ABSTRACT

The primary picture data created by the camera sensor is broad to store, so the usefulness isn't high. Convenient or information move limit obliged systems end up being particularly inconvenient, where the article is a moderate bandwidth cost, for instance, the World Wide Web. The present condition requires the usage of useful picture compression frameworks, for instance, JPEG estimation techniques, that see pictures with no loss of compacted picture height. The objective of image compression is to reduce irrelevance and redundancy of the image data to be able to store or transmit data in an efficient form.

INTRODUCTION

How do we define an image? An image is a rectangular array of dots, called pixels. The size of the image is the number of pixels (width x height). Every pixel in an image is a certain color. Types of images include grayscale images, black & white images, color images.

Why do we need image compression? Since images have become so commonplace and so essential to the function of computers, it is hard to see how we would function without them. We need to compress images to increase productivity, efficiency and transmissibility. When talking about images there are three main sources of redundant information:

- Coding Redundancy
- Inter pixel Redundancy
- Psycho visual Redundancy

In comparing how much compression one algorithm achieves verses another, many people talk about a compression ratio. A higher compression ratio indicates that one algorithm removes more redundancy than another (and thus is more efficient). There are two types of compression systems:

1. **Lossy compression system:**
   Lossy compression techniques can be used in image where some of the finer details in the image can be sacrificed for the sake of saving a little more bandwidth or storage space.

2. **Lossless compression system:**
   Lossless Compression System aims at minimizing the bit rate of the compressed output without any distortion of the image. The decompressed bit-stream is identical to original bitstream.

Types of images

1) Raster
2) Vector

Raster Image

- A raster image is made of a collection of dots called pixels. A 72-dpi image is made of 72 dots-per-inch (dpi) or 72 pixels (ppi) in every inch of that image.
- The number of pixels that comprise a raster image is called the resolution and it is fixed. If you take a 72-dpi image and scale it up 300%, you will not increase the number of pixels or dots of that image, you will simply increase the size of each pixel or dot. The result will be an image where you can clearly see the pixels and no fine detail. Therefore it is recommended to use a high dpi like 300 at size as to get a quality image.
- Raster images are generally used for photography or illustrations that have been scanned, or photos from cameras and phones that work with a raster-based program like photoshop.

Raster file formats

- JPEG
- TIFF
- PNG
- GIF
- RAW
- PSD

Vector Image

- A vector image is made of paths. A path can be a line, a square or a shape. Paths are used to render typography and to create anything from simple diagrams to complex illustrations. Paths are not fixed.
- Vector images are ideal for when detail preservation is critical as in text, logos and flat illustrations.
- Vector images can be scaled to a larger size and do not lose any image quality because they are made of paths and not dots (pixels).

Vector file formats

- PDF
- EPS
- SVG
- AI

Some common Representations

There are a large number of file formats (hundreds) used to represent an image, some more common than others. Among the most popular are:

- **GIF:** Graphics Interchange Format.
  The most common image format on the Web. Stores 1 to 8-bit color or grayscale images.
- **TIFF:** Tagged Image File Format.
  The standard image format found in most paint, imaging, and desktop publishing programs. Supports 1- to 24- bit images and several different compression schemes.
- **PICT:** MacIntosh's native image file format, produced by many programs that run-on Macs. Stores up to 24-bit color.
- **BMP:** Microsoft Windows Bitmap. Main format supported by Microsoft Windows. Stores 1-,4-, 8-, and 24-bitimages.
- **JPEG** File Interchange Format Developed by the Joint Photographic Experts Group sometimes simply called the JPEG file format. It can store up to 24-bits of color.
- **PNG** stands for "Portable Graphics Format". It is the most frequently used uncompressed raster image format on the internet.

IMAGE COMPRESSION MODEL

Although image compression models differ in the way they compress data, there are many general features that can be described which represent most image compression algorithms. The source encoder is used to remove redundancy in the input image. The channel encoder is used as overhead in order to combat charnel noise. A common example of this would be the introduction of a parity bit. By introducing this overhead, a certain level of immunity is gained from noise that is inherent in any storage or transmission system. The channel in this model could be either a communication link or a storage/retrieval system. The job of the channel and source decoders is to basically undo the work of the source and channel encoders in order to restore the image to the user.

Components of Typical Image Transmission

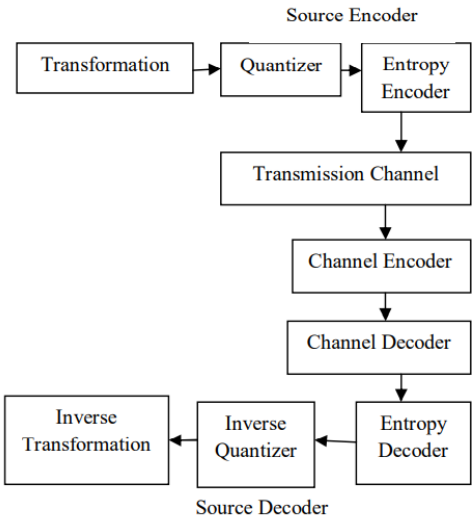


Image Compression Algorithms:

Image compression is mainly of two types lossy or lossless.

1. *Lossy method:-* It is also known as Irreversible Compression. It is the class of information encoding techniques that makes use of inexact approximations and partial information discarding to symbolize the content.
2.
3. *Lossless method:-* It is also termed as Reversible compression. The data which is not noticeable is not eliminated. While in this file can restore in its original form.

Various Lossy Compression Methods are:

1. *Cartesian Perceptual Compression :* abbreviated as CPC. It is a novel image compression method specially designed for document image storage and transmission systems. It is highly effective in the compression of text, black-and-white photographs, and line art.

2. *Fractal compression:* This is the technique for digital images. This is suitable for textures and herbal images, counting on the truth that components of an photograph frequently resemble different components of the equal photograph. These components are transformed into mathematical facts called "fractal codes" which might be used to recreate the encoded photograph.

3. *JPEG and JPEG 2000* :- It is Joint Photographic Experts group. The JPEG defined four compression modes: 1) Hierarchical, 2) Progressive, 3) Sequential and 4)lossless.
   JPEG algorithm is divided into different stages as:
   1. A color transform
   2. A 2D discrete cosine transform
   3. A quantization stage (filtering).
   4. Huffman Encoding.

   After all this stages we get images in '.jpg' format.

4. *Progressive Graphics File* :- abbreviated as PGF. PGF is a wavelet-based bitmapped picture format that employs lossless and lossy data compression. PGF was created to improve upon and replace the JPEG format and focus on speed over compression ratio and adding or improving features such as scalability.

Various Loss-Less Compression Method:

1. *Run-length encoding :-* abbreviated as (RLE). It is a simple form of lossless data compression that runs on sequence with the same value occurring many consecutive times. It encodes the sequence to store only a single value and its count. Use in line drawings and animations.
   Example : WWWWWWWWBBWWWW – 7W2B4W.
   It has major drawback that it can not useful if there are no consecutive repetitions.

2. *Entropy encoding :-* It is independent of specific characteristics of medium. One of the main types of entropy coding creates and assign a unique prefix code to each unique symbol that occurs in the input.

3. *Adaptive Dictionary Algorithms :-* abbreviated as ADA. Such as LZW, LZ&& which uses for GIF and TIFF. It addresses bytes sequence from former contents instead of original data. So all data is coded in same form as
   * address of already coded contents.
   * sequence length
   * first deviating symbol
   if no identical byte sequence is available from former content, the address is zero(0), sequence length is zero(0) and new symbol is created or coded.

4. *Deflation :-* The DEFLATE compressed records layout includes a chain of blocks, similar to successive blocks of input data. Each block is compressed by the mixture of the LZ77 algorithm and Huffman coding.

Steps involved in Compressing and Decompressing of Image:

1. Specify the Rate and Distortion parameters for the target image.
2. Dividing the image data into various classes.
3. Dividing the available bit budget among these classes.
4. Quantize each class separately using bit allocation.
5. Encode each class separately using an entropy coder
6. Reconstructing the image from the compressed data.
7. Read the quantized data from the file, using an entropy decoder.
8. Dequantized the data.
9. Rebuild the image.

Wavelet

In real world when one hears word wavelet , one's mind strikes small wave water .They don't know that it can be use for image compression. But in real life, A wavelet that waves above and below the x-axis with the following properties:
1.Varying frequency
2.Limited duration
3.Zero average value
Wavelet transforms are definitely very important computational tools. A transform is used to transform the given problem to another form with useful features. Initially, wavelets were solely in mathematics. But now, the extent of their usage has reached many areas such as seismology, de-noising of signal ,(non-stationary signals in particular) and data compression

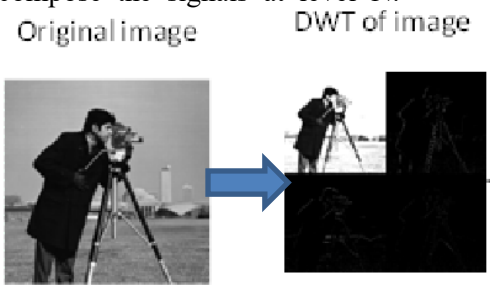
Wavelet Transform

The wavelet decomposition method uses two types of filters, i.e low pass filter and high pass filter. In this decomposition, a Discrete wavelet transform (DWT) image is split into several

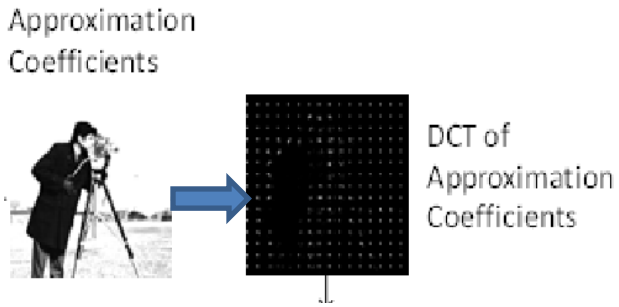
sub bands (LL(cA),LH(cH),HL(cV),HH(cD)), only LL (approximation coefficient) sub band is decomposed further, because it has low frequency and noise compare to other sub band levels.
The proposed technique first decomposes an image into coefficients called sub-bands and then the resulting coefficients are compared with threshold. Coefficients below the threshold are set to zero. Finally, the coefficients above the threshold value are encoded with a loss less compression technique.

The steps of the proposed compression algorithm based on DWT are described below:

1. Decompose-: Choose a wavelet and specify the level N. Compute the wavelet transform. Decompose the signals at level N.



2.Threshold detail coefficients-: For each level from 1 to N, a threshold is selected and thresholding is applied to the detail approximation coefficients



3. Reconstruct -: Computing wavelet reconstruction using the original approximation coefficients of level N and the modified detail coefficients of levels from 1 to N using inverse wavelet transform

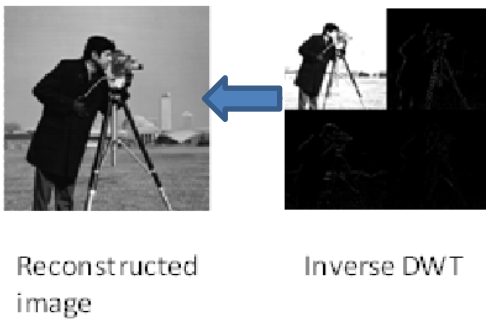


IMAGE COMPRESSION USING DCT(in MATLAB):

The discrete cosine transform (DCT) is a technique for converting a signal into elementary frequency components. Like other transforms, the Discrete Cosine Transform (DCT) attempts to de correlate the

image data. After de correlate each transform coefficient can be encoded independently without losing compression efficiency.

DCT is equivalent to computing 2N point DFT of signal which is made even symmetric by its extension.

Where N point DFT of a sequence x[n] is given by

X[k] =Σ x[n]*exp (j2πk *n/N); over n=0 to N-1.

The following is a general overview of the

JPEG process:

- The image is broken into 8×8 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.
- When desired, the image is reconstructed through decompression, a process that uses the inverse Discrete Cosine Transform (IDCT).

DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. This property is known as ***ENERGY COMPACTION*** property. Hence, DCT finds its importance in image compression technique.

2D-FDCT (2 Dimensional Forward DCT):

The two-dimensional DCT of an M*N image f (x, y) is as follows

F (p ,q) =αp*αq

ΣΣ f(x, y) cos[π(2x+1)p/2M] cos[π(2y+1) q/2N]

Where 0 ≤ p ≤ M

1 and 0 ≤ q ≤ N 1 and

αp = 1/sqrt(M) ; p=0

=sqrt(2/M); 1 ≤ p ≤ M 1;

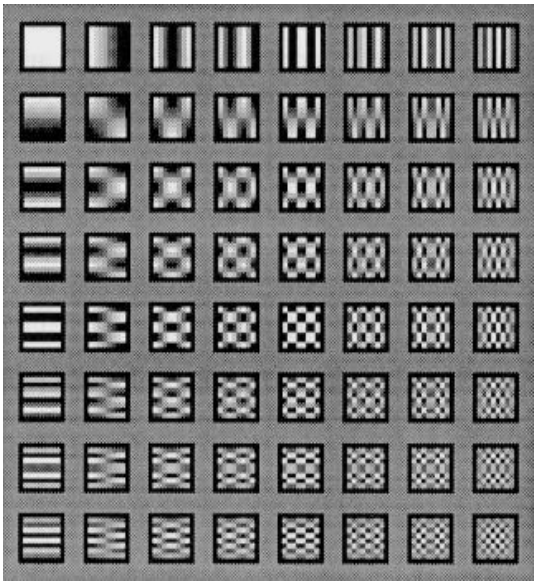
αq = 1/sqrt(N); q=0

=sqrt(2/N); 1≤ q ≤ N 1;

From the 2D FDCT and the 2D inverse DCT(IDCT) we find the term:

αp*αq cos [π(2 x+ 1 / M)] cos[π(2 y+ 1) / N]

Common and same in both the expressions. These functions are called as ***BASIS FUNCITONS OF DCT***.



(DCT basis functions)

The Basis functions for 8 * 8 matrix are shown

- Horizontal frequencies increase from the left to right, and vertical frequencies increase from the top to bottom.
- The constant valued basis function at the upper left is called as DC basis function and corresponding coefficient is called DC coefficient. Rest of the coefficients are called AC coefficients.

DCT Computation using FFT approach:

- It utilizes the FFT structure for speedy computation of DCT, hence suitable for large input images.
- In MATLAB it is achieved by using dct2() function
- Since DCT has very good energy compaction capability, it means that the information is being carried by fewer DCT coefficients , and therefore, large number of coefficients can be neglected to achieve image compression.

DCT Drawbacks:

- A common issue with DCT compression in digital media is ***BLOCKY COMPRESSION ARTIFACTS,*** caused by DCT blocks. The DCT algorithm can cause block-based artifacts when heavy compression technique is applied.
- Truncation of higher spectral coefficients results in blurring of the images, especially wherever the details are high.

- Coarse quantization of some of the low spectral coefficients introduces graininess in the smooth portions of the image.

CONCLUSION:

If high quality images are required, then lossless compression should be used, Ex; image of medical equipment. This could be achieved using RLE and Bit compression. For all other types of images Lossy compression is best choice. DCT procedure can be used. Reductant data can be expelled from the images through quantization. DCT plays essential role in JPEG picture compression. As the camera quality increasing day after day, more data is required to store images.For this we need to acquaint high productivity DCT calculation.