uniform blocks, typically 4 x 4 pixels in size. For each block, the mean (μ) and the standard deviation (σ) are computed, and a bit plane pattern is created [1]. The bit plane 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 values for each block, based on the encoded moments of the block. One value (a) is assigned to the O-valued pixels in the bit, plane,, the orders (b) is assigned to the 1- valued pixels. The reconstruction values are given by:

$$a = \mu - \sigma \sqrt{q/(n-q)}, \ldots\ldots\ldots\ldots\ldots\ldots(1a)$$

$$b = \mu + \sigma \sqrt{(n-q)/q}, \ldots\ldots\ldots\ldots\ldots\ldots(1b)$$

Where n is the number of pixels in the block, and q is the number of pixels greater than or equal to the block mean threshold.

The vector quantization technique:

Since 1980's, vector quantization (VQ) has been found to be an efficient technique for image compression [2]. The images to be encoded are first processed to yield a set of vectors. Then a codebook is generated using, for example, the iterative clustering algorithm by Lind et al.[5]. The input vectors are then individually quantized to the closest codeword in the codebook. Compression is achieved by using the indcies of code words for the purpose of transmission and storage. Reconstruction of the images can be implemented by table look up techniques; the indexes are simply used as addresses to the corresponding code words in the codebook. 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, limit the applicability of the VQ compression method. In this paper, a fast algorithm has been proposed to reduce the computational complexity of the full search encoding process, see [4, 6, 7,8].

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 Dij of motching the code word Ci with Cj, where (i=1, ..., N-1, j=i+1....N), and N is the number of the code-word in the code-book (code-book size), see fig 1.

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

Step3. if $D_{Ln} > 4D_{x1}$, then eliminate the computation of $D_{xn,(n)}$ should be incremented by one (i.e. n=n+1), and repeat the process of step 3 again. Other wise, continue.

Step4. If n>N then give the input vector x a label (L).

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

If $D_{xn}<D_{x1}$ then $D_{x1}=D_{xn}$, L=n,nn+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.

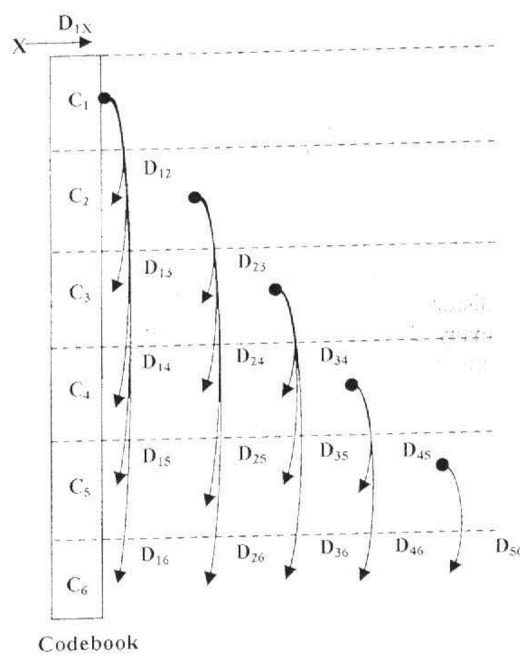

Fig.1: Demonstration of the TIE method, when codebook size=6 code word.

Experimental:

The efficiency of the proposed fast encoding algorithm for adaptive block truncation using VQ- based image coding is examined by simulation. The image is first divided into 4*4 sub images. The BTC is implemented, where for each block, A&B and bit plan are determined. A binary codebook containing 256 code words is then generated from these vectors using the well-known LBG algorithm.

Conclusion:

The effectiveness of applying the TIE method in the fast encoding algorithm is tested using this codebook. The elimination efficiencies of applying TIE in adaptive block truncation using VQ algorithm is listed in table 1. It can be seen from the table that 74.86% codeword matching are eliminated by TIE.

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

Block size	TIE
4*4	74.85%
8*8	60.26%

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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