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Lossless Image Compression Using Data Folding Followed By Arithmetic Coding

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Abstract : *The paper presents a lossless image compression technique using the hybridization of two different entropy coding techniques. Initially data folding technique has been applied to the image. A row folding is applied on the image matrix followed by a column folding. Multiple iterations of this process is applied on the image. After completing the data folding process another entropy coding technique known as arithmetic coding has been applied to the resultant image to get better results.*

Keywords: *Lossless image compression, data folding, arithmetic coding, compression ratio, bits per pixel.*

I. Introduction

Compression can be defined as reducing the size of data so that the amount of space required to store the data becomes less and it takes less time to transmit the data. With the help of compression it becomes easy to store large files. These files may be data files, images, videos, audios and other multimedia files. For transmitting a data, compression can be performed either on just the data content or on the entire transmission unit. There are different types of data content on which compression can be applied.

Image compression can be referred to as reducing the size of the image so as it requires less space for storage and is easily transmitted. This can be done by reducing the memory size required to store each pixel. There are several algorithms to perform image compression. These algorithms can be categorized as lossy and lossless compression techniques. Lossy compression causes loss of information after compression. When the compressed data is decomposed to its original version then both are not same but close. It is an irreversible process. In lossless compression the compressed data can be easily decomposed to its original version. The loss of data is very less. It is a reversible process.

Image compression techniques reduce the number of bits required to represent an image by taking advantage of these redundancies. An inverse process called decompression (decoding) is applied to the compressed data to get there constructed image. The objective of compression is to reduce the number of bits as much as possible, while keeping the resolution and the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks: an encoder and a decoder.

II. Compression Techniques

A. Quantization Technique

Quantization refers to the process of converting the continuous pixel values (such as decimal values) to discrete values (such as integers). The quantizer performs a lossy image compression. The input to a quantizer is the original data, and the output is always one among a finite number of levels. The quantizer is a function whose set of output values are discrete, and usually finite. This is a process of approximation, and a good quantizer is one which represents the original signal with minimum loss or distortion. The different types of quantization are–

- Scalar Quantization
- Vector Quantization.[7]

B. Entropy Coding Technique

After the quantization has been applied to the image, a symbol encoding technique is applied to the image. Entropy is the amount of information present in the data, and an entropy coder encodes the given set of symbols with the minimum number of bits required to represent them.[7] Entropy Coding techniques mostly provide lossless compression. Some of the entropy coding algorithms are-

- Huffman Coding
- Arithmetic Coding
- Run Length Coding
- Data Folding

C. Optimization Technique

The optimization techniques can effectively reduce the encoding time while retaining the quality of the retrieved. Various optimization techniques are listed below:

- Genetic Algorithm
- Particle Swarm Optimization
- Ant Colony Optimization

III. Proposed Technique

Hybridization of two lossless image compression techniques has been used to obtain better results. Data Folding technique has been applied to the image followed by another entropy coding technique i.e. Arithmetic Coding. These two techniques have been individually used earlier to provide lossless image compression. But using these two techniques in one algorithm are supposed to provide better Compression Ratio (CR) and lesser Bits Per Pixel (BPP). Though none of the technique can be considered as completely lossless but using these techniques the loss has been expected to be minimum.

A. Data Folding

Data folding is a very effective algorithm that can be used for lossless image compression. The simple method applied on the image is to subtract the even pixels from odd pixels and the store this difference in a separate buffer. This one step is known as folding. Then further folding is applied to pixel values stored in the separate buffer. In this way, a number of iterations have been applied to the data. The process of data folding consists of two steps:

- Row Folding
- Column Folding

Row folding is the process of folding the rows of the image matrix. Even row is subtracted from the odd row. Then the resultant odd row is stored in a separate buffer. Then column folding is applied on the data stored in this buffer. Column folding is the process of folding the columns of the image matrix. After making a row folding even column is subtracted from the odd column. Then the resultant odd column is stored in a separate buffer. Then further iterations of row folding followed by column folding are applied on the data stored in this buffer.

Fig.1 Image Matrix

Fig.2 Image after 1st Row Folding

Fig.3 Image after 1st Column Folding

B. Arithmetic Coding

After applying the technique of data folding, an entropy coding technique has been used. This entropy coding technique is known as arithmetic coding. In this approach, the entire source symbol is assigned a single arithmetic code. Initially all the symbols are defined inside a fixed window size of (0, 0.5) and arranged according to their probability distribution. All the pixels lying within the interval are used to represent the image and others are removed. Then the window size is narrowed and again the symbols are arranged according to

their probability distribution. All the pixels lying within this narrowed range are used to represent the image and others are removed. This process is being repeated for 6 times.

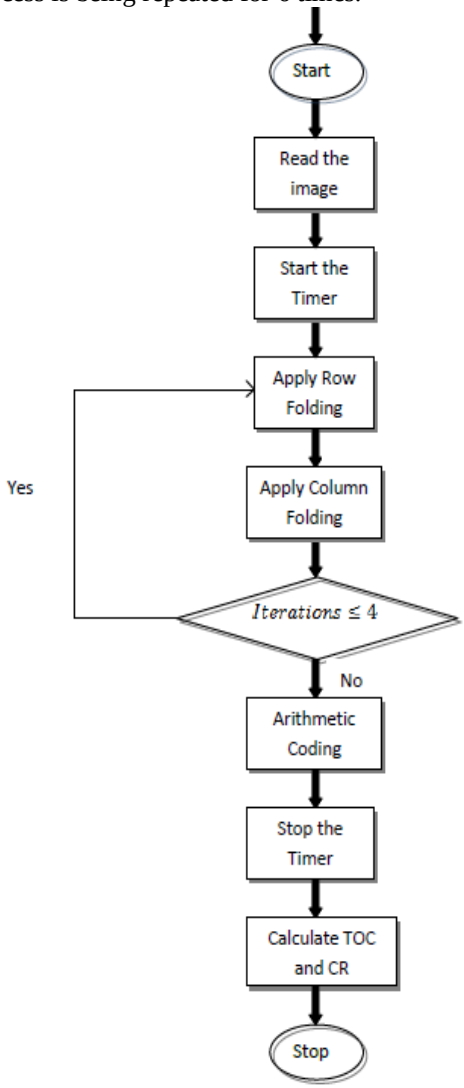
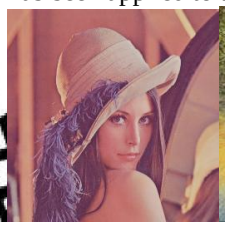


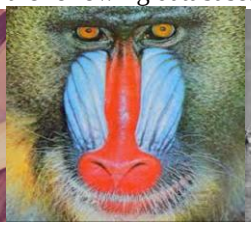
Fig.4 Flow Chart for Compression Procedure

IV. Results

The proposed technique has been applied to the following database:

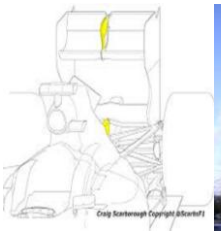

Cmp5 text.jpg


Leena.jpg


Baboon.jpg


Boat.jpg

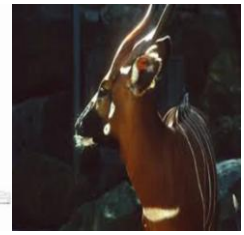

Elaine.jpg


Pod rear draw.jpg


Cathedral.jpg


Flower.jpg


Temple.jpg


Deer.jpg

Fireworks.jpg **Leaves.jpg**

Fig.5 Database being used

After applying the proposed technique on the above database following observations has been concluded on the basis of bits per pixel (BPP):

Image	Wavelet	Huffman Coding	Data Folding	Proposed Technique
Cmp5 txt 256X256	2.5	2.13	6.31	1.11
Baboon 512X512	1.28	1.5	7.22	1
Boat 512X512	1.003	0.946	5.84	0.638
Elaine 512X512	3.986	3.84	5.86	3.07
Pod rear draw 512X512	0.584	0.627	2.28	0.229
Cathedral 1024X1024	0.618	0.796	5	0.534
Flower 1024X1024	0.581	0.594	2.95	0.326
Temple 1024X1024	0.233	0.328	2.66	0.198
Deer 2048X2048	0.249	0.231	4.47	0.203
Fireworks 2048X2048	0.308	0.56	2.4	.287
Leaves 2048X2048	0.504	0.516	5.78	0.426

Table 1 Results based on BPP

V. Conclusion

We had analysis the different compression techniques and concluded that these techniques are either lossy or lossless. After this analysis we have proposed a lossless image compression technique known as data folding followed by arithmetic coding. In this technique we have performed the hybridization of these two techniques. First row folding followed by column folding has been performed, after that arithmetic coding has been applied on the resultant image. This technique has been applied on different images of different dimensions. This technique gives better results in terms of Compression Ratio and Bits Per Pixel. But this technique has the problem of high computational time.

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