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A Combined Approach to Increase the Performance of Image Compression

M.Sivasankar[1*], A.Nagavaratharajan[2] and J.Porkodi[3]

[1&2] Assistant Professor, Dept of E-commerce, VHNSN College (Autonomous), Virudhunagar, India.
[3]Assistant Professor, Dept of Information Technology, VVV College for women (Autonomous), Virudhunagar, India.
[*]Corresponding author email: sivasankar043@gmail.com

Abstract

The availability of images in different applications is augmented owing to the technological advancement which cannot impact on several image operations, on availability of sophisticated software tools that manipulate the image management. Compression is a method for storing easier for large amount of data by dropping the amount of bits to pile up and pass on digital media. Therefore, Image compression has proved to be a valuable technique as one solution. In this paper, a quick lossless compression method like Huffman and LZW method is implemented which consists of two stages. In the initial phase, a Huffman coding is used to compress the image. In the later stage all Huffman code words are mergted together and compressed with LZW coding. This procedure is easy in performance and use a lesser amount of memory. Image compression algorithms have been proved and applied to compress and decompress the image by MATLAB environment.

Keywords: Lzw, unified algorithm, huffman.

Introduction

Image processing is any form of signal processing for which the input is an image, consists of large number of pixels and a high number of bits per pixel, the image such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics related to the image.

Generally images are classified as many types like TIFF (Tagged Image File Format) is a flexible format that can be lossless or lossy compression (John Miano, 2000). The primary limitation of a GIF is that it only works on images with 8-bits per pixel or less, which means 256 or fewer colors. Most color images are 24 bits per pixel (Cameron Newham, Bill Rosenblatt, 2005). Portable Network Graphics (PNG) is a file format for lossless image compression. Typically, an image in a PNG file can be 10% to 30% more compressed than in a GIF format (Cameron Newham and Bill Rosenblatt, 2005). Joint Photographic Expert Group (JPEG) is an excellent way to store 24-bit photographic images, such as those used for imaging and multimedia applications. JPEG 24-bit (16 million color) images are superior in appearance to 8-bit (256 color) images on a Video Graphics Array (VGA) display and are at their most spectacular, when using 24-bit display hardware (which is now quite inexpensive) (Sindhu and RajKamal 2009). RAW refers to a family of raw image formats (output) that are options available on some digital cameras (Skodras *et al.,* 2001).

Image Compression

Image compression is an application of data compaction that can reduce the quantity of data. In a raw state, images can occupy a large amount of memory both in RAM and in storage. Image compression reduces the storage space required by an Image and the bandwidth needed when streaming that image across a network (G. K. Wallace.1992). The image compression techniques are broadly classified into two categories depending whether or not an exact replication of the original image could be reconstructed using the compressed image.

These are:

1. Lossy technique
2. Lossless technique

Lossy schemes provide much higher compression ratios than lossless schemes. Lossy schemes are widely used since the quality of the reconstructed images is adequate for most applications. By this scheme, the decompressed image is not identical to the original image, but reasonably close to it. Major performance considerations of a lossy compression scheme include:

1. Compression ratio
2. Signal - to – noise ratio
3. Speed of encoding and decoding.

In lossless compression techniques, the original image can be perfectly recovered from the compressed image. These are also called noiseless since they do not add noise to the signal. It is also known as entropy coding since it use decomposition technique

Related Work

Yu-Ting Pai, Fan-Chieh Cheng, Shu-Ping Lu and Shanq-Jang Ruan proposed a technique in "Sub-trees Modification of Huffman Coding for stuffing Bits Reduction and Efficient NRZI Data Transmission". They mainly focused on the data transmission and multimedia compression and considered this problem as the encoding of compression and transmission to develop a low bit rate transmission scheme based on Huffman encoding (Gonzales and Woods, 2008). The proposed method could balance "0" and "1" bits by analyzing the probability of the mismatch in the typical Huffman tree. Moreover, the proposed method also modified the transitional tree under the same compression ratio. Experimental results have showed that the proposed method could reduce the stuffing bits to 51.13% of standard JPEG compression.

In "A Hybrid Algorithm for effective Lossless Compression of Video Display Frames" the authors Huang-Chih Kuo and Youn-Long Lin were proposed a simple and effective lossless compression algorithm for video display frames (Lakhani and Ayyagari, 1995). They combined the dictionary coding, the Huffman coding, and innovative scheme to achieve a high compression ratio. They quantitatively analyzed the characteristics of display frame data for designing the algorithm. First, a two-stage classification scheme to classify all pixels into three categories was proposed. Second, employ the dictionary coding and propose an adaptive prefix bit truncation scheme to generate codeword's for video pixels in each category. And subsequently, employed the Huffman coding scheme to assign bit values to the codeword's. Finally, they proposed a head code compression scheme to further reduce the size of the codeword bits. Experimental results show that the proposed algorithm achieves 22% more reduction than prior arts.

Methodology

This system proposes a compression technique using the two lossless methodologies Huffman coding and Lempel Ziv coding to compress image. In the first stage, the image is compressed with Huffman coding resulting the Huffman tree and Huffman code words. In the second stage, all Huffman code words are concatenated together and then compressed by using Lempel Ziv coding. Normally, the Huffman tree and Huffman code words are stored to recover the original image. In the proposed technique, the Huffman code words are applied compression using the Lempel Ziv coding to reduce size. From the experiment results it is observed that the size of the data reduced further. To recover the image data, first decompress the image data by Lempel Ziv decoding technique and as a second step apply Huffman decoding.

a) Lzw Coding

In the second step concatenate all the Huffman codewords and apply the following LZW encoding algorithm. A high level view of the encoding algorithm is shown here .

1. Initialize the dictionary to contain all strings of length one.
2. Find the longest string W in the dictionary that matches the current input.
3. Emit the dictionary index for W to output and remove W from the input.
4. Add W followed by the next symbol in the input to the dictionary.
5. Go to step 2.

The concatenated huffman codewords are

000101110001011111000101000011011011100111101011111110

b) Lzw Decoding

The decoding algorithm works by reading a value from the encoded input and Outputting the corresponding string from the initialized dictionary. At the same time itobtains the next value from the input and adds to the dictionary the concatenation ofthe string obtained by decoding the next input value (which was already read in as the“next value” in the previous pass) and repeats the process until there is no more input, at which point the final input value is decoded without anymore additions to thedictionary(14). The result is the concatenated Huffman code words i.e. 000101110001011111000101000011011011100111101011111110.

c) Huffman Decoding

After the code has been created, coding and/or decoding is accomplished in a simple look-up table manner. The code itself is an instantaneous uniquely decodable block code, it is called a block code, because each source symbol is mapped into a fixed sequence of code symbols. It is instantaneous, because each code word in a string of code symbols can be decoded without referencing succeeding symbols. It is uniquely decodable, because any string of code symbols can be decoded in only one way . Thus any string of Huffman encoded symbols of the string in a left to right manner . After decoding the above Huffman codeword by using the Huffman tree we get the original message i.e., “13371545155135706347”.

d) Unified Algorithm Of Huffman And Lzw

This system basically consists of four steps namely, Huffman encoding, Lzw encoding, Lzw Decoding and Huffman Decoding. Inorder to undergo these steps, we have to follow the below given algorithm.

Step 1: Read the image to the workspace of the matlab.

Step 2:Call a function which will find the symbols (i.e., pixel value which is not repeated) and calculates the probability of each symbol.

Step 3: Probability of symbols are arranged in decreasing order and lower probabilities are merged and this step is continued until only two probabilities are left and codes are assigned according to rule that the highest probable symbol will have a shorter length code.

Step 4: Further Huffman encoding is performed i.e. mapping of he code words to the corresponding symbols will result in a Huffman codewords.

Step 5: Concatenate all the Huffman code words and apply Lzw encoding will result in Lzw Dictionary and final encoded values (compressed data).

Step 6: Apply Lzw decoding process on final Encoded values and output the Huffman code words.

Step 7: Generate a tree equivalent to the encoding tree .

Step 8: Read the input character wise and left to the table until last element is reached in the table.

Step 9: Output the character encodes in the leaf and returns to the root, and continues the table until all the codes of corresponding symbols are known.

Step 10: The original image is reconstructed i.e., decompression is done by using Huffman decoding.

Proposed Flowdiagram

The flowchart for the proposed scheme is as shown below:

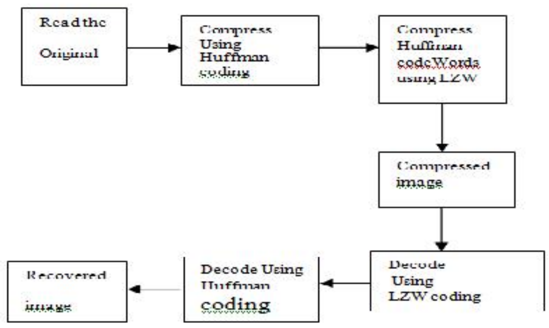

Fig 1. Proposed Flow Diagram

Experimental Results

Four type of sample images with various sizes are taken and experimented with the HL Scheme. The experimental results of those sample images are given below:

Image name	Size in bytes	Compressed size using Huffman coding	Compressed size using HL scheme
Lena 16	2048	1512	1224
Lena 32	8192	6542	3808
Lena64	32764	23952	10136
Lena128	131072	94975	28456

Table 1: Compressed size of image using Huffman coding and HL scheme.

The image with the size 2048 bytes is compressed to a size of 1512 bytes using Huffman coding and 1224 bytes using HL scheme. The image with the size 8192 bytes is compressed to a size of 6542 bytes using Huffman coding and 3808 bytes using HL scheme. The image with the size 32764 bytes is compressed to a size of 23952 bytes using Huffman coding and 10136 bytes using HL scheme. The image with the size 131072 bytes is compressed to a size of 94975 bytes using Huffman coding and 28456 bytes using HL scheme

Image name	Compression ratio Hc (%)	Compression ratio by HL scheme (in %)	Difference
Lena 16	78	64	16
Lena 32	81	46	36
Lena64	73	31	42
Lena128	72	22	50

Compression ratio of the first sample image in Huffman coding is 74% and that of HL scheme is 60%. The difference between the two approaches is 14. Compression ratio of the second sample image in Huffman coding is 80% and that of HL scheme is 46%. The difference between the two approaches is 34. Compression ratio of the third sample image in Huffman coding is 73% and that of HL scheme is 31%. The difference between the two approaches is 42. Compression ratio of the fourth sample image in Huffman coding is 72% and that of HL scheme is 22%. The difference between the two approaches is 50.

From the above Table 1, it is observed that the proposed compression scheme outperforms the Huffman coding and also improves the efficiency of the Huffman coding up to a great extent of 50 percentage compression ratio.

Conclusion and Future Enhancement

This system confirms that the higher redundancy helps to achieve more compression. The above presented new compression and decompression technique called as HL scheme based on Huffman coding and Lempel Ziv coding is very efficient technique for compressing the image to a great extent, as observed from the results of the experiment from table 8, the proposed scheme achieves at the most 50 percentage compression ratios to the Huffman coding. The HL scheme also results in an algorithm with significant time and advantage become most apparent for images with more in size. Since the reproduced image and the original image are equal; the HL Scheme is a lossless compression scheme. As a future work more focus shall be on improvement of compression ratio.

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