Analysis of Image Compression Using Discrete Cosine Transform

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ABTRACT:

In today's technological world as our use and reliance on computers is continuing, so too does our need for efficient ways of storing large amounts of data . Due to the bandwidth and storage limitations, images must be compressed before transmission and storage.

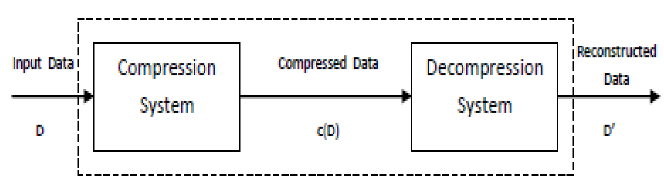
Image compression is the application of Data compression on digital images. The discrete cosine transform (DCT) is a technique for converting a signal into elementary frequency components. It is widely used in image compression. Here we develop some simple functions to compute the DCT and to compress images. An image compression algorithm was comprehended using Matlab code, and modified to perform better when implemented in hardware description language.

Keyword: The main objectives of this paper are reducing the image storage space; Easy maintenance and providing security; Data loss cannot affect the image clarity; Lower bandwidth requirements for transmission; Reducing cost.

1. INTRODUCTION

Data is represented as a combination of information and redundancy. Information is the portion of data that must be preserved permanently in its original form in order to correctly interpret the meaning or purpose of the data. Redundancy is that portion of data that can be removed when it is not needed or can be reinserted to interpret the data when needed. Most often, the redundancy is reinserted in order to generate the original data in its original form. A technique to reduce the redundancy of data is defined as Data compression. The redundancy in data representation is reduced such a way that it can be subsequently reinserted to recover the original data, which is called decompression of the data.

The compression (coding) and decompression (decoding) systems together are called a "CODEC"



Block Diagram of CODEC

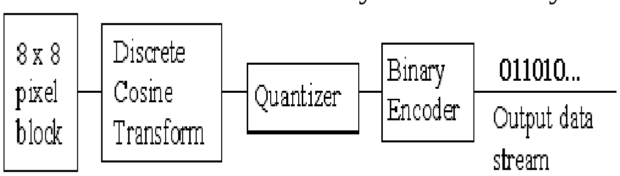
Image Compression Can Be Lossy Or Lossless.

Lossless Compression: Data is compressed and can be reconstituted (uncompressed) without loss of detail or information. These are referred to as bit-

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 09
May 2016

preserving or reversible compression systems also called as Lossless compression.
On the other hand , data is compressed and uncompressed data is not the exact replica of original data i.e some of its instruction has been lost while decompressing.
Video and audio compression techniques are most suited to this form of compression.
The advantage of lossy methods over lossless methods is that in some cases a lossy method can produce a much smaller compressed file than any known lossless method, while still meeting the requirements of the application.

JPEG is primarily a lossy method of compression. JPEG was designed specifically to discard information that the human eye cannot easily see.



Block Diagram of JPEG Compression

JPEG divides up the image into 8 by 8 pixel blocks, and then calculates the discrete cosine transform (DCT) of each block. A quantizer rounds off the DCT coefficients according to the quantization matrix. Then a binary encoder is applied to produced encoded stream of image.

DISCRETE COSINE TRANSFORM

The Discrete Cosine Transform was first proposed by Ahmed et al. (1974).
A discrete cosine transform (DCT) expresses a sequence of finitely many data points in terms of a sum of cosine functions oscillating at different frequencies. Image compression using DCT process includes:

- The image is broken into 8x8 blocks of pixels.
- Working from left to right, top to bottom, the DCT is applied to each block.
- Each block is compressed through quantization.
- The array of compressed blocks that constitute the image is stored in a drastically reduced amount of space.
- The image is reconstructed through decompression, a process that uses the Inverse Discrete Cosine Transform (IDCT)

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

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

The 2-D discrete cosine transform (DCT) is an invertible linear transform and is widely used in many practical image compression systems because of its compression performance and computational efficiency [10-12]. DCT converts data (image pixels) into sets of frequencies. The first frequencies in the set are the most meaningful; the latter, the least. The least meaningful frequencies can be stripped away based on allowable resolution loss. DCT-based image compression relies on two techniques to reduce data required to represent the image. The first is quantization of the image's DCT coefficients; the second is entropy coding of the quantized coefficients

QUANTIZATION:

Quantization is the process of reducing the number of possible values of a quantity, thereby reducing the number of bits needed to represent it. After the DCT, all the coefficients are quantized in lossy compression mode in order to reduce the precision to aid in achieving compression. Quantization of DCT coefficients is one of the main sources of information loss in the encoder. Coarser quantization results in more compression and hence in reducing the reconstruction fidelity of the image because of greater loss of information . Quantization error is the main source of the Lossy Compression.

DCT_quantizer = % levels for quantizing the DCT block (8x8 matrix)

```
[ 16  11  10  16  24  40  51  61; ...
  12  12  14  19  26  58  60  55; ...
  14  13  16  24  40  57  69  56; ...
  14  17  22  29  51  87  80  62; ...
  18  22  37  56  68 109 103  77; ...
  24  35  55  64  81 104 113  92; ...
  49  64  78  87 103 121 120 101; ...
  72  92  95  98 112 100 103  99 ];
```

Quantization is achieved by dividing each element in the transformed image matrix D by corresponding element in the quantization matrix, and then rounding to the nearest integer value.

CODING

Before storage, all quantized coefficients are converted by an encoder to a stream of binary data (01101011...). Entropy coding is a technique for representing the quantized data as compactly as possible.

One of the main types of entropy coding creates and assigns a unique prefix-free code to each unique symbol that occurs in the input. These entropy encoders then compress data by replacing each fixed-length input symbol with the corresponding variable-length prefix-free output codeword.

DECOMPRESSION

Reconstruction of our image begins by decoding the bit stream representing the Quantized matrix. Each element of quantized matrix is then multiplied by the corresponding element of the quantization matrix originally used. The IDCT is applied to the resulted matrix which is rounded to the nearest integer. Final 128 is added to the each element of the matrix to produce the decompressed original image.

SIMULATIONS AND RESULTS:

Image with quality of compression – 10

Image with quality of compression – 40

Quality of compression – 60

With different quality of compression different compressed images can be obtained.

PROBLEMS ASSOCIATED:

The criticism of the DCT is the blocking effect. In DCT, images are broken into blocks of 8x8 or 16x16 or bigger. The problem with these blocks is that when the image is reduced to higher compression ratios, these blocks become visible. This has been termed as the blocking effect. This image is compressed using 8x8 blocks and only 4 coefficients are retained. The blocking effect is very prominent in image compression when quality is very less as seen when image quality considered to be 10.

CONCLUSION:

This paper is a project which successfully implemented the JPEG image compression. The system is designed by using MATLAB software. This project has been tested for all possible situations on MATLAB environment on Windows XP and finally produced an 8x8 Compressed DCT image.

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