Increasing Image Compression Rate using (DWT+DCT) and Steganography

Navneet Kaur Aulakh
Scholar of Department of Computer Science
Chandigarh University,
Gharuan Mohali, Punjab, India

Er. Yadwinder Kaur
Associate Professor Department of Computer Science
Chandigarh University,
Gharuan Mohali, Punjab, India

Abstract—

The target of image compression is to eliminate unnecessary data from image in order to minimize the amount of data bits desired for image representation, to shrink the storage space, transmission bandwidth and time. Similarly, the steganography meets expectations by embedding the anonymous information into the redundancies of an image in invisibility way. This paper gives, a comparative study of image-compression approaches is done by three transform methods, i.e. DCT, DWT and Hybrid (DCT-DWT) transforms utilizing stenography process mutually to compression an image. Simulation results demonstrate, that hybrid (DWT-DCT) along with steganography performs superior than individual JPEG-based DCT and DWT algorithms in terms of their performance measurement: peak signal-to-noise ratio (PSNR) and visual perception at advanced compression ratio.

Keywords— Discrete Cosine Transform (DCT), Compression Ratio (CR), Peak Signal-to-Noise Ratio (PSNR), Discrete Wavelet Transform (DWT), Least Significant Bit (LSB), Hybrid (DCT-DWT), Steganography.

I. INTRODUCTION

The primary motivation behind image compression is to decrease the excess and insignificance information from the image, with the goal that it can be put away and exchanged proficiently. Therefore, compressed image is represented by lesser number of bits in contrast with original. Thus, the mandatory storage volume will be reduced; as a result large number of images can be stored within the same memory space and moved in quicker approach to spare the time, transmission bandwidth. In image compression approach, for the most part spectral and spatial redundancy ought to be decreased as much as could reasonably be expected. There are numerous applications where the image compression is utilized to effectively increased efficiency and performance. For this reason numerous compression methods i.e. differential encoding, scalar/vector quantization, Transform and predictive image coding have been presented. Amongst, these Transform coding is most proficient particularly at low bit rate [1]. Transform coding depends on the rule that pixels in an image demonstrate a definite level of relationship with their adjacent pixels. Subsequently, these relationships can be exploited for the estimation of a pixel level from its relevant neighbors. A transformation in this manner, illustrate to mapping of spatial (correlated) information into transformed (uncorrelated) coefficients. Thus, transformation have to use the way that the data content of an individual pixel is usually very small i.e., to a large extent visual part of a pixel can be calculated make use of its neighbors pixels. Depending upon the compression method used, the image can be reproduced with and without perceptual loss. In lossless compression scheme, the reproduced image after compression is numerically indistinguishable from the original. Whereas, in lossy compression scheme, the reproduced image includes degradation in respect to the original, as the Lossy schemes cause image quality degradation in each compression or decompression step. Hence, all, lossy techniques utilized for image compression having large compression rate compared to lossless methods i.e. good quality of compressed image with a lesser amount of compression, while lossy-compression schemes [2] lead to information loss with higher compression ratio. Methodologies used for lossy compression consist of transform and predictive coding. Transform coding techniques basically applies a Fourier-related transform; i.e. DCT and Wavelet Transforms, for example, DWT mostly employed approach [3]. In this paper, a comparative study of three techniques, viz. DCT, DWT and hybrid i.e. combination of both DCT and DWT and based on different performance measurements, i.e. Compression Ratio (CR) and Peak Signal-to-Noise Ratio (PSNR). The rest of the paper organized as follows: Section 2 explains Discrete Cosine Transform (DCT) algorithm; Section 3 describes the Discrete Wavelet Transform (DWT) algorithm; combination of both DCT and DWT algorithm explained in Section 4; Section 5 included comparative analysis and result in tabular form and in last Section gives the conclusions.

II. DISCRETE COSINE TRANSFORM

General image compression block diagram is demonstrated in fig.1, which clarifies flow of process included in image compression. Discrete Cosine Transform (DCT) utilizes cosine functions, it transform a signal from spatial domain into frequency domain. The DCT characterize an image in the form of sinusoids signal of varying amplitudes and frequencies.
Discrete Cosine Transform (DCT) has the possessions that, for an ordinary image the nearly all part of the visually critical information of an image are concentrated in only couple of coefficients. After processing of coefficients, these are normalized by quantization process using quantization table with diverse scales provided by the JPEG standard. Choice of quantization table influences the entropy and compression ratio. The estimation of quantization is inversely proportional to the quality of reproduced image, better mean square error and good compression ratio. In a lossy compression approach, during Quantization, the less significant frequencies components are discarded, and essential frequencies components that remain are make use of to recover image in decomposition process [4], after quantization, quantized coefficients are adjusted in a zigzag way for further compressed by an proficient coding algorithm. Discrete Cosine Transform (DCT) has many advantages:

1. DCT can pack most data in least number of coefficients.
2. DCT decreases the piece like form called blocking object that outcomes while limits among sub-images get to be noticeable [4]. An image is represented to be as a two dimensional grid, 2-D DCT is utilized to process the DCT Coefficients of an image.

III. DISCRETE WAVELET TRANSFORM

Wavelets techniques are very helpful in the compression, processing and enhance of signals, in various areas like medical imaging, where degradation in image is not accepted. Wavelets techniques can be employed in order to reduce noise from the image. Wavelets are statistical functions, which are employed to transform one illustration into another one. Wavelet transform carry out multi-resolution image analysis purposes. Multi-resolution implies synchronous illustration of an image at different levels. Wavelets represent an image as aggregate of wavelets functions, with different area and scales. The 2D wavelet study utilizes the same mother wavelets; however involve an additional step at each decomposition level.

In 2D transform, the images are consideration to be a grid having N rows and M columns and decomposition of an image into wavelets includes a couple of waveforms at every level.

1. To characterize high frequency components related to the detailed part of image.
2. For low frequency or smooth parts of a image.
At each point of decomposition, horizontal information is filtered out and approximation and points of interest created from this; are filtered from columns. At each point, four sub-images are acquired: approximation, vertical, horizontal detail and diagonal point of interest. After first level decomposition we get four points of interest of images those are:
- Approximate details
- Horizontal details
- Vertical details
- Diagonal details

Approximation details passed throughout a filter bank, and this process is repeated until the mandatory levels of decomposition have been achieved. Filtering footprint is tracked by using sub-sampling function that reduces resolution from one transformation level to other; after 2-D filter is applied up to n levels detail coefficients are yield, as the filter bank is applied over again on the approximation image until the preferred most resolution is achieved, Fig.5 illustrates wavelet filter decomposition. All the decomposed sub-bands are labeled by following notations [6] LL, LH, HL and HH respectively.

### IV. STEGANOGRAPHY FOR DATA HIDING

Steganography is the art of hiding top secret message in the host media with the aim of nobody can guess the presence of the message. An ordinary method for embedding a data (payload) in the media without any perceptual deformation in the media is to adjust the least significant bit of the image pixels and therefore described as least significant bit (LSB) steganography. In JPEG images, top secret information bits are hide into the LSB of rounded quantized DCT coefficients; except for coefficients values (-1, 0 or 1). The requirements for the estimation of coefficients consider keeping away from conceivable uncertainty in the mystery information separating procedure. For illustration, if the top secret information bit is 0 and DCT coefficient value is 1, therefore coefficient value will be changed to 0. Meanwhile, different coefficients with the first esteem 0 don't have any mystery information embedded in them.

![Fig. 5 Three-level DWT decomposition of image tile.](image)

![Fig. 6 An example for embedding secret data bits 11 using LSB](image)
Image compression using steganography have to fulfill parameters i.e. imperceptibility, payload size, and robustness. The hidden bits are imperceptible, if a human with normal vision not able to recognize media that hold concealed data from the individuals that don't have. Further, payload refers to the amount of bits concealed in media, while fulfilling the invisibility constraint. The embedded information is powerful on the off chance that it can be identified after non deliberate adjustment, for example, lossy compression. At last, the last requirement to which consideration must be paid in the wake of embedding process is file size and this requirement is not huge in typical steganography purpose, but after compression the file size must be compact.

V. PROPOSED METHOD

Image compression aim is to shrink file size with high compression level with smaller amount of data loss. In section II and III we introduced two distinct methods for attaining the objectives of image compression, which have a few points of interest and weaknesses, in this section we are proposing a system that will exploit preferences of DCT and DWT, to get compressed image [8].

a) Embedding process

The input color image is first separated into three layers y, cb and cr respectively conversion from rgb model to ycbcr. After this 2D-DWT applied separately on three layers, by applying 2D-DWT, four details are produced and out of these four sub-bands, approximation sub-band is further transformed again by 2D-DWT which gives, another four sub-band of smaller blocks. Approximation sub-band is further decomposed to get new set of four sub-bands. The level of image decomposition is depends on size block obtained initially. After getting four blocks of smaller sizes coefficients are computed form the approximated details using discrete cosine transform (DCT). Further, these DCT coefficients are quantized and coded by entropy coding schemes.

Before embedding bits, the target block is compressed fully using DWT-DCT, including DWT transformation, quantization, and entropy coding as shown in Fig., whereas the receiving blocks are only transformed using DWT and quantized steps only. The receiving blocks accept the bits from the fully compressed target block and depending on the hiding bit (0 or 1); AC coefficient value of the receiving blocks is rounded to the nearby odd or even value. If the hiding bit is equivalent to 0; AC coefficient value is rounded to its odd value, or else to the even value.

b) Extraction process

At decoding end, we decode the compressed image in reverse order by employing inverse entropy decoding technique. First decompress all the blocks then extract hidden bit from each block. Then decode the extracted bits to get the original data. Apply inverse 2D-IDCT on the approximation block and dequantized using quantization table. There after take inverse wavelet transform on the dequantized block and other sub-bands. As the level of decomposition while compressing image was three, we take inverse wavelet transform three times to acquire the identical block size. Assemble all blocks to obtain rebuild image.

VI. EXPERIMENTAL RESULTS

For comparative analysis of DCT, DWT and Hybrid methods codes are composed in MATLAB and results are organized in tables. The outcomes are acquired from images of sizes 512x512. Original and reproduced images are demonstrated in fig. It can be seen from table, the compression ratio CR is high for Hybrid approach in contrast with standalone transforms. DWT embodies between compression ratio and excellence of reproduced image. Hence DWT procedure is helpful in therapeutic applications. DCT gives less compression ratio however it is computationally effective contrasted with different systems.
Fig. 7 Original image in first column, Stego-JPEG (DCT) in second column.

Table

<table>
<thead>
<tr>
<th>Image</th>
<th>Baboon</th>
<th>Lena</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Ratio</td>
<td>1.68223</td>
<td>1.72244</td>
<td>1.71119</td>
</tr>
<tr>
<td>PSNR</td>
<td>29.4396</td>
<td>31.4931</td>
<td>35.3712</td>
</tr>
<tr>
<td>Storage Saving (%)</td>
<td>41</td>
<td>42</td>
<td>42</td>
</tr>
</tbody>
</table>

Fig. 8 Original image in first column, Stego-JPEG (DWT) in second column.

Table

<table>
<thead>
<tr>
<th>Image</th>
<th>Baboon</th>
<th>Lena</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Ratio</td>
<td>2.35446</td>
<td>2.05162</td>
<td>1.80807</td>
</tr>
<tr>
<td>PSNR</td>
<td>26.6876</td>
<td>31.9753</td>
<td>36.1674</td>
</tr>
<tr>
<td>Storage Saving (%)</td>
<td>58</td>
<td>51</td>
<td>45</td>
</tr>
</tbody>
</table>
Fig. 9 Original image in first column, Stego-JPEG (Hybrid) in second column.

<table>
<thead>
<tr>
<th>Image</th>
<th>Baboon</th>
<th>Lena</th>
<th>Papers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Ratio</td>
<td>2.40574</td>
<td>2.12144</td>
<td>1.88712</td>
</tr>
<tr>
<td>PSNR</td>
<td>26.5986</td>
<td>31.4931</td>
<td>34.9202</td>
</tr>
<tr>
<td>Storage Saving (%)</td>
<td>58</td>
<td>53</td>
<td>47</td>
</tr>
</tbody>
</table>

Fig. 2 Compression Ratio Analysis
In this paper comparative analysis of three Image compression approaches for images is done based on parameters compression ratio (CR) and peak signal-to-noise ratio (PSNR). Our result demonstrates that we can attain higher compression ratio utilizing Hybrid approach, but loss of data is more. DWT gives better compression ratio without losing more data of image. DCT defeats this inconvenience since it needs less handling force, but it gives less compression ratio. DCT based standard JPEG uses blocks of images, but there are still relationship exits crosswise over blocks. Block limits are observable. Blocking artifacts can be seen at low bit rates. In wavelet, there is no compelling reason to block the image. It facilitates dynamic transmission of the image (adaptability). As results shows that Hybrid approach using (DCT-DWT and steganography) gives more compression in contrast to DCT and DWT and give more storage saving and good quality of reproduced image. It is more suitable for consistent applications as it is having a decent compression ratio alongside preserving most of the information.

REFERENCES


