PNG vs JPEG Image Compression

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***Abstract*—JPEG and PNG are the two image file formats that prevail over other formats. One format is not better than the other, rather both have their own uses. In this project, we will show how PNG(lossless) compression is done using the LZW(Lempel-Ziv-Welch) method and JPEG(lossy) compression using the DCT(Discrete Cosine Transform) method and discuss their advantages and disadvantages as well.**

***Index Terms*—Image compression, JPEG, PNG, DCT, LZW, lossy, lossless**

I. Introduction

In today's world images or pictures are the new modes of storing data thus, every single moment millions of images are generated, recorded, transmitted, and stored in numerous ways. A digital image is stored in the form of a 2-D array of pixel values. Nowadays because of the generation of high loads of data, we need to reduce the load of data trafficking for smoother networking. We use image compression for reducing data from the image.

Image compression can be either lossless or lossy. Lossy compression gives almost visually negligible difference and also less storage. Lossless compression on the other hand focuses on retaining the quality of the image. The most commonly used lossy compression method is DCT which is used in JPACK compression formats. For lossless compression, LZW is the most widely used method which is used in PNG compression.

II. BACKGROUND

Image Compression is mainly done using lossy image compression and lossless image compression. Lossy image compression leads to the loss of some information. In lossless image compression, the recreated image is similar to the original image. The main aim of lossy image compression is to reduce image size without any noise which leads to the loss of some data. Lossless compression is aimed at no loss of information but it is affected by noise. Generally, a JPEG image is compressed by lossy compression and a PNG image is compressed by lossless compression. DCT and LWZ are the most commonly used image compression methods. The lossy compression process includes lossy predictive coding and transforms coding. Fourier related transforms such as DCT is mainly used for lossy compression. Since lossless compression requires no loss of information, the LZW provides that feature by using methods and algorithms of linear algebra. LZW is a dictionary-based lossless compression technique. In this method, the data is stored in the form of a dictionary and references are given to the repeated data.

III. MOTIVATION

In today's world, data storage is a problem found in every In recent years, transferring of large scale information by remote computing has shown a tremendous growth.In order to cope up with the increase in data, new storage devices have to be installed and themodems and multiplexers have to be improved continuously to permit large scale data transfer. A solution to these problems is "COMPRESSION" which helps avoiding storage of repetitive data and reduces the storage size.A lot of space is consumed by uncompressed data, which is not effective for limited storage devices, hardwares and internet download speeds.Example: One minute of uncompressed HD video can be over 1 GB.How can we fit a two-hour film on a 25 GB Blu-ray disc?JPEG and PNG are the best image compression formats. At times we need high-quality images and on the other side at someplace, even if the quality is reduced but less storage is more preferable. JPEG is a lossy format, which means the compression ratio is high but the quality of the image will be reduced. But it will give a good combination of good quality and compression. The biggest motivation to use this format is that it is available on almost every device and is also storage-friendly. Some cons of using this format are that it supports only 1-3 colours and image quality will be reduced after encoding. PNG is a lossless format so that the quality of the image will not be reduced. There are also some cons of PNG format that due to no compromise with the quality it has less compression ratio and the image storage is not reduced.

IV. LITERATURE REVIEW

As there is a vast flow of images on the internet, and an uncompressed image demands more space and transmission bandwidth, image compression is an essential subject of research. It's also crucial to create a system that compresses the image while keeping the key information in mind. Researchers discovered that the quality of an image created using lossless compression is superior than that created using lossy compression when comparing the two ways of image compression: lossy and lossless. Reading a sequence of symbols, arranging the symbols into strings, and translating the strings into codes is how LZW compression works. We achieve compression because the codes take up less space than the strings they replace. When using LZW compression to compress an image, the type of image and amount of colours must be taken into account, and LZW compression will be utilised in some circumstances. For coloured and grayscale photos, the constraint will be reduced by using bit plan slicing. The proposed method outperforms the typical LZW method by doubling the compression ratio for grayscaled images. The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The dct2 function computes the two-dimensional discrete cosine transform (DCT) of an image. The 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. For this reason, the DCT is often used in image compression applications. For example, the DCT is at the heart of the international standard lossy image compression algorithm known as JPEG. The image is transformed using Discrete Cosine Transform. The DCCoefficient is then extracted from the Discrete Cosine Transformed Matrix and individually saved or communicated. With a threshold value, the Discrete Cosine Transformed matrix is truncated without the DC-coefficient. Singular Value Decomposition is done to this truncated matrix. The Singular Value Decomposition matrices are shortened again with a suitable cutoff value. These matrices are then multiplied back together. The resulting matrix is trimmed once more with the threshold value. The matrix is then quantized. The quantized matrix is then transformed into a sparse matrix. The sparse matrix elements are then converted to data types. The sparse matrix's column elements are run length encoded, and the compressed image may then be obtained. This compressed version can be saved or sent.

V. MATHEMATICAL MODEL

JPEG Compression using DCT: Now, we want to perform image compression on a JPEG file. For that, there is a method for JPEG compression called DCT. JPEG compression is mainly done using DCT. JPEG compression using DCT includes the below given steps: First, we will input an image and then convert it into grayscale image. Then, the input image will be divided into blocks of 8 rows and 8 columns. The 8x8 block contains each pixel's grayscale level. After dividing the image into 8x8 blocks, we will perform DCT on each block. DCT can be applied using the below formula:

$$F(u,v) = (\tfrac{2}{N})^{\frac{1}{2}}(\tfrac{2}{M})^{\frac{1}{2}}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\Lambda(i).\Lambda(j).$$

$$cos[(\tfrac{v.\pi}{2.N})(21+1)]cos[(\tfrac{v.\pi}{2.M})(2j+1)].f(i,j)$$

Here, we want to perform 2D DCT. So, the problem will be reduced to a series of 1D DCTs. In that method, first we will apply 1D DCT (vertically) to all the columns and then apply DCT (horizontally) to the resultant vertical done before. There is an alternative method also, in which the whole image is first broken into 8x8 sections and then multiply those sections with a DCT matrix of 8x8. DCT transform is performed by: DADT (where D is an orthogonal matrix and A is the 8x8 block from image)

Similarly, inverse DCT can be applied by DTAD. D is the standard matrix for 8x8 DCT transform. In the transformed matrix obtained from DCT, the values at the left corner part with lower frequency contribute maximum and the right triangular part with higher frequency contribute minimum. So, we will perform quantization on the transformed matrix and remove the values with higher frequency. In quantization, a quantization matrix is used by which we can divide the DCT transformed matrix value by value and then rounding off the result so that the values with high frequency are removed which contribute significantly less in the image. After quantization, next step is encoding. Encoding is done in two steps, first is zigzag scan and then run length encoding (RLE). Zigzag scan is performed to convert the 8x8 matrix to a 1x64 vector. Zigzag will start from the left most element of the matrix and will scan in a zigzag manner across the whole matrix to the right most element. By doing so the values will be arranged in decreasing order of their contribution in the image. Then the next step is run length encoding (RLE). There will be lots of zeros in the 1x64 vector. So, the data will be encoded as (skip, value) pairs, where skip is the number of zeros before the next non-zero value. After performing encoding we will get a compressed encoded image. After encoding, the image will be reconstructed by the decoding process. First, the encoded data which is in the form of (skip, value) pairs is decoded into a 1x64 vector. Then inverse zigzag scan will convert the 1x64 vector back to 8x8 matrix. After converting to 8x8 matrix, perform dequantization on the 8x8 block by multiplying the quantization matrix with the 8x8 block value by value to obtain dequantized matrix. Then by applying inverse DCT to obtain the grayscale values, on every 8x8 blocks and then merging the blocks will result in the reconstructed compressed gray scale image.

PNG compression using LZW: LZW is a dictionary-based compression algorithm means LZW encodes data by referencing a dictionary. LZW includes two main steps: encoding(compression) and decoding (decompression). In encoding, there is a predefined dictionary of 256 characters which are referred as standard character set. Then it starts reading the input file and every time it comes across a new string, it adds it to dictionary and assigns it a code. If it comes across the string which is already in the dictionary, then it concatenates the string with the current string and forms a new string. In decoding, the decoder reads the encoded data from the dictionary. It looks at the integers and outputs the substring associated with the index. The initial character of the substring is concatenated to the current string and then added to the dictionary. This decoded string will be the current string and the same process will repeat.

VI. NUMERICAL RESULTS

When we applied DCT Compression on a JPEG file of size 29.7KB and 69.KB, the output compressed image turned out to be 15.7 KB and 29.8KB in size. So there is compression of approx 50 Percentage. When we applied LZW Compression on a PNG file of size 19.156MB and 19.158MB, the output compressed image turned out to be 1.338MB and 2.367MB in size. From this result we can observe that there is no certainity in the amount of compression in case of LZW. It depends on the size of repetitive data. More the amount of repetitive data greater is the compression and vice-versa.

VII. Contribution

Kush- Literature Survey and Plan of Action and Numerical Result

Kathan- Introduction, PPT Designing and Plan of Action

Devyash- Reproduced work, Latex and Problem Statement and Mathematical Model

Meet- Motivation, Reproduced work and Research

Dev- Background and reproduced work and Mathematical model

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