ANALYSIS OF DCT AND DWT COMPRESSION TECHNIQUE USING JPEG IMAGE

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ABSTRACT:

JPEG is a commonly used image compression method. We use machine learning techniques to predict DCT and DWT coefficients and pixel values in a compressed image. In this work the identification of good and bad quality of image is focused on the methods using MATLAB. Wavelets perform well only at linear features but not at nonlinear discontinuities because they do not use the geometric properties of structures. DWT separates image into high and low frequency components. High frequency components define contrast of an image. Enhancement is done in two steps namely local enhancement and global enhancement. Local enhancement is based on contrast measure and improves contrast. Global enhancement is needed for overall image quality improvement. A block-oriented discrete cosine transforms compression/decompression implementation based on the Joint Photographic Experts Group Standard for Still Image Compression. Experimental results show pre-compression using our method can improve the performance of JPEG 2000 format.The main contribution of the paper is that analysis is carried out from the viewpoint of compressed image visual quality. Several coders for which the compression ratio is controlled in different manner are considered. We analyze and discuss encryption schemes for JPEG2000 based on the wavelet packet transform with a key dependent sub band structure.

Index Terms—*Image compression, DWT, DCT, JPEG Compression.*

I. INTRODUCTION

Thousands of sensors are connected to the Internet [5], [6]. The "Internet of Things" will contain many "things" that are image sensors [7], [8], [9]. This vast network of distributed cameras (i.e. web cams) will continue to exponentially grow. We are interested in how these image sensors can be used to sense their environment. [23] IMAGE compression leading to efficient representation of information is critical for dealing with the storage and transmission of high resolution images and videos that dominate the internet traffic. JPEG [1] and JPEG 2000 [2] are the most commonly used methods for image compression. To reduce the data size, JPEG and JPEG 2000 use frequency decomposition via the discrete cosine transform (DCT) [1] or wavelet transform [2] as well as the frequency dependence of the human psycho visual perception [24].

Enhancement plays a vital role in image processing. Improving visual quality of an image is termed as enhancement. Enhancement could be done on both Gray level and color images. Many algorithms have been reported to enhance gray-level images viz. Histogram Equalization which equalizes histogram of gray level images for enhancement. Meanwhile Homomorphic filtering Low pass, and high pass filtering are the other techniques to work in spatial domain [11] and [12]. Later, these techniques were used for enhancing color images as well. Increasing need of compression in signal and image processing seeks algorithms to work in compressed domain like DCT, and DWT. One such algorithm which works in DCT domain [10] separates DCT coefficients into various bands and enhances them using a scaling factor. This technique [10] is based on the measurement of contrast [25].

The most common format for digital image compression is JPEG. It compresses 8 by 8 pixel blocks using the discrete cosine transform (DCT) by quantizing pixel information to reduce the size of files. When compressing an image using JPEG, the

image is transformed from the RGB color space into the Y'CbCr color space, which separates the luminance and color components into different channels [26]. One of the first steganography methods for JPEG images embeds data by changing the least-significant bit values of the quantized discrete cosine transform (DCT) coefficients. However, this method can easily be detected by a statistical analysis. Thus, for a good while, evading the statistical analysis has been a major concern. Provos [13] divides the DCT coefficients into two disjoint subsets, hides data into the first subset, and compensates the distorted histogram by modifying the second subset. Other methods in [14, 15] use a similar approach.

Wavelets are efficient and computationally fast representations for data sets or general functions. The properties of wavelets results in fact that for compression, estimating and recovering functions wavelets is optimal bases [3]. Wavelets are being used for image processing for last few decades. Many wavelets have been used for resolution enhancement of images. Discrete wavelet transform (DWT) [4] are wavelet transforms that are recently used for resolution enhancement. DWT uses down-sampling and generates various frequency sub-bands less than the size of input image. Resolution is crucial factor for an image. Images with higher resolution contain more information than that of low resolution. Now-a-days high resolution images are used in many applications. Resolution of an image stands for number of pixels in image. Image with more number of pixels has higher resolution. There are various techniques to increase the resolution of the images and interpolation is one of them. To increase the resolution of images various interpolation methods are there, such as bilinear, bicubic and b-spline interpolation.

The proposed method is compared to various conventional and state-of-the-art methods. The comparison of quantitative, qualitative metrics and images' results shows the eminence of proposed method over traditional and existing methods [27]. The goal of Image enhancement include the improvement of the visibility and perceptibility of the various regions into which an image can be partitioned and of the detect ability of the image features inside the regions. Image enhancement is usually followed by (or is done simultaneously with) detection of features such as edges, peaks, and other geometric features which is of paramount importance in low-level vision. Further, many related vision problems involve the detection of a known template; such problems are usually solved via template matching [28].

Using MATLAB software as a tool in image processing, we can find the quality of images using various algorithms. Finally after collecting lot of inputted image bases, we have proposed certain range. With these ranges we can identify the quality of image, whether it is good or bad [29].

II. PROPOSED TECHNIQUE

In the proposed method interpolation of high frequency components is done using surface fitting. Conventional interpolation method increases smoothness of picture result in loss of sharp detail such as edges and curves. Reason for using surface fitting as interpolation method is that, it uses two dimensional Taylor series of second order. The first order derivative retains edges and second order derivative retains curves of the image [27]. The stages in the proposed methodology are shown in figure 1.

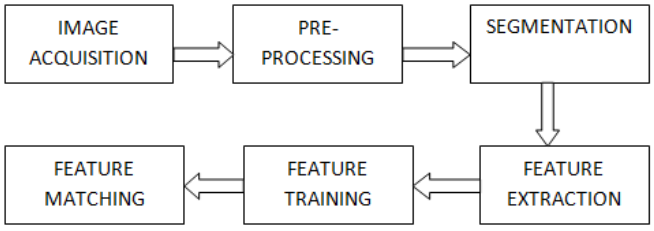

FIG. 1 Image Compression Techniques

A. IMAGE ACQUISITION

The image acquisition is done using a digital camera and it is loaded and saved. It supports file formats such as TIF (TIFF), JPG (JPEG), BMP (bitmap), as well as raw format. Here the input image got is an RGB JPG image format.

B. PRE –PROCESSING

Usually the images that are obtained during image acquisition may not be suitable straight for identification and classification purposes because of certain factors, such as noise, climatic conditions, and poor resolution of an images and unwanted background etc.

C. SEGMENTATION

The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application. The segmentation is based on measurements taken from the image and might be grey level, color, texture, depth or motion .Here edge-based segmentation is most suited. As edge detection is a fundamental step in image processing, it is necessary to point out the true edges to get the best results from the matching process. That is why it is important to choose edge detectors that fit best to the application.

D. FEATURE EXTRACTION

Feature extraction is defined as grouping the input data into a set of features. The features extracted carefully will extract the relevant information from the input data in order to perform the feature matching using this reduced representation instead of the full size input.

E. FEATURE TRAINING

More number of collecting trained features gives more accuracy. In this method, the number of closest code vectors for each training vector is identified and is stored as the corresponding cluster density. This codebook is saved and loaded in MATLAB for feature matching.

F. FEATURE MATCHING

Feature matching methods essentially consist of detecting features in images that can be matched with correspondingfeatures in the other images from which a transformation model can be estimated. Feature matching is an importanttask in the area of image processing [29].

III. JPEG COMPRESSION

JPEG format is one of the most commonly used formats for storing images and photographs. JPEG is an abbreviation of Joint Photographic Expert Group [32]. The JPEG file format has been around for many years, and is support by every image editor and web browser on the market. It is also supported by every digital camera, and any video camcorder that can also take pictures. Every digital photo print shop also supports the JPEG standard. The compression algorithm is "lossy", which means data is discarded when the file is compressed. For the most part, however, you won't notice any loss of data – unless you start to edit the file [33].

While an image was tampered with JPEG manipulation,the un-tampered region undergoes doubleJPEG compression with blocks matching. Although theinserted region undergoes double JPEG compression,the probability of matching between the 8 × 8 grid ofthe original image and that of the copy–paste insertedimage is only 1/64. Therefore, we can regard the tamperedregion of the composite image as singly compressedregion in our proposed algorithm [30]. Figure 2. Depict the architecture of JPEG Compression and JPEG Decompression Technique.

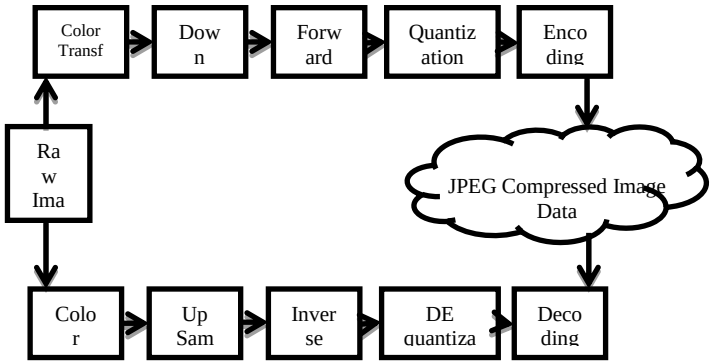

Fig. 2 Image Compression of JPEG Format

IV. DISCRETE COSINE TRANSFORM (DCT)

The Discrete Cosine Transform (DCT) is a technique that converts a spatial domain technique waveforminto its constituent frequency components as represented by a set of coefficients. The process ofreconstructing a set of spatial domain samples is called the Inverse Discrete Cosine Transform(IDCT).2D-DCT has most often implemented by employing row-column or column-row decomposition andoperating 1-D DCT on row and column data separately. This DCT transformation consists of allcoefficients with it. The coefficients are like AC,DC.AC coefficients of the DCT image block represents less energy; however they can be estimated from DCcoefficients of neighboring DCT. AC coefficients are required to reduce the blocking artifacts [28].

The energy in the transformed coefficients is concentratedabout the top-left corner of the matrix ofcoefficients. The top-left coefficients correspond to lowfrequencies: there is a 'peak' in energy in this area andthe coefficient values rapidly decrease to the bottomright of the matrix, which means the high-frequencycoefficients. The DCT coefficients are de-correlated,which means that many of the coefficients with smallvalues can be discarded without significantly affectingimage quality. A compact matrix of de-correlatedcoefficients can be compressed much more efficientlythan a matrix of highly correlated image pixels. Thefollowing equations illustrated DCT and Inverse DCTfunction for two-dimensional matrices [17, 18]:

$$C(u,v) = a(u)a(v)\sum_{x=0}^{n-1}\sum_{y=0}^{n-1} f(x,y)\cos\left[\frac{(2x+1)u\pi}{2N}\right] \times \cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad (1)$$

where

$$a(u) = \sqrt{\tfrac{1}{N}}, \quad \text{for u} = 0$$
$$a(u) = \sqrt{\tfrac{2}{N}}, \quad \text{for u} \neq 0$$

$$f(x,y) = \sum_{u=0}^{N-1}\sum_{v=0}^{N-1} a(u)a(v)C(u,v)\cos\left[\frac{(2x+1)u\pi}{2N}\right] \times \cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad (2)$$

One of the key differences between the applicationsof the DWT and Discrete Cosine transformation(DCT) is that the DWT is typically applied to animage as a one block or a large rectangular region ofthe image, while DCT is used for small block sizes [16, 31].

V. DISCRETE WAVELET TRANSFORMATION (DWT)

The DWT exploits both the spatial and frequency correlation of data by dilations and translations of the mother wavelet on the input data. It supports multi-resolution analysis of data [19]. Another useful feature of a wavelet transform is its symmetric nature meaning that both the forward and the inverse transforms have the same complexity, allowing building fast compression and decompression routines. Its characteristics well suited for image compression include the ability to take into account the HVS's characteristics, very good energy compaction capabilities, robustness under transmission and high compression ratios [20].The implementation of the wavelet compression scheme is very similar to that of sub-band coding scheme: the signal is decomposed

using filter banks. The output of the filter banks is down-sampled, quantized, and encoded. The decoder decodes the coded representation, up-samples and recomposes the signal. Wavelet transform divides the information of an image into an approximation (i.e. LL) and detail sub-band [21]. The approximation sub-band shows the general trend of pixel values and other three detail sub-band shows the vertical, horizontal and diagonal details in the images. If these details are very small then they can be set to zero without significantly changing the image, for this reason the high frequency sub-bands compressed into fewer bytes [22]. In this research the DWT is used twice, this is because the DWT assemble all low frequency coefficients into one region, which represents a quarter of the image size. This reduction in size enables high compression ratios [31].

VI. Compression Algorithm

The proposed image compression method depends on the single level DWT, which decomposes an image into approximation coefficients (LL) and high frequency domains (LH, HL and HH). The LL matrix is divided into non-overlapping blocks of data of 4 9 4pixels that are transformed by DCT producing a DC matrix and an AC-matrix. The AC-matrix contains the high frequency sub-bands and is coded by the Minimize-Matrix-Size Algorithm whiles the DC-matrix is transformed again by DWT. This research also describes Limited-Sequential Search Algorithm (LSS-Algorithm) used to decode the DC-matrix and AC-matrix. Finally these sub-bands are recomposed by low frequency and high frequency through inverse DWT. Figure 2 depicts the main steps of the proposed compression method in a flowchart style [31].

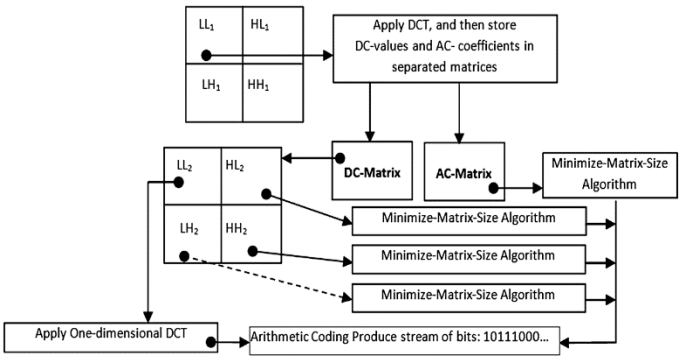

Fig. 3 Proposed image compression method flowchart

VII. Result and Analysis

The proposed method was applied on well-known image database. All programs were written in MATLAB. The resolution factor was for all images. Figure 4 Depicts Image with 320 x 240 dimensions with 8 bit depth. DCT image compression applied on this Image as shown in figure 5. Inverse DCT image compression applied on figure 6.

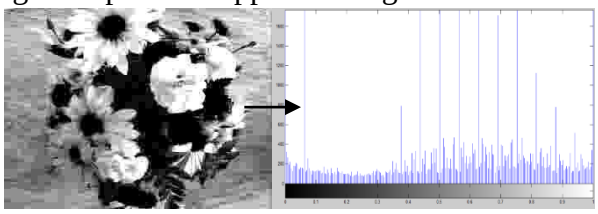

Fig. 4 Original Image with its Histogram

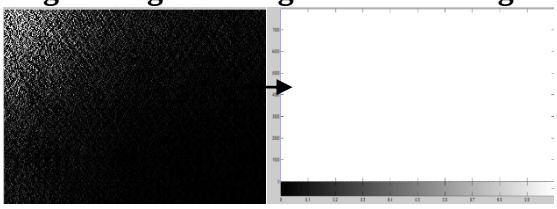

Fig. 5 DCT Image with its Histogram

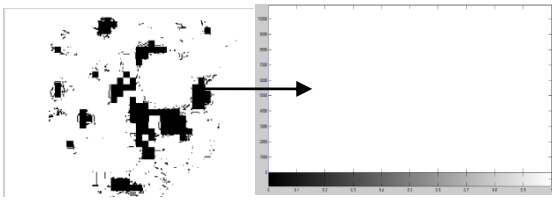

Fig. 6 Inverse DCT Image with its Histogram

DWT assembles on 4 different sub-bands with shown in figure 7. Approximate Image represents

LL sub-bands with its histogram shown as figure 8. Horizontal Description represents HL sub-bands with its histogram shown as figure 9. Vertical Description represents LH sub-bands with its histogram shown as figure 10. Detail Description represents LL sub-bands with its histogram shown as figure 11.

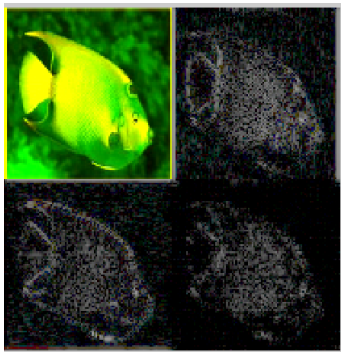

Fig. 7 Discrete Wavelet Transform with 4 sub-bands

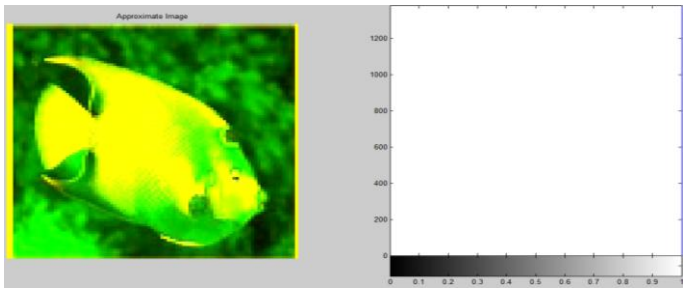

Fig. 8 Approximate LL sub-band Image with its Histogram

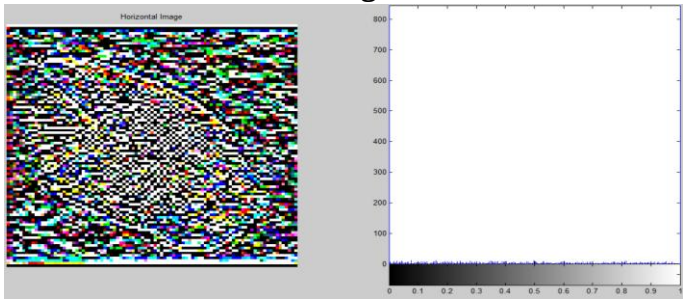

Fig. 9 Horizontal HL sub-band Image with its Histogram

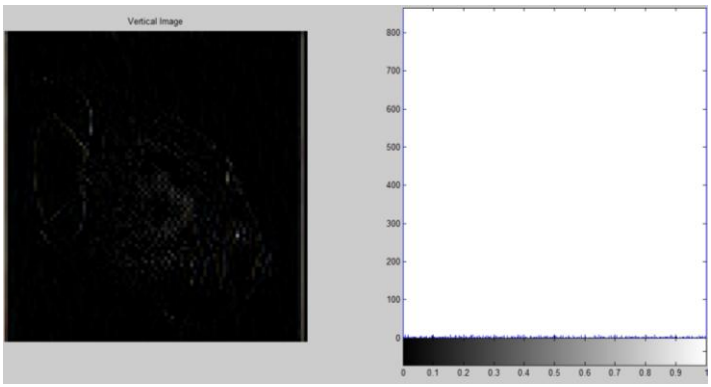

Fig. 10 Vertical LH sub-band Image with its Histogram

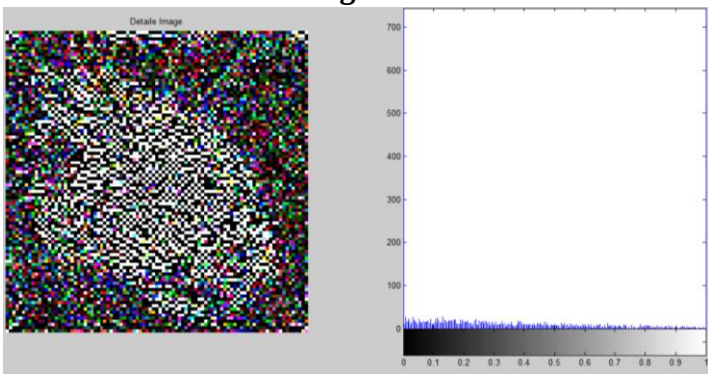

Fig. 11 Detailed HH sub-band Image with its Histogram

VIII. CONCLUSION

This research has presented and demonstrated a new method for image compression used in 3D applications. The method is based on the transformations (DWT and DCT) and the proposed Minimize-Matrix-Size Algorithm. The results show that our approach introduces better image quality at higher compression ratios than JPEG2000 and JPEG being capable of accurate 3D reconstructing even with very high compression ratios. On the other hand, it is more complex than JPEG2000 and JPEG. By the use of the DCT technique both the AC & DC coefficients are adjusted separately, here we are enhancing the color images in the block by DCT domain. In this the chromatic component in addition to the process of luminance component gives better visualization on images. The time constraints are also get reduced by the use of this

method.

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