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JPEG and Sequential Search Algorithm applied on Low-Frequency Sub- Band for Image Compression (JSS)

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Abstract. In this research we introduce and idea for image compression, based on JPEG technique and Sequential Search Algorithm, at first using Discrete Wavelet Transform (DWT) to obtain LL sub-band, then apply JPEG technique on the LL sub-band. JPEG technique consist of; JPEG Transformation, and JPEG Coding. The LL sub-band transformed by JPEG transformation for obtaining more compression ratio. Before apply JPEG coding, our algorithm used feedbacks system for inverse JPEG transformation to get decoded LL sub-band, and then the difference between decoded LL and original LL are stored in a new matrix called D-Matrix, finally the D-Matrix compressed by Sequential Search Algorithm. The Decompression algorithm consists of; Inverse JPEG transformation to get decoded LL, Sequential Search Algorithm to find D-Matrix, Add D-Matrix with the decoded LL and apply inverse DWT to get decompressed image. Our algorithm tested on two different gray level images and compared with JPEG and JPEG2000.

Keywords: Discrete Wavelet Transform, JPEG Technique, Minimize Algorithm, Sequential Search Algorithm

1. Introduction

Since the mid-80s, members from both the International Telecommunication Union (ITU) and the International Organization for Standardization (ISO) have been working together to establish a joint international standard for the compression of grayscale and color still images. This effort has been known as JPEG, the Joint Photographic Experts Group the "joint" in JPEG refers to the collaboration between ITU and ISO) [1,2,4,5]. Officially, JPEG corresponds to the ISO/IEC international standard 10928-1, digital compression and coding of continuous-tone (multilevel) still images or to the ITU-T Recommendation T.81. The text in both these ISO and ITU-T documents is identical. The process was such that, after evaluating a number of coding schemes, the JPEG members selected a DCT1-based method in 1988. From 1988 to 1990, the JPEG group continued its work by simulating, testing and documenting the algorithm. JPEG became a Draft International Standard (DIS) in 1991 and an International Standard (IS) in 1992 [5,6]. Lossy compression is compression in which some of the information from the original message sequence is lost. This means the original sequences cannot be regenerated from the compressed sequence. Just because information is lost doesn't mean the quality of the output is reduced [8]. For example, random noise has very high information content, but when present in an image or a sound file, we would typically be perfectly happy to drop it. Also certain losses in images or sound might be completely imperceptible to a human viewer (e.g. the loss of very high frequencies). For this reason, lossy compression algorithms on images can often get a factor of 2 better compressions than lossless algorithms with an imperceptible loss in quality. However, when quality does start degrading in a noticeable way, it is important to make sure it degrades in a way that is least objectionable to the viewer (e.g., dropping random pixels is probably more objectionable than dropping some color information). For these reasons, the ways most lossy compression techniques are used are highly dependent on the media that is being compressed [11]. Lossy compression for sound, for example, is very different than lossy compression for images.

2. Compression Algorithm

In this research we introduce an idea for image compression depends on JPEG technique and Sequential

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Search algorithm. We will explain Sequential Search Algorithm in section 4, while in this section we describe how the JPEG technique applied on the low-frequency coefficients.

2.1. Discrete Wavelet Transform (DWT)

A single-stage wavelet transformation consists of four frequency bands as shown in Fig. 1. The top-left corner of the transformed image "LL" is the original image, low-frequency coefficients and the top-right corner "HL" consists of residual vertical frequencies (i.e. the vertical component of the difference between the "LL" image and the original image) [8-11]. The bottom-left comer "LH" contains residual horizontal frequencies, whilst the bottom-right corner "HH" contains residual diagonal frequencies.

The main reason for use DWT, for reduce an image dimensions, and the high-frequencies coefficients are ignored (i.e. not used in this research), this will effects on the image quality, while this process increasing compression ratio.

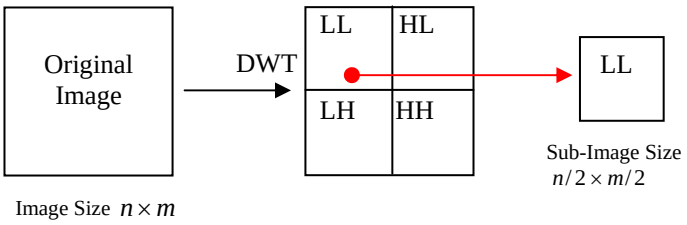

Fig .1: Original image dimensions reduced by DWT

2.2. JPEG Technique

JPEG is a sophisticated lossy compression method for color or grayscale images. An important feature of JPEG is its use the quality parameter "*Quality*", allowing the user to adjust the amount of the data lost over a very wide range [1]. The problem of this technique, the compressed images, degraded when the user select low quality parameter for obtains for higher compression ratio [1,3]. In this research we apply this technique on the sub-image LL, and the image quality problem are solved in the Section 2.3. The JPEG technique illustrated in the following steps:

1. The pixels of an image are organized in groups of 8×8 pixels called *data units*, and each data unit is compressed separately. If the number of image rows or columns is not a multiple of 8, the bottom row and the rightmost column are padded with zeros as many times as necessary [4].

2. The discrete cosine transform (DCT) is then applied on the each group of 8×8 pixels to create an 8×8 map of frequency domain. The frequency domain consists of; DC coefficient at the first location in 8×8 frequency component, which is represents average pixels value. The components are called AC, which is representing high-frequency coefficients [5].

3. Each of the 64 frequency components in an 8×8 map are divided by a separate numbers its called *Quantization Coefficient* (QC), and then rounded to an integer. This is where information is irretrievably lost. A simple quantization table *Q* is computed, based on one parameter *R* specified by the user. A simple expression such as $Qij = 1+(i + j) \times R$ guarantees that QCs start small at the upper-left corner and get bigger toward the lower-right corner [6].

4. Each 8×8 map frequency component scanned by using zigzag scan, to create a one dimensional array contains 64 quantized frequency coefficients. The one-dimensional array encoded using a combination of Run-Length-Encoding (RLE) and Huffman coding [1,2,6].

The Fig-2 illustrates sub-image compressed by JPEG technique

The parameter "R" in QC computed by selecting maximum coefficient from an 8x8 frequency components and then multiply by ratio=75%. This process removes small high-frequency coefficients to increase zeros and convert large coefficients to small coefficients, for gaining high compression ratio[6]. But in the decompression part, we obtain low quality image (degraded image).