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# Embedding and Extraction of Image Watermarking using Alpha Blending Technique based on Discrete Wavelet Transform

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**Abstract**
Digital watermarking has become a promising research area to face the challenges created by the rapid growth in distribution of digital content over the internet. To prevent misuse of this data, digital watermarking techniques are very useful. Here, a new algorithm that can be used for copyright protection is introduced for the embedding and detection of a watermark in the domain of discrete wavelet transform (DWT). The elements of the logo watermark are embedded directly to the one-level DWT decomposed sub-bands. The experimental tests and results of this scheme have shown that the scheme has the desired properties such as invisibility and robustness.

***Keywords—Discrete Wavelet Transform, Image Processing, Image Watermarking, Alpha-Blending.***

## I. Introduction

Digital Watermarking is the process that embeds data called a watermark, digital signature, tag or label into a multimedia object such that watermark can be detected or extracted later to make an assertion about the object. With the fast growth of the Internet, people have paid more and more attention to the security of the network information. The protection of the digital data is an important topic to the owners of the multimedia products. Digital watermarking is embedding hidden data into the multimedia in such a manner that it cannot be removed and its detection verifies the ownership of digital products. To be used as a means of copyright protection, the two main requirements of high robustness and capacity and high imperceptibility (low visibility) should be ensured for watermarking schemes. The peak signal-to-noise ratio (PSNR) is criteria that are used to evaluate imperceptibility.

A digital watermark can be fragile, semi-fragile and robust. The watermark which disappears when the image is processed (e.g. compression or resizing) is called more fragile. The watermark that survives wide variety of attacks and transformations is called more robust.

The watermark which is less fragile but not completely robust is called semi-fragile watermark. Extraction process of watermark may be dependent or independent of the original image or embedded watermark, which is based on level of required information that are classified into non-blind and blind detection process. In non-blind watermarking, both cover data and embedded watermark is required for extraction. In blind watermarking, only watermarked data is required for extraction/detection of original cover data.

According to the domain in which the watermark is inserted, the techniques are classified into two categories, i.e., spatial-domain and transform-domain methods. In spatial domain watermarking techniques, the watermark can be directly embedded within the image by modifying its pixel value. The watermarking procedure in which the technique first transform an image into a set of frequency-domain coefficients is frequency-domain technique. These techniques include discrete cosine transform (DCT), discrete Fourier transform (DFT), radon transform, discrete wavelet transform (DWT), etc. In these techniques, the watermark is embedded in the transform co-efficient of the image. These classes are application-dependent and directly affect on the capacity of the watermarking scheme.

## II. Study Literature

There are several research works has been done in watermarking area. Some of the works special domain watermarking which directly change the pixel values of the multimedia elements, and most works are frequency domain based watermarking.

Abdul R. Zubair presented the study about Digital watermarking in spatial domain[1]. The 3-D watermark is first pre-processed by converting it from the rgb color space to an index image. The resulting index image has a 2D matrix and a color map. The color map is stored and is available as part of the watermark extraction key. The 2D matrix is essentially a 2D gray-scale image which is decomposed into a series of binary digital images using stack filter’s threshold decomposition technique. The resulting binary digital images are then used to implement multiple watermarking in the spatial domain. Due to its higher dimensionality, copyright ownership is more secret and robust in multiple watermarking.

Vidyasagar M. Potdar, Song Han presented a Detailed survey of existing and newly proposed steganographic and watermarking techniques[2]. This paper provides classification of the watermarking techniques based on different domains in which data is embedded. Here author gave detailed analysis over 3 watermarking techniques, they are discrete cosine transform (DCT), discrete wavelet transform (DWT), discrete Fourier transform (DFT). We also came to know about the requirements of digital watermarking like transparency, capacity and robustness. Applications of watermarking in several fields are also analyzed. Here we limit the survey to images only.

ShachiNatu, PrachiNatu presented, Improved Robust Digital Image Watermarking with SVD and Hybrid Transform[3], which uses two methods of color image watermarking. Both methods uses SVD and DCT Walsh hybrid transform. First method uses SVD on column hybrid transformed host and watermark images. Second method uses SVD on sorted column hybrid transform coefficients of host and watermark images. In both methods, low frequency transform coefficients are used in contrast to traditional way of using middle frequency coefficients. In first method, 30 singular values of watermark are needed per plane to embed it in host. In second method, this number is drastically reduced to 3 values. This is possible because high energy compaction property of SVD gets further enhanced due to sorting of transform coefficients prior to SVD.

Mauro Barni and Franco Bartolini presented a DCT-domain system for robust image watermarking[4] which is suitable for the marking of grey-level images. A pseudo-random sequence of real numbers having normal distribution with zero mean and unity variance is embedded in a selected set of DCT coefficients. The set is produced by arranging the DCT coefficients in a zigzag scan and by extracting the first L+M coefficients; the lowest L coefficients are then skipped to preserve perceptual invisibility, and the watermark is embedded in the following M coefficients. After embedding, the watermark is adapted to the image being signed by exploiting the characteristics of noise masking of the HVS, to further ensure the watermark invisibility.

Ersin Elbasi and Volkan Kaya presented Robust Medical Image Watermarking using Frequency Domain and Least Significant Bits Algorithms[5]. Here both spatial domain (LSB) and frequency domain (DCT, DWT, DFT) watermarking techniques are used. Watermarking in medical images has been analyzed by using DWT, DCT, DFT and LSB algorithms. The purpose of this study is calculating peak to signal ratio (PSNR) and similarity ratio (SR) values on medical images via different algorithms and comparison of the results. In this work, logo images are inserted into the medical images (MR) utilizing DCT, DWT, LSB and DFT methods and different attacks are connected on the subsequent images. DFT method has been found as the best PSNR value (48, 1430). DCT, DFT and LSB values are almost same. When compares DCT, DFT and DWT methods SR values, DFT SR values are worst SR values As a result embedding in MR images using frequency domain is resist against one group of attack, and embedding using spatial domain resist against another group of attacks.

Sumedh P. Ingale and Prof. C. A. Dhote proposed a study on Digital Watermarking Algorithm using DWT technique[6]. In his work, watermarking technique based on a 3-level discrete wavelet transform is has been implemented. In which DWT transform is performed on both host and watermark image and watermark is embedded the host image with a scaling factor ‘a’. Experiment results shows that the quality of the watermarked image and the recovered watermark are dependent on the scaling factor ‘a’ and also higher scaling factor results in a visible watermark thus we can use scaling factor to make watermarked image visible or invisible according to the need of media distribution.

## III. Methodology

In this scheme, DWT technique used for image decomposition and alpha blending algorithm used for embedding and extraction of a watermark .

### *A. Discrete Wavelet Transform*

A discrete wavelet transform (DWT) is any wavelet transform for which the wavelets are discretely sampled. It is useful for processing of non-stationary signals. Discrete Wavelet Transformation is very suitable to identify the areas in the cover image where a secret image can be embedded effectively. This property allows the exploitation of the masking effect of the human visual system such that if a DWT co-efficient is modified, it modifies only the region corresponding to that coefficient.

In transform small waves which are called wavelets of varying frequency and limited duration are used as mother wavelet. Wavelets are created by translations and dilations of a fixed function called mother wavelet. Wavelet transform provides both frequency and spatial description of an image DWT is the multi resolution description of an image the decoding can be processed sequentially from a low resolution to the higher resolution.

A function (signal) f(x) using discrete wavelet transform can be decomposed into a weighted sum of basic functions (scaling and wavelets functions) shown in eq (1):

$$f(x) = \frac{1}{\sqrt{M}} \sum_k W_\phi(j_0,k)\phi_{j_0,k}(x) + \frac{1}{\sqrt{M}} \sum_{j=j_0}^{\infty} \sum_k W_\psi(j,k)\psi_{j,k}(x), \quad j,k \in \mathbb{Z}, \qquad (1)$$

Where j0 is starting scale, M is the length of the signal, W(j0,k) and W(j,k) are approximation and details coefficients, respectively.

For image, the decomposition of signal f(x, y) of size MxN given in eq (2):

$$f(x,y) = \frac{1}{\sqrt{MN}} \sum_m \sum_n W_\phi(j_0,m,n)\phi_{j_0,m,n}(x,y) + \frac{1}{\sqrt{MN}} \sum_{i=H,V,D} \sum_{j=j_0}^{\infty} \sum_m \sum_n W_\psi^i(j,m,n)\psi_{j,m,n}^i(x,y) \qquad (2)$$

The DWT splits the signal into high and low frequency parts. The high frequency part contains information about the edge components, while the low frequency part is split again into high and low frequency parts. The high frequency components are usually used for watermarking since the human eye is less sensitive to changes in edges.

In 2-D applications, both cover image and watermark is first pre-processed by converting it from the rgb color image to a grey scale image. The 2D matrix are created which essentially a 2D gray-scale images which are decomposed. The resulting digital images are then used to implement multiple watermarking. With this decomposition, the 2D signal is filtered by the filter coefficients g(n) (low-pass filter) and h(n) (high-pass filter) that have two directions X and Y along with a down-sampling in each direction to produce the coefficients of the four sub bands( LL, LH, HL, HH).There are many classes of filters such as Haar, Daubechies, Orthogonal and Bi-orthogonal filters etc. These converts an input series x0, x1....xm into High-pass wavelet coefficient series and Low-pass wavelet coefficient series. After decomposition of the image, the details coefficient and approximation coefficients are obtained which are used by inverse DWT to recompose the original image.[7-8]

After the first level of decomposition, there are 4 sub-bands: LL1, LH1, HL1, and HH1 as shown in the figure 2.1.

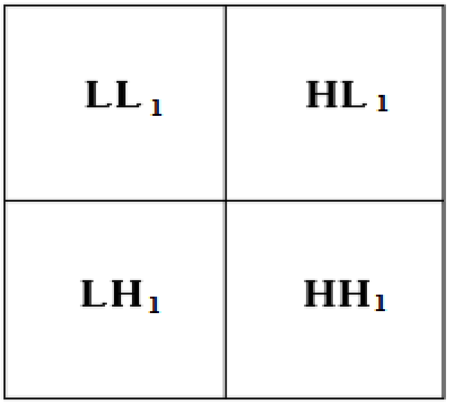


**Figure 2.1: One-level decomposition of an image**

B. *Watermark Embedding and Extraction using Alpha-Blending Algorithm*

- *Embedding Algorithm*

- For this process firstly we apply one-level DWT on host image decomposes the image into sub-images, 3 details and 1 approximation. The approximation looks just like the original.
- The same manner one-level DWT is also applied to the watermark image. For this Haar wavelet is used.
- Then technique alpha blending is used to insert the watermark in the host image. In this technique the decomposed components of the host image and the watermark are multiplied by a scaling factor and are added.

Formula of the alpha blending embedding for watermarked image is given in eq (3)

$$\mathbf{WI=k*(LL1)+q*(WM1)} \qquad (3)$$

Where, WM1 = low frequency approximation of Watermark, LL1 = low frequency approximation of the original image, WI=Watermarked image, k, q- Scaling factors

- After embedding the watermark Image on cover image Inverse DWT is applied to the watermarked image coefficient to generate the final secure watermarked image (WI).

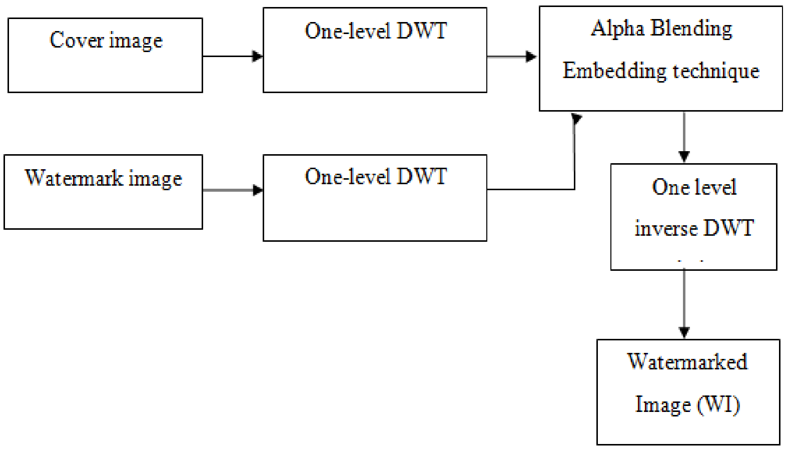


**Figure 2.2: Flow of Watermark Embedding process using Alpha-Blending**

- *Extraction Algorithm*

- For this firstly we applied 1 level DWT to watermarked image and cover image which decomposed the image in sub-bands.
- After this we apply alpha blending on low frequency components.

Formula of the alpha blending extraction for Recover watermark is given by is given in eq (4)

$$\mathbf{RW = (WMI - k*LL1) /q} \qquad (4)$$

RW= Low frequency approximation of Recovered watermark, LL1=Low frequency approximation of the original image, and WMI= Low frequency approximation of watermarked image.

- After extraction process, Inverse discrete wavelet transform is applied to the watermark image coefficient to generate the final watermark extracted image.

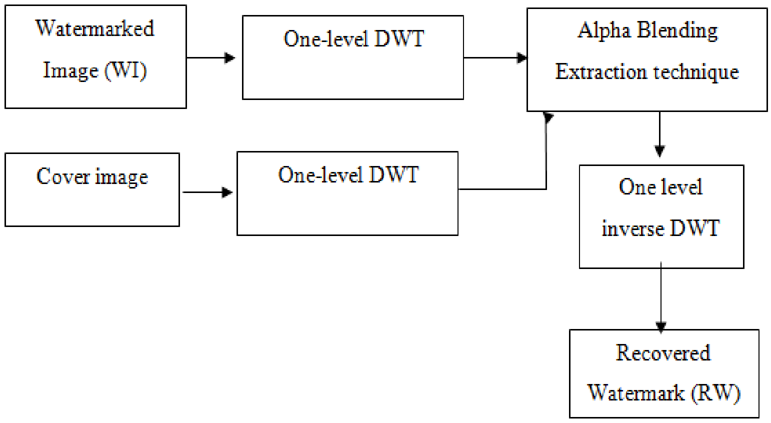


**Figure 2.3: Flow of Watermark Extraction process using Alpha-Blending**

## IV. Experimental Results And Performance Evaluation

In order to evaluate the performance of the watermarking algorithm, the Imperceptibility, the Peak Signal-to-Noise Ratio (PSNR), and Mean Square Error (MSE) must be evaluated.

- **Imperceptibility**

Imperceptibility is one of the important requirements of digital watermarking. Imperceptibility refers to the quality of watermarked media as noticed visually. Hence, imperceptibility depends on human visual system. Since digital watermarking embeds the watermark into a cover, image and is not directly visible to observer. Obviously, there would be distortion introduced to the digital watermarked content caused by embedding process. It is therefore desirable that an algorithm used for watermarking should add minimal distortions to the digital content.

- **Mean Squared Error (MSE)**

It is a method to check distortions between cover image and watermarked image. With the calculation of mean square error, we can detect any change in the watermarked image. Below equation gives the MSE where MxN is the size of the image and MSE is the mean square error between the two images. Below eq 5 shows the MSE between the two images.

$$\text{MSE} = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} (x(i,j) - y(i,j))^2, \qquad (5)$$

- **Peak Signal to Noise Ratio (PSNR)**

The peak signal-to-noise ratio (PSNR), which is used to estimate the imperceptibility, is criteria to evaluate the similarity between the host image x and the watermarked image y. PSNR is a better test to check distortions between original image and watermarked image because it uses mean squared error also. We can calculate PSNR by the following eq 6.

$$\text{PSNR} = 10 \log_{10} \left( \frac{\text{Max}(x(i,j))^2}{\text{MSE}} \right), \qquad (6)$$

A high PSNR implies good imperceptibility of the watermarked image and its high similarity to the original image, and then, the host image is very slightly affected by the embedding process. PSNR is most usually used to check the nature of remaking of lossy image. The image for this situation is the information, and the noise is the error. PSNR is an estimate to human view of reproduction quality. The least acceptable value for PSNR is about 38 dB.

In figure 2.4 cover image and watermark to be embed are selected both of size 512X512.

Cover Image

Watermark

**Figure 2.4: Cover Image and Watermark of size 512X512**

After applying one-level decomposition on both cover image and watermark image and embedding them using alpha blending embedding, Watermarked image having PSNR value of 49.5 db is obtained which is shown in figure 2.5.

**Figure 2.5: Watermarked Image (PSNR=49.5 db)**

To extract the watermark again we need to apply one-level decomposition on cover image and watermarked image and extract watermark using alpha blending extraction which is shown in figure 2.6.

**Figure 2.6: Recovered Watermark**

## V. Conclution And Future Scope

A new robust image watermarking based on discrete wavelet transform (DWT) is introduced. Here DWT properties are used to achieve the watermarking requirements. These properties are the edge detection and perfect reconstruction of the DWT. This scheme also uses alpha-blending technique for embedding and extraction of watermark. The experimental results showed that the scheme is invisible with a high PSNR value.

In future work we can include embedding of multiple watermarks within a single cover image. The DWT technique for decomposition can be extended to include 3-level decomposition. Considering robustness criteria, extraction process can be extended to blind technique to produce more robust digital watermarked image.

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