Fence Downsampling Technique for Image Compression

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***Abstract*— Image compression technique is the most frequently used technology. Researchers have been looking for more efficient methods to compress the images challenging the previous methods of oversampling. In this paper a technique has been proposed that first downsamples the image then subsamples it for compression. The downsampling technique used in this paper is the fence-downsampling technique. Then the fence-downsampled image matrix is compressed using a already existing third party compressor. The third party encoder presented in this paper uses the discrete cosine transform and then the resultant image is quantized and then encoded. The encoder used is the run length encoder. The decoder first decompresses the image using third party decompressor then upsamples the image. The PNSR value obtained using the fence-downsampling technique is better than that of the JPEG compression technique.**

I INTRODUCTION

Image processing is field where the digital images are analysed or processed or manipulated in such a manner that the resultant image is a better quality image. Image compression is a methodology that is used to extract only the important information that is required to represent an image. This methodology helps reduce the file size of the image which conserves the memory resource and the bandwidth resource which are the limited resources available. Image compression technique has been a boon to the technology where a large number of images have to be stored and transmitted every second. Image compression makes it easier to transmit images using very less bandwidth and store those compressed images in a very less memory space.

Image compression is divided into two compression techniques namely lossy compression method and lossless compression method. The lossy compression technique is the one in which the decompressed image losses some of the important information which is required to represent the image. the lossless compression technique is the one in which the important information needed to represent the image is conserved and not lost. In other words there is no loss of data while the image is compressed. The quality for visualization of the image is the same as the original.

In this paper, the proposed technique is nearly lossless compression technique. The quality for visualization of the image is not affected when the image is reconstructed. The fence-downsampling process is used here which helps to reduce the redundant data in the image. Once the downsampling is done, the fence-downsampled image is processed further by applying the third party compression technique which first divides the image into 8x8 matrices. Then each 8x8 matrix is processed separately. This is done so, so that there will be no computational overhead which would have been so if whole image is processed at once.

The 8x8 matrix is transformed using discrete cosine transform. Periodic function is the sum of sines and/or cosnines of various frequencies, each multiplied by different coefficients. This series is the fourier series. In the discrete cosine transform, only the cosine is used where the real part of the fourier series is present. Sine consists of imaginary part of the fourier series. Discret cosine transform(DCT) is used to transform the image from spatial/time domain to frequency domain .

The reason why the discrete cosine transform has been used is that for a typical image, colors and the intensity values do not change abruptly between pixels and hence the transformation on observation shows that most of the information about the image which is visually significant is concentrated in just few coefficients of the dct. One of the advantages of using dct is that it can be reconstructed completely via an inverse process, with no loss of information.

Human eye is quite good at observing slight difference in brightness over a relatively large area, but it is not that good at differentiating the exact strength of a high frequency brightness variation. This allows the user to reduce the amount of information required to represent an image by ignoring the high frequency components. Then the quantized matrix is entropy encoded.

The encoder presented in this paper is the run length encoder. The run length encoder is a lossless encoder. No information is lost while encoding the quantized image. The scanning order used here is the zigzag order scan. The result when the run length encoder is executed is two one-dimensional arrays that contain the image pixels and pixel count respectively.

The decoder decompresses the previously compressed image using the third party decoder. The decompressed image is then upsampled to get a higher resolution image. The restored image will have a resolution same as the input original image.

Fig. 1 shows a block diagram for the proposed technique of fence-downsampling technique for image compression. Input image is first downsampled using the fence-downsampling technique with an integer factor. As the Fig. 1 shows fence-downsampling technique is applied in collaboration with JPEG compression technique.

The proposed method gives a better PSNR value than the JPEG compression technique. it has a better visual quality.

II REVIEW OF LITERATURE

Weisi Lin et. al[6] has proposed a system that at low bit rates, by down-sampling the image prior to the image compression, and by doing portion estimation that is missing after decompression, better coding standard can be achieved. A new algorithm is presented to achieve the above method. Here standard gray-scale images were used during the performed experiments.

A.M.Raid et. al[7] presents the Discrete-Cosine-Transform (DCT) based image compression. The authors experiment the lossy compression technique using the DCT method. Image space can be mapped into a frequency using DCT. Block based DCT is performed and each block size is 8 x 8 [img ref7]. The encoder consists of three main parts, forward DCT, quantization and entropy encoding.

Pao-Yen Lin [11] introduces the JPEG and MPEG standards. The basic idea for the compression of data is to decrease the data correlation. By applying Discrete-Cosine Transform (DCT), the data in time/spatial domain can be converted into frequency domain.

Bing Zing et. al[9] presents two novel approaches for upsampling using depth map. A depth upsampling process using image decomposition is proposed by the authors. Most of previous depth upsampling methods proposed have discussed the use of colour image as a guide.

This paper is organized as follows. Section I describes the preview of the image compression and the overview of the proposed system of image compression. Section 2 gives the review of the literature. Section 3 presents the methodology and the main contribution of the paper, Fence-downsampling. We then report the conclusion in section 4.

III Methodology

The motivation of compression of data is using very less amount of data to represent the actual data without losing any of them. In this paper, an integer factor of 2 is used for fence-downsampling. This is where the image size is reduced dramatically. Since a factor of 2 is used. The image size is already reduced to half. The downsampled image is then divided into 8x8 matrices. Each 8x8 matrices are processed separately.

Fig 2 shows the graphical representation of downsampling. The sampling rate is reduced by an integer factor in the downsampling technique. Fence-Downsampling reduces the pixels column wise hence fence-downsampling. As represented in the Fig 2, the sampling rate of the image signal is reduced. By reducing the sampling rate, bit rate also reduces.

Discrete-cosine-transform is then performed on the fence-downsampled 8x8 blocks. Dct transforms the image from spatial/time domain to the frequency domain. The formula for discrete cosine transform is as shown in (1).

$$c(u,v) = \alpha(u)\alpha(v)\sum_{x=0}^{N-1}\sum_{y=0}^{N-1} f(x,y)\,A \qquad (1)$$

$$A = \cos\frac{\pi(2x+1)u}{2N}\cos\frac{\pi(2y+1)v}{2N} \qquad (2)$$

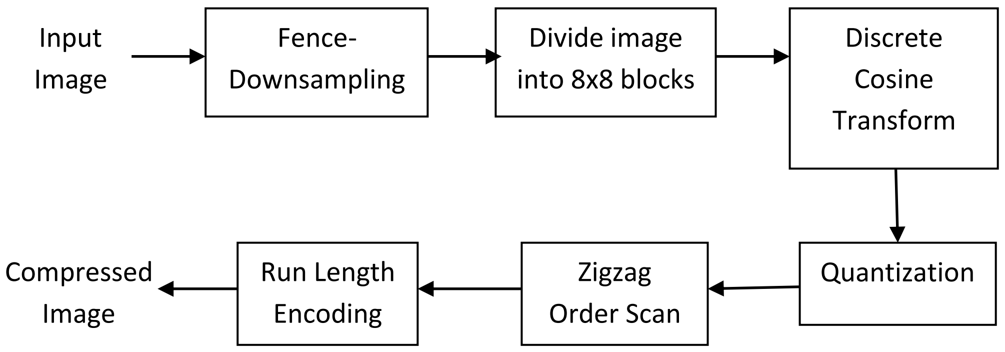

Fig 1: System architecture for the proposed system of fence-downsampling technique for image compression.

The discrete cosine transforms works for pixel values between -128 to 127. Hence before dct is applied, subtract 127 from each of the pixel intensity in each block. The above formula is applied to every block. By observing the resultant block, it is noticeable that visually important information about the image is accumulated in just a few coefficients of the discrete-cosine-transform.

The starting pixel of the DCT applied block will have a larger value than the other pixel values in the image block as it contains most of the information in it. The other few pixel values will have less information in it. It also means that the low frequency information is stored in the left top comers of the blocks. However the other pixel values will have values which are nearing to zero or which are negligible, which means that it has high frequency information.

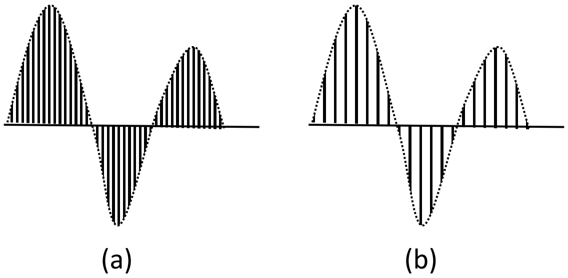

Fig 2: The difference between the original image signal and the decimated image signal. (a). Over-sampling of original image signal and (b). Downsampling of original image signal.

The next step is to quantize the DCT image block. Each coefficient we get is divided by some number which we call as quantization factor. Quantization factor can be any integer number. Then it is rounded off to its nearest number. This is the step where huge space saving is done. Since quantization step is done in frequency domain, this loss of accuracy does its best preserving visual image quality.

Next step is the scanning step which is an important step in encoding. The scanning order presented in this paper is the zigzag order scan. The zigzag order scan takes matrix as input and returns 1-D array consisting of scanning result. Fig 3 shows the zigzag order scan used in this paper. During DCT, the low frequency information is highly concentrated in the top left corner of each 8x8 matrix block, and high frequency information is concentrated at the right bottom of the matrix block. Hence zigzag order scan is used which scans the matrix from top left corner of the matrix block through the matrix to the right bottom corner. It scans the low frequency information first which is most important information for the presentation of the image and the high-frequency information which is not necessary information for the representation of the image.

As shown in the Fig 1, the next step is the run-length encoding step. Run-length-encoding is lossless compression of data in which runs of data are stored as array of data value and count, instead of original run. This is a very useful array of data that consists of a number of such runs. These arrays are then used to decode the compressed image using run length decoding method. The arrays are used as lookup to reconstruct the matrix. The decoded array uses inverse zigzag order scan to produce a matrix out of the decoded array. The decompressed image then undergoes upsampling method which restores the fence-downsampled decompressed image to its original resolution. The system first decompresses the image which is fence-downsampled and compressed. Then the decompressed image is upsampled to get an image of original resolution.

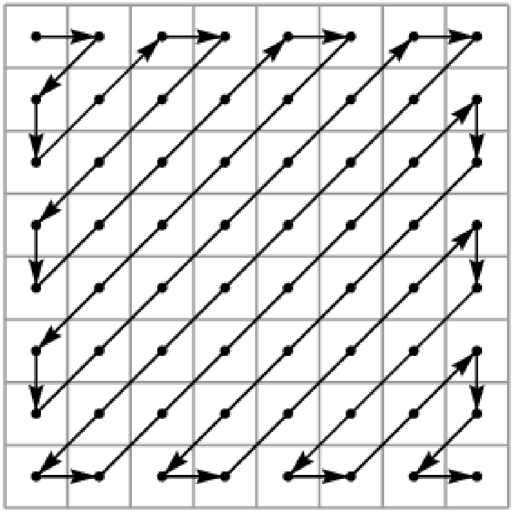

Fig 3: The zigzag order scan used in the proposed system.

IV RESULT AND DISCUSSION

Experiments were conducted to get a better visual quality images using the fence-downsampling method for image compression. The snapshot shown in Fig 4 is the snapshot when the system has read the input image. The user interface for the compression scheme is shown. Duck image is selected and compression. The system selects a grayscale image for image compression task. It is then divided into 8x8 matrix blocks and then passed through dct step. The Fig 5 presents the result of DCT performed on each 8x8 block matrices separately. Fig 6 shows the resultant matrix of DCT transformation for a single 8x8 matrix block. Most of the information is concentrated at the left top corner of the DCT block. The Fig 7 shows the quantized 8x8 block matrix. It can be clearly observed that the low frequency information is concentrated at the top-left corner of the block. At the right-bottom is the high frequency information.

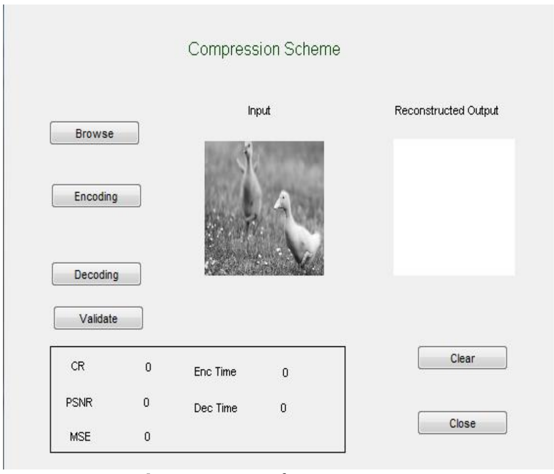

Fig 4: The input image for image compression.

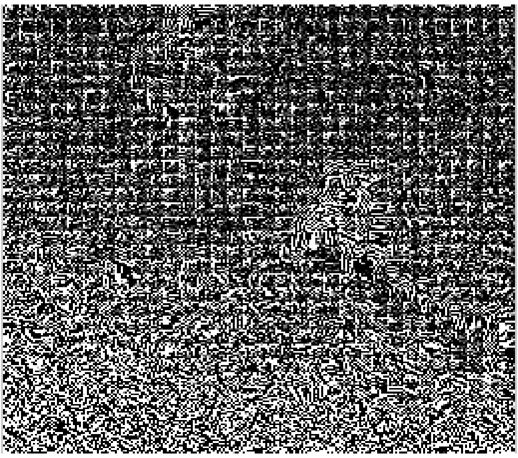

Fig 5: The image in frequency domain transformed using DCT.

The image is transformed from the spatial domain to the frequency domain as it is easier to work with images in frequency domain.

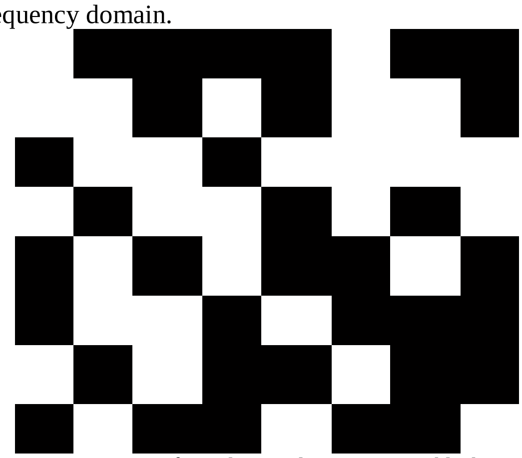

Fig 6: DCT performed on random 8x8 matrix block.

51	-4	-1	0	-1	0	0	-1
5	4	-1	0	0	0	0	-1
-2	3	1	-1	1	1	0	1
1	-3	1	0	-1	1	-1	1
-3	5	-2	2	0	-1	1	-1
0	0	1	-1	1	-1	0	0
0	0	1	-1	0	1	0	0
-1	0	0	0	0	0	0	0

Fig 7: The quantized image block where low frequency information is highly concentrated at the left-top corner.

V CONCLUSION AND FUTURE ENHANCEMENT

A new fence-downsampling technique is presented in this paper which has a better compression ratio than that of the jpeg compression scheme. The PSNR value is better than that of the jpeg compression. Our findings suggest that fence-downsampling is better than the oversampling method used in the yesteryears. The downsampling has a disadvantage of forming block artifacts. In the future system, the blocking artifacts has to be removed to get a better visual quality of the image.

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