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Lossy Hybrid Binary Merge Coding for Image Data Compression

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Abstract: Image processing applications were drastically increasing over the years. In such a scenario, the fact that, the digital images need huge amounts of disk space seems to be a crippling disadvantage during transmission and storage. So, there arises a need for data compression of images. This sutdy proposed a novel technique called Lossy Hybrid Binary Merge Coding for Lossy compression of images. This method is based on spatial domain of the image and it works under principle of Inter-pixel redundancy reduction. This technique was taken advantage of repeated values in consecutive pixels positions. For a set of repeated consecutive values only one value is retained. The proposed Lossy Hybrid Binary Merge Coding achieved the compression rate more than the compression rate achieved by standard JPEG. This technique was simple in implementation and required no additional memory area. The experimental results of Lossy Hybrid Binary Merge Coding were compared with standard JPEG and it showed that the Binary Merge Coding improved compression rate compared to JPEG. The same algorithm can be extending to colour images. This algorithm can also used for Lossless compression with few modifications.

Key words: Binary Merge Coding (BMC), huffman coding, difference coding, JPEG, bit plane, data table

INTRODUCTION

Data compression is a technique of encoding information using fewer bits than an un encoded representation would use through specific encoding or compression algorithms (Abramson, 1963). All forms of data, which includes text, numerical and image contain redundant elements. Through compression, the data can be compressed by eliminating the redundant elements.

The history of image data compression started probably about a half of century ago with the works on predictive coding and variable length codes. The technological breakthrough that took place in 60's, 70's and 80's resulted in efficient compression algorithms (Rafael *et al*., 2007; Jayant, 1992) that have been standardized in early 1990's and currently are in common use together with the improvements achieved during the last decade. These advances have brought substantial increase in efficiency of earlier basic techniques. Nevertheless, the last decade was also, a period of strenuous search for new technologies of image data compression.

This study discusses about the proposed Lossy Hybrid Binary Merge Coding approach for compression and decompression. In this study, we also presented experimental results and finally the study concludes.

Lossy hybrid binary merge coding: In this technique, the quantization is shown in Fig. 1 is applied to reduce number of possible values of pixels, there by reducing the number of bits needed to represent it.

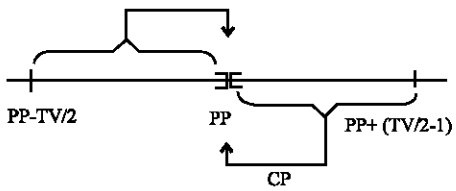

Fig. 1: Quantization used in lossy technique, Previous Pixel (PP), Current Pixel (CP) and Threshold Value (TV)

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The quantizer (Subhash *et al*., 2009a) used in the Lossy Hybrid Binary Merge Coding takes a threshold value, which is varied between 4 and 32 to control the degree of quantization. The approximation for the current pixel is made based on the TV. The current pixel is approximated to previous pixel if the Current Pixel with the range as:

$$(PP-TV/2) \geq CP \leq (PP+TV/2-1)$$

There is a trade off between image quality and degree of quantization. A large quantization step size can produce unacceptably large image distortion. Finer quantization leads to lower compression rate. JPEG (Skodras *et al*., 2001) uses a much higher step size for the high frequency coefficients with little noticeable image deterioration (Subhash *et al*., 2008).

MATERIALS AND METHODS

Method of approach for compression: In the Lossy Hybrid Binary Merge Coding, two codes are used to build the Bit Plane. The codes are given as:

Code 1: It is used to indicate that current pixel is different from previous pixel. In this case, the current pixel is moved to the data table.

Code 0: It is used to indicate that the current pixel is exactly same as previous pixel or within the threshold limit used. This eliminates the storage of current pixel.

After generating and merging the bit plane and data table, the difference coding (Wei and Chinya, 2003) and huffman coding (Shannon, 2001) are applied in the same order is shown in Fig. 2, to generate final form of compressed file.

Compression algorithm for lossy hybrid binary merge coding:

```
Procedure
Lossy_Hybrid_Binary_Merge:
Begin:
    // Generates bit plane and data tables
call
Lossy_Binary_Data_Compress () // Merges the bit plane and data table
call Lossy_Binary_Data_Merge () //converts the data suitable to huffman
coding
call DIFFERENCE_CODING ()
      // Generates the final form of compressed file
 call HUFFMANCODE ()
End
```

Method of approach for reconstruction of the image: In the reconstruction of image the Bit Plane (Subhash *et al*., 2009b) and data table (Subhash *et al*., 2009 a, b) are built from compressed file using inverse huffman coding and inverse difference coding. Each byte from bit plane file is read and each bit is checked. If the bit is 1 then a fresh byte from data table is read and written to the reconstructed image file otherwise, instead of reading fresh byte the previous byte read itself is written to the reconstructed image file. The block diagram of the Reconstruction model is shown in Fig. 3.

Reconstruction algorithm for lossy hybrid binary merge coding:

```
Procedure
Lossy_hybrid_binary_merge_reconstruction ():
Begin:
      // To retrieve intermediate file from Huffman format
call Inverse_Huffmancode ()
      // To retrieve intermediate file from difference format
      Call
Inverse_Difference_coding ()
      // To separate the bit plane and data tables
call
      Lossy_Binary_Data_Demerge ()
      // To build original image from bit plane and data table
call
      Lossy_Binary_Data _Decompress ()
End
```

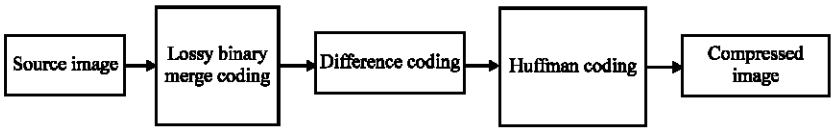

Fig. 2: Lossy binary merge coding image compression model

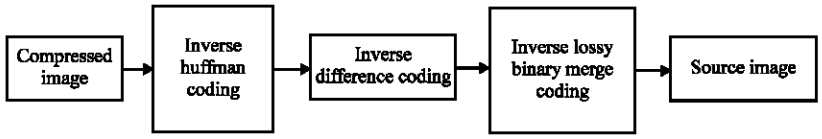

Fig. 3: Lossy hybrid binary merge coding image reconstruction model

Table 1: The size and compression rate of JPEG, BMC and hybrid BMC compression approaches

		JPEG		BMC		Lossy hybrid BMC	
Image	RAW	Size	Comp rate	Size	Comp rate	Size	Comp rate
Brain	12610	15109	0.835	8424	1.497	5278	2.389
Head scan	15625	15184	1.029	14041	1.113	6909	2.262
Madhuri	16384	15293	1.071	16114	1.017	6353	2.579
Foot	16740	16144	1.037	8536	1.961	5990	2.795
Chest x-ray	18225	16180	1.126	18262	0.998	7842	2.324
Knee joint	18225	17193	1.06	14382	1.267	9631	1.892
Shoulder	18225	16962	1.074	13831	1.318	7901	2.307
Lena	49152	18509	2.656	21139	2.325	13244	3.711

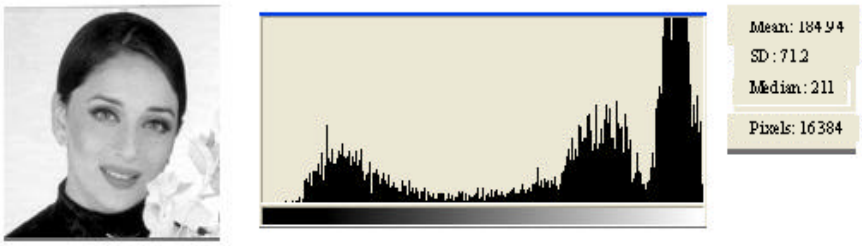

Fig. 4: Histogram and statistical information for Madhuri image

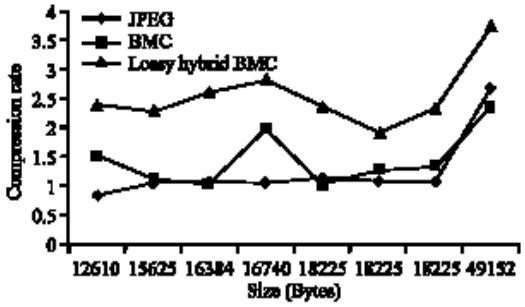

Fig. 5: Graph for the comparison between Compression rates of JPEG , BMC and lossy Hybrid BMC Compression Techniques

RESULTS AND DISCUSSION

The Madhuri image is taken as a sample source image and applied Lossy Hybrid Binary Merge Coding to compression and decompression. The reconstructed image, its histogram and statistical information are shown in Fig. 4.

The generated results after executing Lossy Hybrid Binary Merge Coding are given in the Table 1. The memory requirement for BMC technique is very less compare to JPEG, because the processing is done byte by byte.

In the case of JPEG the entire image needs to be brought into memory. As per as the process complexity is concerned, the Lossy Hybrid Binary Merge Coding is simple to implement comparatively JPEG in Table 1.

CONCLUSION

In Lossy technique, by varying threshold value, the different compression rate can be achieved. More the value of threshold, more will be the compression rate and also more will be the degradation in quality of the image. In the results shown above for Lossy Hybrid Binary Merge Coding the threshold is set as 8 (–4 to +3). If it is varied between 4 and 32 the compression rate is modified and quality of the image changes.

The Lossy Hybrid Binary Merge Coding produces much higher compression rate than all the three techniques but introduces little loss. The loss is visually insignificant when the threshold value is 4 or 8. When, the threshold is 16 or 32 the loss is visually observable.

The compression rate of Lossy Hybrid Binary Merge coding is better than Binary Merge Coding and more better than JPEG.

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