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REVIEW OF IMAGE COMPRESSION TECHNIQUES FOR MULTIMEDIA IMAGES

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ABSTRACT

Image compression is very interesting because it deals with the real world problems. It plays important role in transfer of image data. In this paper our main focus is on compression techniques use for multimedia images. Image compression techniques rely upon the removal of information within images to reduce amount of pixels to represent images. Multimedia applications cannot store images directly because it requires large space and need more time for transmission. The comparison of techniques done so that before you begin compression of image users need to know about the different techniques for image compression. Lossy compression involves removing all unnecessary information from the original file. Lossless image compression will end up not affecting quality of image with reducing image size. The following sections introduce work done on various image compression techniques like Huffman coding, arithmetic coding , RLE, LZW, JPEG and JPEG 2000.

Keywords- RLE, LZW, JPEG, PSNR, Image compression.

Image becomes very important document these days. Everyone is very much fond of images, photos and videos. It becomes a man's wish to capture all his unforgettable moments. This
results in huge record of photos and videos. The number of pictures person collect over days fill their hard drives as well as cloud storage. The size of image can be affected in two ways :-The storage space and when considering with transmission time in commonly used multimedia applications such as Instagram, Facebook, Hike, Whatsapp and many more. These applications are very much depending on transmitting time for messaging. Uncompressed image file are often huge and require large space to store. Image compression is an area that studies methods of reducing the number of bits required to represent image and reduce redundant information present in image [1]. Image compression can be achieved by eliminating redundancy in images. Three basic redundancies are:-

- *Psycho-visual redundancy:* In this type of redundancy less important information in image can be eliminated without introducing any significant effect on the human eye.
- *Inter-pixel redundancy*: In this pixel value reasonably predicted from its neighboring pixel is inter-pixel redundancy.
- *Coding redundancy:* Variable length code words are selected from codebook.

II. TYPES OF IMAGES

There are many types of images, here we introduce detail about different types of images and distribution of color in images [2].

Type	Explanation
Binary	Contain only 0s and 1s, introduced as black and white.
Indexed	Array of class unit8, unit16, single or double whose pixels values are direct relate to color map.
Gray scale	For single or double logical array value range from (0, 1), for unit8 value ranges from (0,255). For unit16, values range from (0, 65535).for unit16, values from (-32768, 32767).
True color	Array of class unit8, unit16, single or double arrays range from (0, 1).

Table 1: Types of Images

III. FORMATS OF IMAGES

Image representation formats on collection of images. Image representation formats can divided into two parts lossless format and lossy format .Lossless formats are TIFF, PNG, BMP and Lossy formats are JPEG, JPEG2000. These formats can explain as:

○ *BMP (Bitmap):* It is commonly used simple uncompressed graphic format by Microsoft windows graphics subsystem (GDI).

○ *PNG (Portable network graphics):* PNG supports pallete based; gray scale and RGB images.PNG is used for transformation of images on internet rather than for professional uses. For ex: Facebook use PNG format.

○ *TIFF (Tagged Image file Format):* TIFF is more popular and flexible format currently being using rather than other Formats. TIFF supports colored depth image along with photographic and art images.

○ *JPEG (Joint Photographic Experts Group*): JPEG is designed to compress gray scale images.

○ *JPEG2000 (Joint Photographic Experts Group):* JPEG2000 is wavelet based lossy image compression standard. JPEG 2000 is wavelet based compression format.JPEG 2000 is new version of JPEG. It is created by JPEG group. It is based on coding method JPEG2000 provides higher compression rates but it blurr image more than JPEG [3].

FORMAT	NAME	CHARACTERSTICS
BMP	Bitmap	Uncompressed Format
TIFF	Tagged Image File Format	Lossless: Imaging format
PNG	Portable Network Graphics	Lossless
JPEG	Joint photo experts Group	Lossy and good for photographic images.
JPEG2000	Joint photo experts Group2000	Lossy and replacement of JPEG

Table 2: Image representation Formats

IV. IMAGE COMPRESSION METHODS

A number of image compression techniques have been introduced to address main problems faced by transferring digital images. These compression techniques can be partitioned as lossy compression and lossless compression. Lossy compression involves loss of information in compressed image. In lossless compression no loss of any type of pixel information.

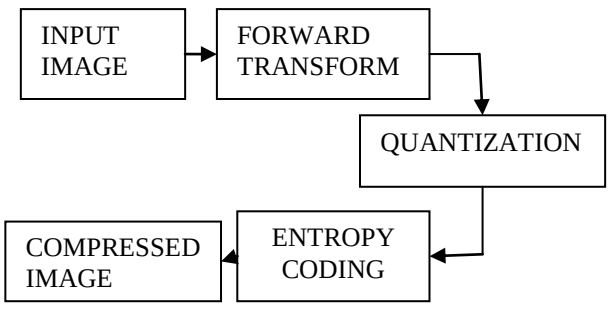

Fig 1. Image Compression Model

- *Original Image:* An input image which we to compress.

- *Transformer:* Transformer helps in transform the original image into format designed to reduce interpixel redundancies in the original image. Operations are reversible.

- *Quantizer:* It reduces the accuracy of the mapper's output in accordance with some predefined criteria. Quantizer helps to reduce psycho –visual redundancy.

- *Entropy encoding*: It is use to create variable length code to represent quantizer's output [4].

V. LOSSLESS COMPRESSION

Lossless compression is a two step process. In the first stage the original image is transform of original image into some other format so that inter pixel redundancy is reduced. In second stage an entropy coder will remove coding redundancy. In lossless compression quality is not compromised while maintaining its original information. The exact input image can be obtained without loss of information such as Huffman coding; Run Length Encoding, Arithmetic coding and LZW are example of lossless compression techniques. These techniques are very useful for images that are needed to be compressed without loss of information for example space images, medical images and are not much suitable for internet applications.

Huffman Coding: Huffman coding can be explained as frequency of occurrence of data item . In this technique they use lower no of bits to encode frequency of data item that occur most frequently. There is also a Huffman coding dictionary that contain each data symbol and associate every data symbol with a code word in the dictionary .This coding is based on the coding tree according to Huffman which gives us small code words to symbol that are frequently used and large code words to symbols that are used rarely. Each symbol is encoded with a variable length code. Mostly in cases of images having individual pixels values are used to represent individual symbol and set of symbol consists of all gray values of an image. The Huffman code for n symbols can be computed in (nlogn) times using a greedy algorithm [5].

Arithmetic coding: Arithmetic coding assigns a set of bits to a data item, a string of symbols. Arithmetic coding will treat the whole symbols in a list or in a message as one set .Arithmetic coding cannot use a discrete sequence of bits for each. The number of bits used to encode each symbol varies into problem assigned to symbol. Low probability symbol use large bits, high probability symbol use less symbol. The main purpose behind arithmetic coding is to assign symbol an interval .The starting interval[0,1] each interval categorized in several sub intervals in which its sizes are proportional to the problem related symbols. The problem subinterval further coded symbol is then divided as the interval for next symbol. The final output will be last interval [6].

Limpel, Ziv and Welch (LZW): In LZW fixed length codes are generated as concern to Huffman coding which generate variable length coding. In an example we assume that symbols. that present in the source file are a,b,c and here the string is *ababcabc* need to compressed . In first step we Strings are a,b,c. the sting can be

given to its position in the dictionary . So the code for a is 0, For b is 1 and for c is 2. The starting symbol in the file to be compressed. The main objective to find takes place in dictionary. This procedure will follow again until we get code for whole string as output. Thus the coding of string is 01325. Here is encoded string and we can decode it in reverse way [5].

Run Length Encoding: Run length encoding is a lossless image data compression type. It represent image data by a (length, value) pair, where value is any repeated value and the length is total number of repetitions. RLE is simple image compression type and easy to implement. Here data is in form of runs. Runs will be the sequences in which same data value represent in many data elements store as a single value and then count as value. For an instance , consider a screen having plain black text on a white background . there can be many long runs of white bits in the black space and many short runs of black bits within the text. Here represent a single scan line in which X represent a black pixel and Y represent a white pixel. the longest prefix of the input image which is in dictionary is a. The longest prefix in *ababcabc* in dictionary is a. Its code 0 is output as part of the compressed file and the prefix and next input symbol[7]

XXXXXXXXXXXXXYXXXXXXXXX

XXXYYYXXXXXXXXXXXXXXXXX

XXXXXXXYXXXXXXXXXXXXXX

After applying RLE data compression algorithm in above example after scan line we get 12X1Y12X3Y24X1Y14Y. This can be interpreted as 12 Xs, 1Y, 12 Xs, 3Ys etc. The RLE identifies 67 characters only 18. But actually image data is represent in binary rather than ASCII format but we can apply same procedure to them also initialize code to string dictionary to contain the single symbol string that can be generated these using these code and can provide better flexibility in code. Run length coding is easy to implement and provide better image quality after image compression and decoded image .

VI. LOSSY COMPRESSION

Lossy compression helps to provide high compression ratio as compare to lossless. The compressed image is not same as original image , loss of some amount of information is there . Lossy compression can applied on images like photographic in which reduction in pixels value is not generally visible to human eyes. Lossy compression techniques are JPEG, JPEG2000 and Fractal Algorithm

JPEG: JPEG stands for Joint Photographic Experts Group. A property in most of images is that the image pixels are related and therefore comprise duplicate information. Here main objective becomes is to extract less related information in representation of image. Two primary attributes of image compression are redundancy and irrelevant reduction. Reducing irrelevant redundancy aims to removing duplication from the source. Irrelevance reduction remits parts of the signal. It cannot discern by the signal receiver named as Human Visual System (HVS) in which humans cannot understand slight differences made in image. JPEG methods are mostly recognized and easy to use image compression standard. JPEG standard is established by ISO (International Standard Organizations) and IEC (International Electro Technical commission) [8].

JPEG 2000: JPEG 2000 is wavelet based coding and an image compression standard. It was introduced by The Joint Photographic Experts Committee in 2000 with the requirement of discarding their transformation base JPEG standard developed in 1992 and have completely designed wavelet transmission based method. The JPEG 2000 compression allows the use of discrete wavelet transformation to compress image source. Nowadays advancement achieved in compression performance of JPEG 2000 as relate to JPEG is much

The major increment offered by JPEG 2000 is its flexibility of the code stream. [9].

Fractal Compression: Fractal image compression was introduced in 1980s. FIC is used for compressing and decompressing photographic images. Fractal method is based fixed point theorem for iterated function system containing a group of contraction transformation. A factor image compression algorithm first dividean image into 8*8 non overlapping, called range blocks and collect them to forms a domain pool contain overlapped 16*16 blocks. For single block it exhaustively searches in a domain pool of blocks for a matched domain block having minimum square error after a block having condition minimum square error after a transformation is applied to the block [10]. A fractal image compression code for a domain block pool consists of quantized factors in the affine transformations. The decoding is to identify the static point, in the image and starting with any original image. The technique will be applied on a local transformation on the domain block pool corresponding to the position of a range block until all of the decompression domain blocks are purposed. The above technique has to repeat iterated. There is occurrence of mainly two restrictions in fraction compression are computation expectations and problem of best range index identification. The most attractive property is the decompression property. We can also enlarge an image size by decompression of an image of reduced size so that the compression ratio increased and can get image with better quality [11].

VII. PERFORMANCE PARAMETERS

Above presented techniques will be evaluated based on certain parameters. Because during compression process quality of image will not compromised. Quality of image can be measured using various parameters. Mostly used parameters are Compression Ratio (CR), Mean Square Error(MSE), Peak Signal Noise Ratio(PSNR), Bits Per Pixel(BPP)[12].

Peak Signal Noise ratio: PSNR is a parameter used to compare the subjective criteria of original image, basically it a quality measure of an image. Its equation is:

$PSNR(dB)=10log_{10}(255^2/MSE)$

PSNR=

Where MSE is mean square error explained below

Compression Ratio: Compression Ratio is defined as the ratio between original image sizes to the compressed image size.

$$CR = \frac{\text{Original Image Size } (I_1)}{\text{Compressed Image Size } (I_2)}$$

Mean Square Error (MSE): MSE is error metrics used to compare in different compression techniques.

MSE=$1/mn \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} (X(i,j) - X'(i,j))^2$ Σ

X (I,j) is the original image, X‟ (i,j) is the compressed image and m*n is the dimension of image.

Bits per Pixel (BPP): Bits per pixel provide us number that can be able to store in single pixel of the given image[12].

$$BPP = \frac{\text{MSE of Compressed Image}}{\text{Total number of pixels in image}}$$

VIII. CONCLUSION

Instead of transmitting the compressed image at a full resolution it becomes more efficient to deliver a part of bit stream that approximate of the original image first. Image compression is mainly a trade between compression ratio and Peak signal noise ratio. Thus Improved compression algorithm much is very in demanding in image compression field to reduce compression ratio. Scope exists for new techniques as well. In this paper review and discussion about all techniques are presented and according to our image type we can select best compression technique.

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