Image Compression Using Discrete Wavelet Transform And Discrete Cosine Transform

Dr. Taif Sami Hasan

Computer Science Department Al-Mamoon University College

Received 12 January 2016; Accepted 10 March 2017; Available online 26 March 2017

ABSTRACT

The area of digital image processing has witness a great deal of development during the past few decades. Image compression is one of most important aspects of the fields. The paper presents simple and efficient algorithm for compressing image data, the algorithm involved using the glory wavelet transform technique, which was the most usable method for varied image processing field due to its results and properties. The next step is to ignore the less affected element and adopt the high impact elements, where they could be handle using adaptive Discrete Cosine Transform (DCT) method within the whole steps for JPEG image compressing strategy. Excellent results have been obtained depending upon two main criteria check; the compression ratio, and the reconstructed image quality (through PSNR criteria).

KEYWORDS: DCT, Huffman, Image Compression, JPEG, Wavelet, ZigZag.

INTRODUCTION

By entrance the Digital Age, the reality globe has faced a vast measure of data, which exhausted a lot of computer memories. Dealings with this vast amount of data can often issue termination in many operations. Digital information must be stock, retrieve, analyze and cognitive process in an efficient way, so as in order to put them to practical use. In the last decades many aspects of digital technologies have been developed, specifically in the field of image enhancement, information storage, and bitmap printing. There are many branches in the fields of image processing and the most important one is the image compression field. Image compression plays a glory role in the process of transmitting and storing of images. The compression aims is to reduce redundancy in data and especially images, in order to store or transmit only a minimal number of elements and from this we can reconstruct a trade good accession of the original image in accord of right field of operations with human visual perception. [1]

Review Papers:

- Entropy based image segmentation with wavelet compression for energy efficient LTE systems, the paper deal with the segmentation using wavelet transform [2].
- Irreversible wavelet compression of radiological images based on visual threshold, working with the field radiology images and by using wavelet transform [3].
- A wavelet compression based channel feedback protocol for spatially correlated massive MIMO systems. This paper proposes a wavelet compression based channel feedback protocol aiming to reduce the feedback load by exploiting the correlation features among large scale antenna arrays [4].

To Cite This Article: Dr. Taif Sami Hasan, Image Compression Using Discrete Wavelet Transform And Discrete Cosine Transform 2017. Journal of Applied Sciences Research 13(3); Pages: 1-8
• Image compression via wavelets and row compression. This work exploit a stable row compression algorithm used for decomposing a hierarchically or sequentially structured matrix to compress an image represented by a wavelet transform[5].

So, these papers and other work in the fields of image compression using wavelet transform but they are far from the structure and arrangement of our work. Also great result has been obtained with our paper.

Wavelet Transform:
The initial step is to apply discrete wavelet change (DWT) to the embraced picture; standard Lenna picture. The yield is four areas (CA, CH, CV, and CD). Wavelet change decay the quadratic indispensable capacity s(x) ε L2(R) in a group of scaled and interpreted capacities. It is more exact finding and better treatment device. For the situation in the Fourier change, the premise are adjusted into: [6]

\[ \exp(j(\omega_1 t_1 + \omega_2 t_2)) \] instead of \( \exp(j\omega t) \).

The scaling and wavelet capacity are two variable capacities, signified \( \varphi(x, y) \) and \( \psi(x, y) \) here. The scaled and deciphered premise capacities are characterized as:

\[
\begin{align*}
\varphi_{j,m,n}(x, y) &= 2^j/2\varphi(2^jx - m, 2^jy - n) \\
\psi_{i,j,m,n}(x, y) &= 2^j/2\psi_{i}(2^jx - m, 2^jy - n), i = \{H, V, D\}
\end{align*}
\]

There are three distinctive wavelet capacities, \( \psi H(x, y), \psi V (x, y) \) and \( \psi D(x, y) \). Adroitly, the scaling capacity is the low recurrence segment of the past scaling capacity in 2 measurements. In this manner, there is only one 2D scaling capacity. Nonetheless, the wavelet capacity is identified with the request to apply the channels. On the off chance that the wavelet capacity is divisible, i.e. \( f(x, y) = f1(x)f2(y) \). These capacities can be effortlessly revised as:

\[
\begin{align*}
\varphi(x, y) &= \varphi(x)\varphi(y) \\
\psi H(x, y) &= \psi(x)\varphi(y) \\
\psi V (x, y) &= \varphi(x)\psi(y) \\
\psi D(x, y) &= \psi(x)\psi(y)
\end{align*}
\]

In the event that we characterize the capacities as divisible capacities, it is less demanding to examine the 2D capacity and we can concentrate on the plan of 1D wavelet and scaling capacities. The investigation and union conditions are adjusted to

\[
\begin{align*}
W\varphi(0, m, n) &= \int f(x, y)\varphi_{0,m,n}(x, y) \\
W\psi (j, m, n) &= \int f(x, y)\psi_{i,j,m,n}(x, y), i = \{H, V, D\}
\end{align*}
\]

\[
f(x, y) = \int \varphi_{j,0,m,n}(x, y) + \int \psi_{i,j,0,m,n}(x, y)
\]

Fig. 1: Schematic diagram for 2D wavelet transform
The summation of the 2D distinguishable wavelet change capacity and scaling capacity could be decayed into two phases. Initial step is along the x-pivot vertebra and afterward figure along the y-hub. For every pivot, we can apply fasting wavelet change to quicken the speed. A schematic outline is appearance in Fig.(1) and Fig.(2). The two dimensional flag (normally picture) is isolated into four move symphony s: LL(left beat), HI (right-best), LH (left base ) and HH(right-base). The HL banding demonstrated the variation along the x-pivot while the LH band demonstrates the y-hub variety. The power is more pledge in the LL band. In the purpose of coding, we can spend more bits on the low oftenest band.

**Joint Photograph Expert Group (JPEG):**

In the second stage the three changed picture segments were dismissed and equivalent to zeros, while the four zones (CA) has been embraced keeping in mind the end goal to execute JPEG system. The picture square was isolated into 8X8 pieces and the JPEG was apply to each square. For as far back as few class, a joint ISO/CCTT board of trustees known as JPEG (Joint Photographic Experts Group) has been attempting to set up the primary International buildup standard for compacting constant tint still picture, both grayscale and similarity. JPEG's proposed standard bearing to be non specific, to bolster a wide assortment of utilizations for persistent quality pictures. To meet the various needs of numerous applications, the JPEG presents two strategies

**DCT-based technique acting** is determined for "lossy" pressure, and a prescient strategy for "lossless" pressure. JPEG include film a basic lossy system known as the Service line technique, a subset of the other DCT-based way of operation. The Service line technique has been by a long shot the most broadly actualized JPEG strategy to date, and is adequate in its own privilege for an expansive number of covering [7] It begins with the Discrete Cosine Transform DCT. The accompanying graph demonstrate the full broad structure for the techniques
Discrete Cosine Transform (DCT):

The discrete cosine change (DCT) point is to separate the picture into parts of contrasting significance (as for the picture's visual quality). The DCT is like the discrete Fourier change: it changes a flag or picture from the spatial space to the recurrence area Fig.(4).[8]

\[
F(u, v) = \left(\frac{2}{N}\right)^{1/2} \left(\frac{2}{M}\right)^{1/2} \sum_{i=0}^{N-1} \sum_{j=0}^{M-1} \Lambda(i) \Lambda(j) \cos \left[\frac{\pi u}{2N} (2i + 1)\right] \cos \left[\frac{\pi v}{2M} (2j + 1)\right] f(i, j)
\]

The essential stride for actualizing DCT is:

- Dimensions of unique picture is \(N \times M\);
- \(f(i,j)\) is the power of the pixel in line \(i\) and section \(j\);
- \(F(u,v)\) is the DCT coefficient in line \(k1\) and section \(k2\) of the DCT grid.
- For most pictures, a great part of the flag vitality lies at low frequencies; these show up in the upper left corner of the DCT.
- Compression is accomplished since the lower right values speak to higher frequencies, and are frequently little - sufficiently little to be disregarded with minimal unmistakable twisting.
- The DCT info is a 8 by 8 exhibit of numbers.
- 8 bit pixels have levels from 0 to 255.

Quantization:

The quantization step starts by choosing the statistical criteria for all successive image block in order to create the quantization table. All image blocks will be divided on the quantization table. Also special parameter introduces, which determine the quantization table effecting power by dividing the quantization table on this parameter.
Zig-Zag Scanning And Run-Length Encoding:

Mostly, the energy of the transformed block are distributed in positions close to the DC-level, at the upper left corner of the block, yielding large variances or standard deviation values. Therefore, the best method for retaining sequences of large absolute valued coefficients is to follow the zig-zag scanning. However, in our coding technique, the quantized coefficients is converted into 1D sequence vector using Zig-zag scanning method. Because the coding vector will involve a large number of zeroes, therefore, the run length coding method can be applied to these sequences of “0” values. The whole operations, i.e. Zig-Zag scanning, 2D into 1D transformation, and the run length coding process are illustrated in Fig.(5)[9].

The Encoding Process:

Compression is a necessity in the current world of technology, which is centered on speed and efficiency. Consequently, large and bulky pieces of information are abandoned for smaller bits of data.

Up to this point, quantized coded coefficients are presented in the form a sequence of integer numbers ready to be stored or transmitted through a channel from place to another. For higher compression, the storage or the transmission of the coded values is preferable to be in variable lengths of coded word than in fixed length. Huffman encoding, is one of the most efficient coding method that is used to achieve this requirement. By this error-less encoding method, the shorter binary code is, usually, assigned to higher probability coded word, while longer binary coded is gone to coded word of lowest probability. However, the problem arises with the implementation of the Huffman encoding lies in its requirement to generating a very long library, especially, when the input set has a long extent. In our present research, Huffman encoding is adopted to convert the vector coefficients obtained by the run-length encoding “RLE” method into binary codes.[10]

Results:

The algorithm was implemented on the standard Lenna image with 256X256 image size and the best suitable block size of 8X8 as shown in fig(6), while fig.(7) shows the transformed wavelet four images section. The figs.(8-10) explain the other reconstructed images with compression ratio and PSNR. A very good results have been obtained as shown in table(1)

<table>
<thead>
<tr>
<th>Quantization Parameter</th>
<th>Bit Rate Entropy</th>
<th>Bit Rate Huffman</th>
<th>PSNR</th>
<th>Wavelet Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.088362</td>
<td>0.089215</td>
<td>21.25</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>2</td>
<td>0.0946017</td>
<td>0.095092</td>
<td>24.70</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>3</td>
<td>0.10022</td>
<td>0.10071</td>
<td>25.83</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>4</td>
<td>0.10453</td>
<td>0.10521</td>
<td>26.23</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>5</td>
<td>0.10863</td>
<td>0.10924</td>
<td>26.47</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>6</td>
<td>0.1122</td>
<td>0.11244</td>
<td>26.64</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>7</td>
<td>.1156</td>
<td>0.116</td>
<td>26.65</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>8</td>
<td>0.1177</td>
<td>0.118</td>
<td>26.71</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>9</td>
<td>0.119</td>
<td>0.11959</td>
<td>26.76</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
<tr>
<td>10</td>
<td>0.12152</td>
<td>0.12205</td>
<td>26.79</td>
<td>CH=0 CV=0 CD=0</td>
</tr>
</tbody>
</table>
Fig. 6: Original Lena Image

Fig. 7: wavelet transformed images (CA, CH, CV, CD)
Discussion and Suggestions:

The adopted system depends on the most powerful compression technique in the field. The wavelet transform, which is the superior method in all image processing science (image compression, image enhancement, pattern detection, and others) and also the JPEG strategy which was adopted for long time as best compression method standard in the practical usage. Four sections have been results from the discrete wavelet transform. The three sections (CH, CV, and CD) have reserve little amount of image energy and have little effect to whole image. The upper left section (CA), which has most image detail and energy will adopt in order to implement a second stage compression process. This image section has been divided into blocks, each is 8 X 8 sizes and then applying discrete cosine transform (DCT), quantization process, zigzag and run length encoding (RLE). Finally the encoding process using Huffman technique was implemented. Great result has been obtained when comparing our strategy with the modern used compression techniques. Our suggestion for future work is to program and convert the model to hardware by using FPGA technique in order to improve the implementation speed.

REFERENCES