A Robust Color Image Watermarking using Combination of DWT and DCT

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ABSTRACT
Watermarking on Digital Images have different methods, some of them deals with frequency domain. The Watermarking techniques using frequency domain produce better results either concerns with image quality or invisibility of the watermark. The digital watermarking is such that it provides copyright protection by information hiding. The researchers all over the world are still trying to find out the way to create robust Digital Image Watermarking Techniques. This research paper produces the new concept of efficient watermarking technique for the Color Image by combining both DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform). The result includes combine features of both transformations, so the Watermarking is more Robust than earlier approaches. The Color Image Watermarking is done by selecting one color component from RGB (Red, Green, and Blue) Components of Color Image. The Watermark embeds into any selected component and then again merges with other components. The R (Red) Component plays very important role to the present the color object as well as it is robust to the preserve information associated with it. So, in this research, R (Red) Component is selected to hide Watermark. This approach is more secure because the embedded watermark can only be extract from the Red Component after decomposing Watermarked Image into RGB components, other components (i.e. Blue and Green) does not contain any information about the Watermark.

KEYWORDS
Digital image watermarking; Discrete cosine transform (DCT); Discrete wavelet transform (DWT); Color Image; RGB Components.

1. INTRODUCTION
In the recent years, the use of digital data is increased and transmission of the digital data through network also increased. For the secure transmission and protection of digital data from the illegal use, some special techniques are require, which protects the digital data. Digital Image Watermarking is a technique which proves the copyright protection and authorship protection through the network from the attackers and illegal use. Digital Watermarking is a technique to insert the hidden detail of ownership inside the image for copyright protection and claim to authorship. There are many application of the digital image watermarking as copyright protection, copy control, fingerprinting, broadcast monitoring and medical etc [1]. There are several elements which decide the efficiency of the any watermarking techniques. The two most important elements are robustness and imperceptibility.

Robustness measures the immunity of the watermark image against the various types of attacks like image manipulation and modification. It is measured by the Correlation Coefficient. Correlation Coefficient presents the similarity measures between the Watermark and the Extracted Watermark. The values of the Correlation factor lies between 0 and 1.

Imperceptibility measures the quality of host image with the presence of Watermark information. The Imperceptibility of the Watermarked Image is measured by the Peak to Signal Ratio (PSNR). High values of PSNR means the better quality of the Watermarked Image and Low values means the low quality of the Watermarked Image. [2]

The Digital Image Watermarking Techniques can be classified in two different groups by their working domains, are Spatial Domain and Frequency Domain. The Spatial Domain deals directly with the pixel values of the Image. It is highly sensitive to the basic operation of signal processing, so can easily be damage. It has Low-Bit capacity comparatively to the Frequency Domain technique. The Frequency Domain (or Transform Domain) Techniques transform the original image into frequency values and then the Watermark is Embedded to the Transformed Image, and then

Retransformed to the original form. It increases the Robustness of the Digital Image [3] [4]. Working with Frequency Domain, there are three important types of transformation perform on digital image are DFT (Discrete Fourier Transform), DCT (Discrete Cosine Transform), DWT (Discrete Wavelet Transform). This research includes combination of DWT and DCT to compensate the drawbacks Watermarking [2][3][4].

2. DISCRETE COSINE TRANSFORM
Discrete Cosine Transform transforms the Image data signal to another form of representing the signal. It does not modify the information content present in the signal. DCT domain based watermarking is divided into two types Global DCT and Block based DCT. The Global DCT performs on the whole image. And the Block based DCT divides image into the blocks and apply DCT on each block.

From the computation of each block there three frequency bands are formed as Low, Medium, and the High frequency band. The Watermark is generally embedded into the Medium frequency band, which provides the robustness against various Watermarking Attacks. The Low frequency band are not used for Embedding the watermark because the Low frequency band contains the details of image, from embedding the Watermark in the low frequency band it effects visibility of image and degrade the quality of image.

Let Image ‘f’ is given and it have N × N size then the DCT of Image ‘f’ can be find out by following equation.

$$F(u,v) = c_u c_v \sum_{i=0}^{n-1}\sum_{j=0}^{n-1} f(x,y)\cos\frac{((2j+1)y\pi)}{2N}\cos\frac{((2i+1)x\pi)}{2N} \quad (1)$$

For the inverse DCT, equations are as follows:

$$f(x,y) = c_u c_v \sum_{i=0}^{n-1}\sum_{j=0}^{n-1} F(u,v)\cos\frac{((2j+1)y\pi)}{2N}\cos\frac{((2i+1)x\pi)}{2N} \quad (2)$$

Where

$c_u\, c_v = \left(\frac{1}{N}\right)^{\frac{1}{2}}$ For u, v=0

$c_u\, c_v = \left(\frac{2}{N}\right)^{\frac{1}{2}}$ For u, v =1,2……N-1

Where F (u,v) is the DCT coefficient of the image in row 'u' and column 'v'. [2] [3] [4]

3. DISCRETE WAVELET TRANSFORM

The Discrete Wavelet transform decomposes an Image into the collection of band limited components, which can then be reassembled to reform the Original Image without error. DWT applying on 2D images corresponds to processing the image by 2-D filters in both dimensions. The filters decompose the Input Image into four non-overlapping multi-resolution sub bands or parts. These sub-bands are Approximation Image (LL1), Horizontal (HL1), Vertical (LH1), and Diagonal (HH1). The division of the image can be repeated a several times to compute multilevel wavelet decomposition [5]. Fig. 1 shows the Wavelet Filter Coefficients.

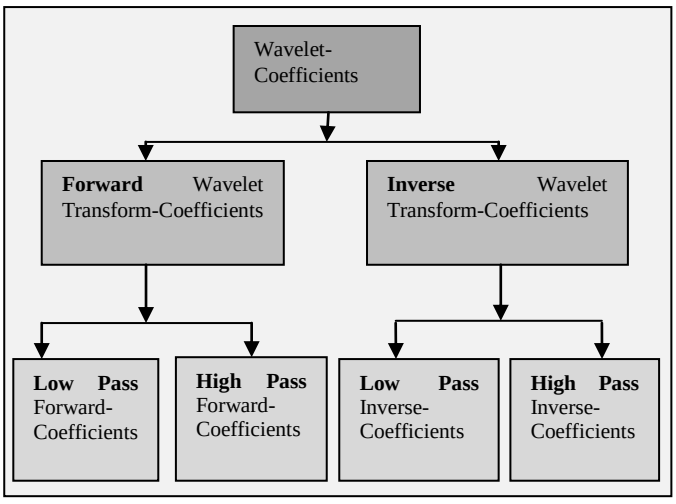

Fig. 1. Wavelet Composition of High and Low filters [9].

4. LITERATURE SURVEY

Researches over the Digital Watermarking have limited history, while researchers are still finding the best way to incorporate multiple techniques each other. The similar research work is done by Kaushik Deb and Md. Sajib Al-Seraj with the Gray Image and evaluated the performance by JPEG-Compression, Noise Attacking, Filtering, Cropping and Contrast adjustment [3].

Another, similar approach was discussed by Yang Qianli and Cai Yanhong in their research. They had developed the algorithm for Gray Image Watermarking. And experimentally, presents that the watermarking is robust to the common signal processing techniques. [6]

As reviewed, the research paper on "Digital Image Authentication System based on Digital Watermarking" by Dr. Neeraj Bhargava and Dr. M. M. Sharma provides a core concept about the image security and presents the new motivation to develop an authentication system. In addition to this research work, it is clear that watermarking by using DWT is not enough. [10]

After study the many research papers, it analyzed that Color Image Watermarking with the combination of DWT with DCT is require. Color Images are very common today, as it is very easy to copy, edit, and share. So, this research mainly concentrates to develop on best Color Image Digital Watermarking technique.

5. PROPOSED WORK

5.1 Color Image

A Color Image contains color objects which provide more information about the scenario as human eyes are more sensitive to the color variations. It is the basic concept all the colors can be derived from the three basic colors i.e. Red (R), Green (G), and Blue (B) [7]. MATLAB organized the color components into separate matrix and allow us to work on any component independently. As the research of human affections to the color, Red (R) color is most important than others due to its wavelength. In this research, Red (R) component is selected for embedding the Watermark. [7]

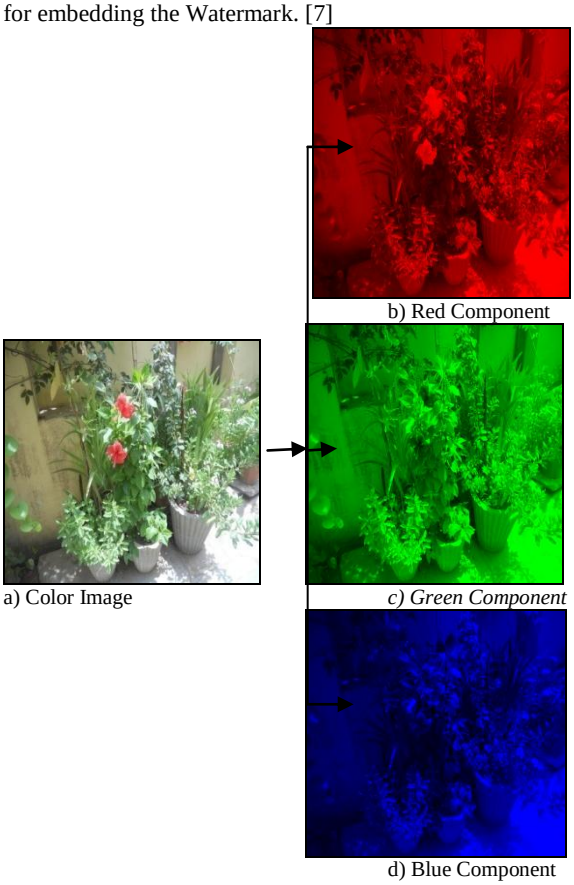

Fig. 2. Color Image gudhal.jpg and its RGB components

5.2 Discrete Wavelet Transform

The two dimensional Discrete Fourier or Cosine Transform are represents their forward discrete transform function as F [u,v] which is entirely a function of the spatial frequency u or v. There is no direct information about the pixel or spatial variable. Similarly, Discrete Wavelet Transform uses other kind of basic functions i.e. Haar, Daubechies, etc. These basic functions are also known as Mother Wavelet. In this research, Haar is used as Mother Wavelet. [8]

5.3 Discrete Cosine Transform

A DCT is applied on the entire red component matrix and watermark is inserted. The energy of each block is concentrated on the low frequency after transformation. Binary bits of watermark are embedded into the low frequency of DCT coefficients of the selected frequency sub-band of DWT. [8]

The marking process consists of sorting the DCT coefficients according to their absolute magnitude. The owner then defines a percentage of the total energy P, and identifies the largest n coefficients that frame P percent of the total energy. The watermark sequence is then added to the entire AC coefficients in this list. As P increases, the number of element of watermark can be embedded in the original image. Watermark and the list of chosen coefficients must be kept secret. [9] [10]

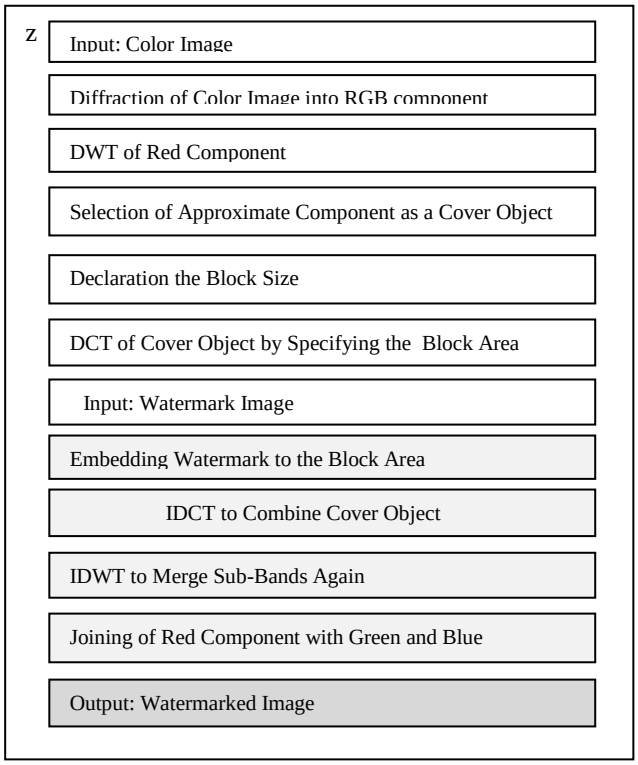

Fig. 3. Proposed Algorithm

6. EXPERIMENTS AND RESULTS

This research also includes the implementation of proposed scheme on MATLAB. The number of images was used as a practical image and finally measured the corresponding affection of the image.

6.1 Select Input Images

To test the efficiency of algorithm, four different color images are used.

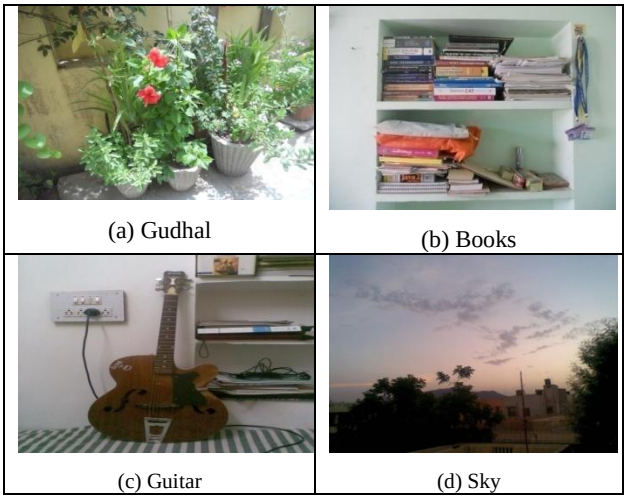

Fig. 4. Original Input Images for Watermarking

6.2 Select Watermark Image

Fig. 5. The Watermark Image copyright.bmp

6.3 Output of Invisible Watermarking

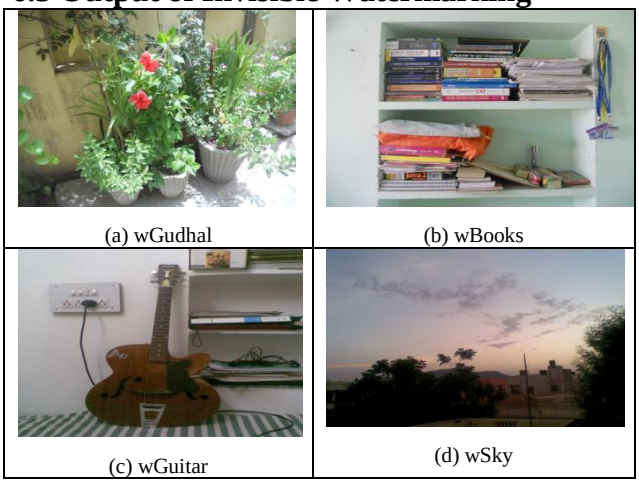

Fig. 6. Four Output Images that contains Hidden Watermark

6.4 Recovered Watermarks

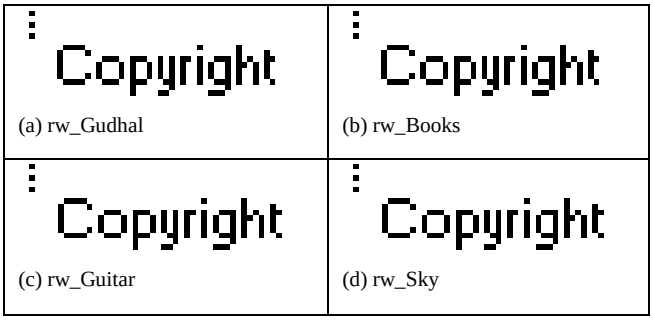

Fig. 7. Watermark Recovered from the Original Image.

6.5 Image Quality and Similarity Measurement

PSNR is a standard to evaluate image Quality, where its value under 30 to 50 expresses the good quality of image. Another most popular measurement is done by calculating Correlation Coefficient between two identical images. It basically, used to calculate the similarity of one with another. If Correlation Coefficient is 1, it means both images are same. So, it is a finest way to calculate similarity between watermarked and original images.

The results obtained for individual images are as follows:

Table 1. Between Original and Watermarked Image.

Sr. No.	Original Image	Watermarked Image	PSNR Value		
			Red	Green	Blue
1.	Gudhal.jpg	wGudhal.bmp	31.3414	31.9975	32.0122
2.	Books.jpg	wBooks.bmp	36.3297	37.1931	37.3647
3.	Guitar.jpg	wGuitar.bmp	39.8328	42.4653	41.9791
4.	Sky.jpg	wSky.bmp	40.3163	42.9321	42.8721

Table 2. Between Original and Recover Watermark

Sr. No.	Original Image	Watermarked Image	Correlation Coefficients
1.	Gudhal.jpg	wGudhal.bmp	0.9780
2.	Books.jpg	wBooks.bmp	0.9921
3.	Guitar.jpg	wGuitar.bmp	0.9983
4.	Sky.jpg	wSky.bmp	0.9991

7. CONCLUSION

For the sake of color inspiration, this research focuses on the Color Image Watermarking, while merging two transformation techniques i.e. DWT and DCT for the best results. The PSNR values are calculated for each color component separately, which produce depth information about the affection of watermarking to the color image and objects. The calculated values of Correlation Coefficient prove that the Watermarked images are too similar. This research concludes that the Watermarking by incorporating DWT and DCT is possible, whereas the results include advantage from both. Especially, Color Image processing in this research provides more security because Embedded Watermark can only identify by knowing the selected Color Component. It is clear by the experiment that, not only the Watermark Images are of good quality but also Extracted Watermark information is clear to read and identify.

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