A Digital Image Watermarking Technique Based on 5-Level DWT

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Abstract—In this paper, an algorithm based image watermarking scheme in the discrete wavelet transform (DWT) domain is proposed. In this method a multi-bit watermark is fixed in the lowest frequency sub-band of an image. .The insertion and extraction of the watermark image in the grayscale is found to be simplest than another transform methods. The proposed method compared with the 3-level DWT based image watermarking methods by using statistic parameters such as peak-signal-to-noise-ratio and mean square error. The experimental results shows that the watermarks generated with the algorithm are not visible and watermarked image quality should be improved and recovered better-quality image. The experimental results demonstrations that the watermarking method has strong robustness in contradiction of some common attacks such as Gaussian noise adding, cropping, frame dropping salt & pepper noise adding and adding frame. The implementation of the proposed algorithm based on image watermarking us used Matlab software. The implementation is done under the Image Processing Toolbox in the Matlab.

Keywords — MSE, 5-level DWT, PSNR, Wavelet Transform

I. INTRODUCTION

With the pervasive distribution of digital information over the World Wide Web,the protection of intellectual property rights has become progressivelyimportant [1][7]. These information, which include images, audio,image,or text are stored and transmitted in a digital format. Information is stored in digital format can be easily copied without any loss of quality and efficiently distributed. Digital watermark is then introduced to solve this problem. Digital watermarking is a branch of information hiding which is used to hide proprietary information in digital media like photographs, digital music, or digital image. The ease with which digital content can be exchanged over the Internet has created copyright contravention issues. Copyrighted material can be easily exchanged over peer-to-peer networks, and this has caused major concerns to those content providers whoproduce these digital contents.In order for a digital watermarking method to beeffective it should be unobserved, and robust tocommon image manipulations alike compression,filtering, rotation, scaling cropping, and collusionattacks among many other digital signal processingoperations. Digital image watermarkingtechniques can be grouped into two major classes [2] [3][14]:

Spatial Domain Watermarking and Frequency DomainWatermarking.To spatial domain methods, frequency-domain watermarking methods proved tobe effective with respect to achieving theunobserved and robustness requirements of digital image watermarking algorithms. Generally usedfrequency-domain transforms include the DiscreteWavelet Transform (DWT), the Discrete CosineTransform (DCT) and Discrete Fourier Transform(DFT). However, Discrete Wavelet Transform has been used in digital imagewatermarking more frequently due to its betterspatial localization and multi-resolution characteristics,which are coequal to the theoretical models of the humanvisual system. Further performance improvements inDWT-based watermarking image algorithmscould be obtained by increasing the level of DWT.In the previous work we looked into the digitalwatermarking for images. This describes the precedingwork which has been finishedusing DWT method on digital watermarking and other methods, containingthe analysis of several watermarking techniques and theirresults.

II. PROPOSED WATERMARKINGTECHNIQUE

This section illustrates the overall technique of our proposed digital image watermarking technique based on 5-level DWT. At first, the formation of 5-Level DWT is presented. Then we proposed watermark embedding process. Finally, the watermark detection process and its different steps are discussed in detail.

A. 5-Level-DWT

Discrete wavelet transform is a mathematical tool for hierarchically decomposing an image [4][11]. DWT is the multi-resolution description of image [5]. The decoding processed sequentially from a low resolution to the high resolution. The Discrete wavelet transform splits the signal into high and low frequency parts. The higher frequency part contains information about the edge components, while the lower frequency part is split again into high and low frequency parts. The higher frequency components are generally used for watermarking since human eye is less sensitive to changes in edges. After the first level of decomposition, there are four sub-bands: LL1, LH1, HL1, and HH1. For each following level of decomposition, the LL sub-band of the preceding level is used as the input. To do second level decomposition, the DWT is applied to LL1 band which decomposes the LL1 band into the 4sub bands LL2, LH2, HL2, and HH2. To

perform third level decomposition, the DWT is applied to LL2 band which decompose this band into the 4 sub-bands: LL3, LH3, HL3, and HH3 [6].

B. Watermark embedding

In this process firstly the grey scale host image is taken and 2-D, 5-level DWT is applied to the image which decompose image into low frequency and high frequency components. In the similar manner 2-D, 5-level DWT is also applied to the watermark image which is to be embedded in the host image. The wavelet family used here is the wavelets of Daubechies [8][9]. The technique used for inserting the watermark is alpha blending. This method decomposed components of the host image and the watermark are multiplied by a scaling factor and are added. Since the watermark embedded in this paper perceptible in nature or observable, it is embedded in the low frequency approximation component of the cover image. According to image standard, the intensity for a RGB frame can be calculated as,

I = 0:299R + 0:587G + 0:114B … (1)

Where R, G and B are Red, Green and Blue channel value of the pixel. Generally, the human visual system is least sensitive to the range of high frequency. Among the three channels of the RGB image, the blue channel has property of the highest frequency range. Thus, for the high performance the blue channel is transformed into DWT and the watermark is embedded from HL3 sub-band of the blue channel of the cover image frame. If HL3 sub-band is filled then the remaining watermark signal is embedded in LH3 sub-band. Again, if the LH3 sub-band is over then HH3. If HH3 is over then the next upper level is used that is HL2, LH2, HH2 is used [10][15]. In this way all the watermark is embedded into the image frame (see Figure 1). This process has the benefit of larger watermark can be embedded into the image. As we are placing the watermark into the high frequency part of the blue channel, so the greater invisibility of the watermark in the watermarked image frame is achieved.

LL5	HL5	HL4	HL3	HL2	HL1
LH5	HH5				
LH4		HH4			
LH3			HH3		
LH2				HH2	
LH1					HH1

Fig. 1: Watermark embedding order in 5-level DWT sub-bands.

For the intensity histogram difference we are looking for, it can be expressed as,

$$|SDi| = \sum_{i=1}^{G}|Hi(j) - Hi+1(j)|\dots (2)$$

Where $H_i(j)$ is the histogram value for i^{th} frame at level j. G signifies the total number of levels for the histogram. In a continuous image frame sequence, the histogram change is small, while for sudden transition detection, the intensity histogram change spikes. Even there is a remarkable movement or illumination changes between neighbouring frames, in which intensity histogram change is relatively smaller compared with peaks that caused by sudden variations. Hence, the difference of intensity histogram with a suitable threshold is effective in detected rapid transitions in image frames. The threshold value to determine whether the intensity histogram difference indicates a sudden transition can be set to,

$T_{b = \mu + \alpha\sigma}$ … (3)

Where and are the mean value and standard deviation of the intensity histogram difference. Empirically we estimate that the value of typically varies from 2 to 6.

Before embedding the watermark it should be pre-processed. The watermark is converted into binary image form as w^0(i; j) 2 f0; 1g, for i; j = 0 to M, where M is the number of binary pixel in the image to be encoded. Here the value 0 represents black and 1 represent white value. The binary form of the image w^0(i; j) is then transformed to obtain the vector w(i; j) 2 f1; 1g, where 0 is replaced by 1 and 1 is replaced by 1. Finally two dimensional watermark w(i; j) is changed into one dimensional watermark w(l)(l = 1; 2; ::::; L); L is the length of the watermark.
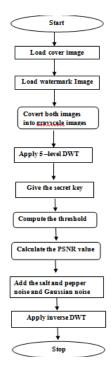
C. Watermark detection

In this process first of all 3-level DWT is applied to watermarked image and cover image which decompose the image into sub-bands [12]. After that watermark is recovered from the watermarked image by using the formula of the alpha blending. Afterthe extraction process, 5-level Inverse DWT is applied to the watermark image coefficient to configure the final watermark extracted image.

Without the host image, authorized detection of the hidden information can be easily accomplished by using the watermarked image and signal [13]. The detector detect whether the watermark is present or not in the watermarked image. Similarly for the embedding process, before detecting the watermark the system need to extract the image and then select the identical frame from each image shot. Then the 3-level wavelet transform is performed on the blue channel of the particular frame. Lastly compute the average.

D. Proposed algorithm

1) Load the cover image (original image).
2) Load the watermark (secret) image.
3) Covert both images into grayscale images from step 1 and 2.
4) Perform 5 level watermarking using discrete wavelet transform and haar of the image using equation 1.1
5) Give the secret watermark key for the protection of the secret image.
6) Compute the threshold T for each sub band by using equation (3.3).
7) Calculate the PSNR value of the image at level 3 DWT and level 5 DWT by using equation (1.6).
8) Add the salt and pepper noise and Gaussian noise at 3 level and at 5 level DWT.
9) Apply inverse DWT for the detection of watermark.

E. Flowchart for proposed work

III. EVALUATION AND RESULTS

To verify the effectiveness (qualities and robustness) of the proposed image watermarking technique, we conduct several experiments with this procedure on several uncompressed image. We compared proposed 5-level DWT to the 3-level DWT technique. For both the technique we have used grayscale images Lena as original image and the cameramen's image as the watermark. Both the images are of equal size of 256X256. There are some steps of our proposed technique are Phase1: Firstly we develop a particular GUI for this implementation. After that we develop a code for the loading the Cover Image and message image or message in the Matlab database.

Phase2: Develop a code for the Discrete Wavelet Transform and Inverse Discrete Wavelet Transform with partitioning technique. After that we apply DWT on the selected image for embedding purpose.

Phase3: Develop a code for the finding the watermarked data. Then we got the image with message data this is called Embedding technique. For the embedding process we apply the key for the security purpose.

Phase4: After that we develop code for the extraction process. Within the extraction process we develop coed for the message extraction from the watermarked file using 5-level IDWT. After the extraction process we got the original image and message data by using the key.

IV. RESULTS

In this paper, an image watermarking technique based on a 5-level discrete wavelet transform is proposed. The result of our proposed work is more accurate and consumed less time to run as compare to previous work.
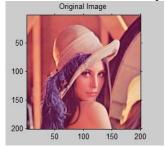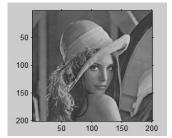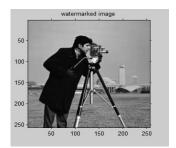

Fig. 1. Original Image

Fig. 2. Gray Image

Fig. 3. Secret Image

Fig. 4 level-3 DWT Image

```
Enter secret image file name with extension: 1.bmp

*******************************
Please enter secret key
*******************************
Enter secret key: 5555
Elapsed time is 16.082775 seconds.
*********************************
Please enter secret key
*********************************
Enter secret key: 5555
CORRECT KEY
```


Fig 5: level -5 DWT image
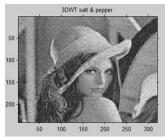
Fig 6: Salt and pepper noise 3-DWT
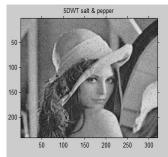
Fig 7: Salt and pepper noisy image of DWT -5
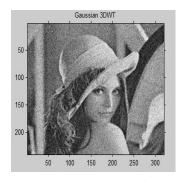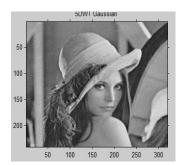

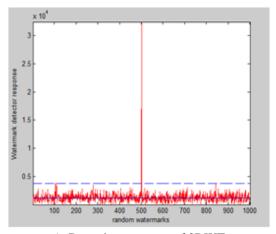Fig 8: Gaussian noisy image of DWT-3

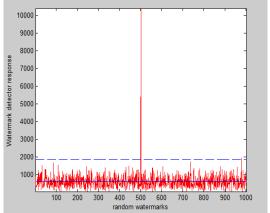Fig 9: Gaussian noisy image DWT-5

Table 1: Results

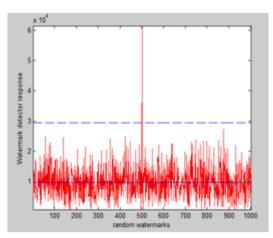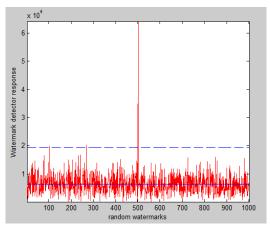| LEVELS	3DWT	5DWT
PSNR	53.7764	53.8189
SALT & PEEPER	24.0207	37.8408
GAUSSIAN	28.0982	36.8520

a) Detection response of 3DWT
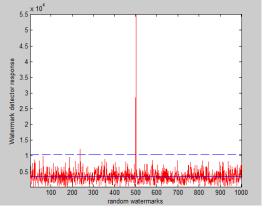
b)   Detection response of 5DWT

c)   Detection response of salt & peeper3DWT

d)   Detection response of salt & peeper 5DWT

e) Detection response of Gaussian 5 DWT

V.   CONCLUSION AND FUTURE SCOPE

In this paper, an image watermarking technique based on a 5-level discrete wavelet transform has been implemented. This technique can embed the invisible watermark into salient features of the image using DWT technique. Experiment results shows that the quality of the watermarked image and the recovered watermark are dependent only on the scaling factors k and q and also indicate that the 5-level DWT provide better performance than 3- level DWT. All the results obtained for the recovered images and the watermark are identical to the original images. Though the system has some limitations but it shows better results in various attacks. Our results with noise are too good as compare to previous work. For future scope we can increase levels of DWT for obtainbetter result.

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