Image Compression Algorithm Using Two Dimensional Discrete Cosine Transform

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Abstract: In this proposed work the two dimensional discrete cosine transform is used for image compression. This transforms process the signal in frequency domain. The significant feature of discrete cosine transform is to store the most of the information in lower frequency components. The performance of proposed technique over existing technique is superior. PSNR is considered quality check parameters in image compression. Keywords: Image compression, fractional transform, discrete cosine transform

1. Introduction

The authentic techniques that are required for compression has been increased by the increasing usability of images in the development of audio visual applications [1] because transmission and visual information is directly proportional to usability of image of multimedia. However, for downloading audio visual files from internet is an extremely time consuming, because of this necessity, digital image compression has become an important that’s why need of efficient algorithms that can produce large compression ratio with low loss has increased [2]. Multimedia communication contain a major portion of image data which consumes more bandwidth during transmission of data over the network [3,34]. Therefore, the composition of authentic techniques for image compression has become important paradigm [4]. Various image compression techniques have been developed in response to increasing need for medical and microbial consortial images, virtual conferencing and multimedia. The pre-existing algorithms focused on analyzing two dimensional singularities and achieving the fascinating characteristics such as high peak-signal-to-noise ratio (PSNR). Discrete cosine transform (DCT) [5] is very important form the prospective of compressions. The DCT provides accurate approximation of a signal with fewer transform coefficients [6]. Discrete sine transform (DST) is a complementary transform of DCT. DST is used as audio coding and low rate image in compression applications [7-8]. Discrete Walsh Hadamard transform (DWHT) is the simplest transform, but its energy compaction is poorer than DCT, so it does not have a potential to be used for digital image compression [9, 10]. KLT, DST and DCT are linear orthogonal blocked transformations which eliminate the interrelating data points or pixels inside the block. These transforms do not care of interrelating over the block boundaries [11]. The hybrid fractal image compression technique [12] which required more execution time due to its high complexity of algorithm.

In 1929, the fractional power of FT operator appeared in the mathematical literature [13-15]. The Fractional Fourier Transform (FrFTs) are commonly called as rotational Fourier transform or angular Fourier transform in some research papers [16, 17]. The applications of FrFT are quantum mechanics [18], signal processing [19-21], pattern recognition [22], and optical, video and audio processing [23-24]. In optics, the continuous FrFT is implemented [25]. Thus in short, it is proved fact that difference provides a richer solution set as compared to their continuous limit differential equations [26]. The decomposition discrete and continous signals and systems in FrFT domain has been introduced [27]. In present time, FrFT has various authentic application areas [28-33].

2. Proposed Image Compression Algorithm

Two Dimensional discrete cosine transform (DCT2) is applied for image compression. The quantization of these coefficients is done using quantization table. After it to get the compressed image we have applied the inverse DCT (IDCT2) to the quantized image.

Figure 1. Block diagram of proposed technique
2.1 DCT Encoding

The general equation for a 1D ($N$ data items) DCT is defined by the following equation:

$$ F(u) = \left( \frac{2}{N} \right)^{1/2} \sum_{i=0}^{N-1} \Delta(i) \cdot \cos \left[ \frac{\pi}{2N} (2i + 1) \right] f(i) $$

and the corresponding inverse 1D DCT transform is simple $F^{-1}(u)$, i.e.:

$$ \Delta(i) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } i = 0 \\ 1 & \text{otherwise} \end{cases} $$

The general equation for a 2D ($N$ by $M$ image) DCT is defined by the following equation:

$$ F(u,v) = \left( \frac{2}{N} \right)^{1/2} \left( \frac{2}{M} \right)^{1/2} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Delta(i) \Delta(j) \cdot \cos \left[ \frac{\pi}{2N} (2i + 1) \right] \cos \left[ \frac{\pi}{2M} (2j + 1) \right] f(i,j) $$

and the corresponding inverse 2D DCT transform is simple $F^{-1}(u,v)$, i.e.:

$$ \Delta(\varepsilon) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } \varepsilon = 0 \\ 1 & \text{otherwise} \end{cases} $$

The basic operation of the DCT is as follows:

a) The input image is $N$ by $M$.

b) $f(i,j)$ is the intensity of the pixel in row $i$ and column $j$.

c) $F(u,v)$ is the DCT coefficient in row $k1$ and column $k2$ of the DCT matrix.

d) For most images, much of the signal energy lies at low frequencies; these appear in the upper left corner of the DCT.

e) Compression is achieved since the lower right values represent higher frequencies, and are often small - small enough to be neglected with little visible distortion.

f) The DCT input is an 8 by 8 array of integers. This array contains each pixel's gray scale level.

g) 8 bit pixels have levels from 0 to 255.

h) Therefore an 8 point DCT would be:

i) The output array of DCT coefficients contains integers; these can range from -1024 to 1023.

j) It is computationally easier to implement and more efficient to regard the DCT as a set of basic functions which given a known input array size (8 x 8) can be precompiled and stored. This involves simply computing values for a convolution mask (8 x 8 window) that get applied (sum m values x pixel the window overlap with image apply window across all rows/columns of image). The values as simply calculated from the DCT formula. The 64 (8 x 8) DCT basis functions are illustrated in given below figure.

2.2 Huffman Encoding and Decoding
The main aim of Huffman coding is to eliminate the coding redundancy. It is a form of statistical coding which attempts to reduce the amount of bits required to represent a string of symbols. And due to use of Huffman coding the use of optimal code word having minimum average length. And decoding is the reverse of coding. Decoding is done to get back the original.

3. Results and Discussion

\[
MSE = \left[ \frac{1}{255} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} [o(i, j) - i(i, j)]^2 \right]
\]

\[
PSNR = 10\log_{10} \left[ \frac{M \times N}{MSE} \right]
\]

where \( M \times N \) is the size of the image.

In order to test the efficiency of proposed technique, we have used the test images: “Lena”, “Peppers”, “Barbara” and “Baboon”. In it we have worked on the entire image without block processing. Therefore, the proposed algorithm performed well and provides blocking artifacts free compressed images. Figure 5 gives the visual results of proposed algorithm. Table 1 presented comparative results of various existing techniques and our proposed technique, which shows that proposed algorithm is superior in performance. Which depicts that proposed algorithm provide better PSNR. Another important advantage of proposed technique is, it required less execution time. Image compression with DCT2 performs better and tries to save the bandwidth.
4. Conclusions

In this paper, we have proposed an efficient technique for image compression using DCT2. The proposed technique efficiently compressed the images and found optimum PSNR. Many existing techniques produce blocking artifacts. As we are not working on non-overlapped blocks or subimages in our proposed approach and here, artifacts were removed by working on the whole image not by blocks. We have worked with a single block (of size 256x256) due to which another advantage is that it required less execution time. From the simulation results, we have proved that the proposed technique is required less time for execution and efficient for compressing the images of different types. The future scope will be implementation of other discrete fractional cosine transform for image compression.

References

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