A Wavelet based Image Watermarking Technique using Image Sharing Method

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***Abstract*—Recent advancement in communication technology protection of digital data is a severe problem. In this paper we propose a watermarking technique based on wavelet domain and sharing of an image with the motivation to maintain the quality of the image. The original image is diagonally shared and one of the shares is horizontally merged and watermarking process is employed in fusion image using wavelet. Further breakaway the pixels into normal share. Stack the two watermarked images in to single image. At the receiver end again shared and merged a watermarked share in horizontally and extracts a watermark Image. Simulation results indicate that the proposed watermarking scheme is highly robust and does not reduce the quality of watermark image.**

***Keywords*—Digital Image Watermarking, Discrete Wavelet Transform, Horizontal merging, Watermark Embedding Algorithm, Watermark Extracting Algorithm.**

I.INTRODUCTION

The digital revolution has resulted in explosion of knowledge in today's technology-driven economy. It has resulted in encouragement and motivation for digitization of the intellectual artefact. Several researches have been focused on providing solutions to copyright protection and authentication. Since the digital data has no difference in quality between an original and its copy, it is impossible to distinguish original from the copy [1]. Hence humans can easily access or distribute any multimedia data from networks. Hence, the protection of intellectual property becomes more and more attentive and important for the society[1]-[6]. Digital watermarking is a suitable method for copyright protection of multimedia .General block diagram of watermarking is shown in Fig.1.

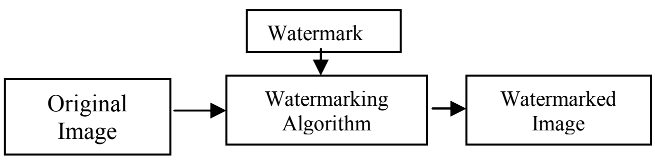


Fig. 1. Block diagram of a watermarking algorithm

Digital watermarking algorithm is used to hide secret signal into digital audio, video, image. The secret signal, noted as the watermark, can be copyright notices or authentication information or secret text. The original signal is called as cover signal. The process of inserting the secret signal is called embedding and the image after embedding is called "watermarked image". Extraction or detection is a process retrieves the stored watermark. Thus the two main components of digital watermarking systems are (i) Embedding and (ii) Extraction.

In general Watermarking can be categorized into visible and invisible. For visible watermarking, the embedded watermark can be visually observed. That clearly indicates the ownership of the image [8]. The merits of visible watermarking is that it is easy to authenticate the owner of the image without any problem, but its demerits is that the embedded watermark signal can also be easily removed or destroyed. An Invisible watermark is intended to be imperceptible but is detected and extracted by an appropriate piece of software when the need arises. An image containing an invisible watermark should look similar to the original unmarked image.

Invisible watermarking can be classified into two types: Semifragile or Robust and Fragile watermarks. Semifragile watermarks are usually designed to protect the attacks such as image scaling, bending, cropping, lossy compression, etc. It is also used in copyright protection to declare rightful ownership. In contrast to image authentication, fragile watermarks are designed to detect any unauthorized modification such as distortion under the slightest changes to the image.

II. BACKGROUND

Many watermarking algorithms are specifically designed for digital images are proposed. Regarding watermarking authors are mainly preferred frequency domain than the spatial domain because the characteristics of the former are more robust invisible, and stable. In this domain, a watermark is inserted into coefficients obtained by using an image transform process. The common well-known transform methods are the discrete cosine transforms (DCT), Discrete Fourier Transform (DFT), and Discrete Wavelet Transform (DWT). Some previous researches are briefly described in the following.

Cox *et al.* [3] proposed a secure algorithm to construct a watermark as an independent and identically distributed Gaussian random vector that is inserted in a spread spectrum like fashion into spectral components of the data. The watermark is spread over many frequency coefficients, so that the number of coefficients that are modified is very small and they are difficult to detect. Xia, Boncelet, and Arce [7] proposed a watermarking scheme based on the Discrete Wavelet Transform (DWT). The decoding process involved taking the DWT of a potentially marked image. new image to hide the watermark. Kundur and Hatzinakos [10] embedded the watermark in the wavelet domain.

The strength of the watermark was determined by the contrast sensitivity of the original image. Both techniques showed resistance to common signal processing operations. Delaigle *et al.* [11] also proposed a unique watermarking scheme based on the Human Visual System. Binary m-sequences were generated and then modulated on a random carrier. This image served as the watermark, and then it was masked based upon the contrast between the original signal and the modulated image. The masked watermark was added to the original image to form the watermarked image. Their technique was robust to additive noise, JPEG coding, and rescanning.

Yongquiang [12] proposed a novel optimal color image watermarking scheme in the DWT domain to meet watermarking properties such as: security, imperceptibility and robustness. In the scheme, the watermark was a meaningful gray image encrypted by a two-dimensional chaotic stream encryption. Genetic algorithm was used to embed the watermark into the host color image so as to improve the imperceptibility of the watermarked image.

Mehdi Khalili[13] proposed a novel watermarking algorithm which compare to the existing watermarking techniques, this proposed method has combine imperceptibility, security and robustness. In this paper a wavelet-based watermarking approach for hiding watermark image in color host images is proposed. This approach provides extra imperceptibility, security and robustness against JPEG compression and different noise attacks such as Gaussian and salt & pepper compared to the similar proposed methods. Moreover, the proposed approach has no need of the original image to extract watermarks

III.PROPOSED METHOD

A. Image Sharing.

In this proposed method an Original image is divided in to two matrices, i.e., diagonal wise sharing. Let us consider (8x8) matrix (A) is divided into two shares (B&C) as shown below.

$$A=\begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 & 13 & 14 & 15 & 16 \\ 17 & 18 & 19 & 20 & 21 & 22 & 23 & 24 \\ 25 & 26 & 27 & 28 & 29 & 30 & 31 & 32 \\ 33 & 34 & 35 & 36 & 37 & 38 & 39 & 40 \\ 41 & 42 & 43 & 44 & 45 & 46 & 47 & 48 \\ 49 & 50 & 51 & 52 & 53 & 54 & 55 & 56 \\ 57 & 58 & 59 & 60 & 61 & 62 & 63 & 64 \end{pmatrix}$$

From a matrix (A) , we need to separate the two images for that, first we read a number of rows and columns of matrix(A). Check whether the rows are even or odd. If rows are odd then read only odd columns. Otherwise read even columns.

1) Algorithm for First share.

```
For i=1 to Rows
    For j=1to (Columns/2)
        If mod(i,2) ≠ 0 //Check only Odd Rows
        Read only Odd Columns
    Else
    Read only even column
   End
  End
End
B= Image share1
```

Advancement of the above schemes was possible by utilizing properties of the Human Visual System. Bartolini *et al.* [9] first generated a watermarked image from DCT coefficients. Then spatial masking was performed on the

$$B=\begin{pmatrix} 1 & 0 & 3 & 0 & 5 & 0 & 7 & 0 \\ 0 & 10 & 0 & 12 & 0 & 14 & 0 & 16 \\ 17 & 0 & 19 & 0 & 21 & 0 & 23 & 0 \\ 0 & 26 & 0 & 28 & 0 & 30 & 0 & 32 \\ 33 & 0 & 35 & 0 & 37 & 0 & 39 & 0 \\ 0 & 42 & 0 & 44 & 0 & 46 & 0 & 48 \\ 49 & 0 & 51 & 0 & 53 & 0 & 55 & 0 \\ 0 & 58 & 0 & 60 & 0 & 62 & 0 & 64 \end{pmatrix}$$

Similarly for matrix (C), read a number of rows and columns of matrix(A). Check whether the rows are even or odd. If rows are odd then read only even columns. Otherwise read odd columns.

2) Algorithm for Second share.

```
For i=1 to Rows
    For j=1to (Columns/2)
        If mod(i,2) = 0 //Check only Even rows
        Read only Odd columns
        Else
        Read only Even columns
        End
    End
End

C=Image share2
```

$$C=\begin{pmatrix} 0 & 2 & 0 & 4 & 0 & 6 & 0 & 8 \\ 9 & 0 & 11 & 0 & 13 & 0 & 15 & 0 \\ 0 & 18 & 0 & 20 & 0 & 22 & 0 & 24 \\ 26 & 0 & 27 & 0 & 29 & 0 & 31 & 0 \\ 0 & 34 & 0 & 36 & 0 & 38 & 0 & 40 \\ 41 & 0 & 43 & 0 & 45 & 0 & 47 & 0 \\ 0 & 50 & 0 & 52 & 0 & 54 & 0 & 56 \\ 57 & 0 & 59 & 0 & 61 & 0 & 63 & 0 \end{pmatrix}$$

Further we select one share (B) for watermark embedding. Read the rows and columns of matrix (B). Add the first rows with last rows .

3) Algorithm for Horizontal Merging

```
For i=1 to Row/2
  For j=1to Columns
   Add First row with Row.
   Add Second row with Row-1
```

```
    Add Third row with Row-2
    .........
    ............
    .............
  End
End
S=Horizontally Merged Image.
```

$$S=\begin{pmatrix} 1 & 58 & 3 & 60 & 5 & 62 & 7 & 64 \\ 49 & 10 & 51 & 12 & 53 & 14 & 55 & 16 \\ 17 & 42 & 19 & 44 & 21 & 46 & 23 & 48 \\ 33 & 26 & 35 & 28 & 37 & 30 & 39 & 32 \end{pmatrix}$$

4) Algorithm for Reconstructing an Image

Finally we reconstruct a fusion cover watermarked image in to normal watermark share, and then we stack with non watermarked share.

```
For i=1 to Row
  For j=1to Column
    If mod(i,2) ≠ 0 //Check only Odd Rows
      If mod(j,2) = 0 //Check only Even Columns
      Move the pixel position to Row+1-i
      Else
      Don't move
      End
    Else
      If mod(j,2) ≠ 0 //Check only Odd Columns
      Move the pixel position toRow+1-i
      Else
      Don't move
      End
    End
  End
End
R=Reconstructed Image
```

$$R=\begin{pmatrix} 1 & 0 & 3 & 0 & 5 & 0 & 7 & 0 \\ 0 & 10 & 0 & 12 & 0 & 14 & 0 & 16 \\ 17 & 0 & 19 & 0 & 21 & 0 & 23 & 0 \\ 0 & 26 & 0 & 28 & 0 & 30 & 0 & 32 \\ 33 & 0 & 35 & 0 & 37 & 0 & 39 & 0 \\ 0 & 42 & 0 & 44 & 0 & 46 & 0 & 48 \\ 49 & 0 & 51 & 0 & 53 & 0 & 55 & 0 \\ 0 & 58 & 0 & 60 & 0 & 62 & 0 & 64 \end{pmatrix}$$

B. Discrete Wavelet Transform

Discrete Wavelet Transformation (DWT) of image produces the multi-resolution representation of an image. This multi-resolution representation provides a simple hierarchical framework for interpreting the image information. At a low level resolution, these details correspond to the larger structures which provide the image content. Wavelet transformation consist of two main steps namely,

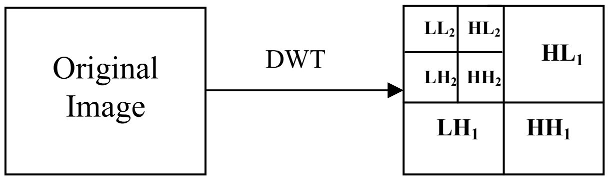


Fig. 2 .Two level DWT decomposition

DWT segments a digital signal into high frequency quadrant and low frequency quadrants. The low frequency quadrant is split again into two more parts of high and low frequencies and this process is repeated till the signal has been entirely decomposed. In watermarking, generally 1-5 level of decompositions is used. The reconstruct of the original signal from the decomposed image is performed by IDWT.

Several types of wavelets exist for decomposition. Some examples include Haar, Daubeschies, Coiflets, Symlets, Morlets, Mexican Hat Meyer and Biorthogonal wavelets. More generally, application of DWT divides an image into four subbands which arise from separable applications of vertical and horizontal coefficients.

C. Algorithm for proposed technique as stated below

1) Watermarking Embedding Process

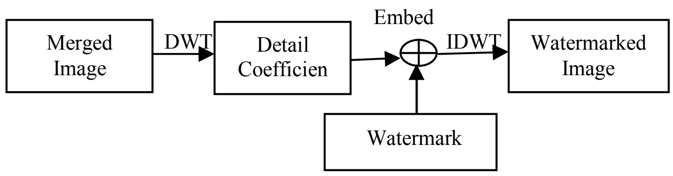


Fig.3 Proposed watermark embedding method using DWT

For embedding the watermark, we can follow the steps given below

Step 1 Get a merged Image

Step 2 Apply Wavelet Transform of the input image is performed.

Step 3 Single level of decomposition is performed to get four subbands.

Step 4 Watermark Image is taken for embedding with host shuffled image.

Step 5 Secret image is multiplied with a weighting function and it is added to the subband information.

Step 6 Perform the inverse of the DWT (IDWT) to obtain the watermarked image

Step 7 Reconstruct the shuffled cover image in to normal share

Step 8 Stack the watermarked share with non watermarked share.

2) Watermark Extraction Process

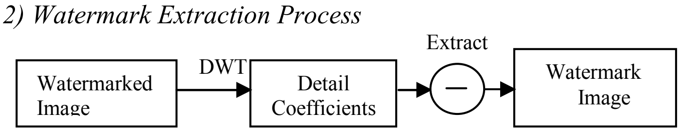


Fig. 4. Proposed watermark extracting method

Step 1 Read an original image.

Step 2.Divide an image into two shares.

Step 3 Select a watermarked share and shuffle the pixel.

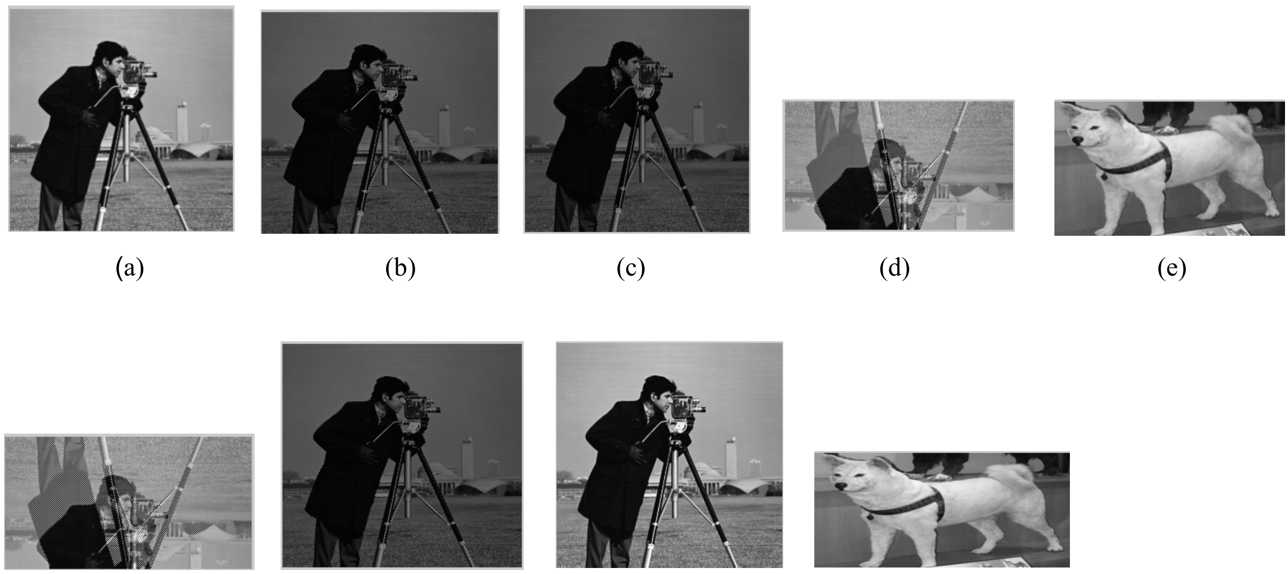
Step 4.Now forward wavelet transform is applied to the watermarked image.

Step 5 Subtracted from the wavelet coefficients of the original image.

Step 6 Extract a watermark image.

IV EXPERIMENTAL RESULTS

More number of images which come from some standard image libraries has been taken as the test image of our MATLAB program. Our technique works on gray-scale images. In this section, some simulation results are illustrated to show the effectiveness of the above algorithm. We have tested our technique on “Cameraman” images, of 256×256. As per proposed method we need to separate an original image in to two (256x256) gray scale images as a watermark. Select one share and rearrange the pixels after that embedding process is performed.



(a) (b) (c) (d) (e)

(f) (g) (h) (i)

Fig.5 Original image (256x256), (b) Image share1, (c) Image share2, (d) Horizontal Merging of pixel in image share1 image(128x256), (e) Watermark Dog Image (128x256), (f) Watermarked Image(128x256) ,(g) Reconstructed watermarked image share1, (h). Stacking of reconstructed watermarked image share1 and image share2. (i) Extracted Watermark Image.

V. DISCUSSION

Effectiveness of an algorithm is measured by object fidelity criteria. The mean square error between the original image A*(x,y)* and the reconstructed image O(*x,y*) is given by *X* and *Y* represents the size of the Image.

$$\mathrm{MSE}=\left(1/_{XY}\right)\sum_{x,y}\left(A(x,y)-O(x,y)\right)^2 \qquad (1)$$

PSNR values received to be treated more meaningfully when quantifiably comparing different image coding algorithms.

$$\mathrm{PSNR} = 10\log_{10}[255^2/\mathrm{MSE}] \qquad (2)$$

This proposed method gives just comparable results in terms of the PSNR.

TABLE I
EFFECT OF NOISE ATTACKS

Attacks	PSNR between Input image and Stacked shares of Cameraman Image	PSNR between Input image and Extracted watermark of Dog Image
Without Attack	42.439	24.503
Salt & Pepper	36.405	23.813
Gaussian	40.729	24.247
Speckle	37.362	22.247

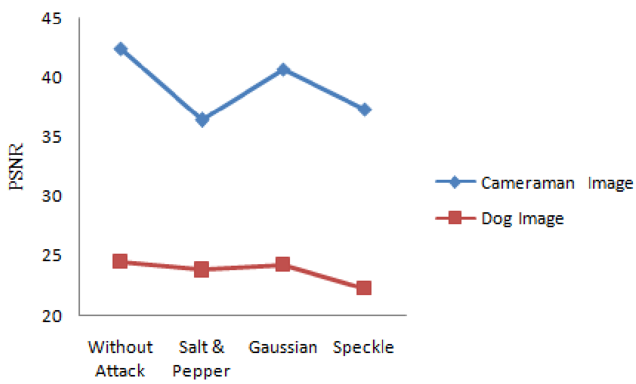


Fig 6.Comparison between various noises and PSNR

VI. CONCLUSION

In this paper, we proposed a robust and secure image watermarking algorithm that embeds watermark in the shuffled images using wavelet transform. The proposed scheme provides very high payloads and imperceptibility when compared to similar transform-domain techniques. Furthermore, experimental results showed that the proposed algorithm can achieve excellent robustness against attacks such as noise addition.

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