

A Survey on Digital Watermarking and its Discrete Wavelet Transform Approach

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Abstract: *The technique Digital Watermarking is one of the best method for copyright protection. Protection of digital multimedia content has become an important issue for content owners. Watermarking can be done by using least significant bit (LSB), discrete wavelet transform(DWT), discrete cosine transform(DCT), discrete Fourier transform(DFT), singular value decomposition(SVD). In this paper the watermarking algorithm based on Discrete wavelet transform are used for embedding and extraction of watermark. In this paper the detail study of watermarking, its type, concept based on discrete wavelet transform are proposed. Firstly features of watermark than categories of digital watermark and watermark based on DWT and their algorithm with performance evaluation matrix are proposed. This paper successfully explains the digital watermark technique based on DWT by analyzing various values of PSNR, SNR and MSE.*

Keywords: *Digital Watermarking, Alpha Blending, Discrete Wavelet Transform, PSNR, MSE, SNR.*

1. INTRODUCTION

The technique digital watermarking is one of the best methods for copyright protection. With the rapid growth of internet downloading, a new challenging problem is introduced in copyright protection regarding illegal distribution of privately owned image and security [1]. Digital watermark embeds copyright information into multimedia data. Each watermark method consists of an embedding algorithm and extracting algorithm. Embedding algorithm adds the watermark information in the data and extracting algorithm decodes the watermark information. There are several desirable characteristics that a watermarking technique should exhibit [8]. A watermarking technique should at least include the following requirements:

- **Robustness**-This is the basic property of watermarking. The digital watermark is always present in the image after attacks and can be easily detectable by the user.
- **Readability**-Readability is an important feature of watermark. A watermark should consist as much information as possible.
- **Security**-A watermark should be secret and must be undetectable by user. A watermark should only be accessible by authorized users.
- **Complexity**-Complexity describes the expenditure to detect and encode the watermark information. It is recommended to design the watermarking procedure and algorithm as complex as possible so that different watermark can be integrated.
- **Imperceptibility**-It refers to perceptual similarity between the original and watermark image. That is quality of host image should not be destroyed by presence of watermark.

Types of digital watermarking based on human perception can be divided into two parts visible and invisible watermark. Visible watermarking can be seen directly by the viewers. Invisible watermark cannot be seen by the viewers and it is more robust than visible watermark. Based on level of required information all watermarks are sub divided into

Blind watermark, semi-blind watermark and non-blind watermark. Blind watermark detect the embedded information without the use of original signal. Semi-blind watermark require some special information to detect the embedded data in the watermark signal. On-blind watermark require the original signal to detect the embedded information in the watermarked signal.

Watermarking technique can be divided into two main group's spatial domain watermarking and frequency domain watermarking [1], [4]. Rather than the spatial-domain-based watermarking, frequency-domain-based techniques can embed maximum bits of watermark and also are more robust: thus, they are more use full than the spatial-domain-based watermarking. Spatial domain technique embeds the data by directly modifying the pixel values of the host image, Example is Least Significant bit (LSB) method [5].

Transform Domain Method produce high quality watermarked image by first transforming the original image into the frequency domain by the use of Fourier Transform, Discrete Cosine Transform (DCT) or Discrete Wavelet transforms (DWT).

The transform watermarking is comparatively much better than the spatial domain encoding. In this paper a digital watermarking algorithm based on two dimensions discrete wavelet transform in order to protect digital media copyright efficiently are proposed [8],[5]. Blossom et al. [2] proposed a DCT based watermarking scheme which provides higher resistance to image processing.

2. TYPES OF DIGITAL WATERMARKING

2.1. According to Human Perception

Based on human perception watermarking can be divided into visible watermarks and invisible watermarks.

➤ Visible Watermarks

Visible watermarks can be seen by the user, logo and the owner details are identified by person. These technique changes the original signal.

➤ Invisible Watermarks

Invisible watermarks cannot be seen by other party and output signal does not change when compared to the original signal.

2.2. According to Application

➤ Fragile Watermarks

These technic are more sensitive than other and can be easily destroyed with small modification.

➤ Semi-Fragile Watermarks

If modifications of watermark image are more than the previous threshold then these technic are broken easily.

➤ Robust Watermarks

These methods are used for copyright protection because this type of watermark cannot be broken easily.

2.3. According to Level of Information

➤ Blind Watermarks

Blind watermark are not more robust to any attacks. Embedded information is detected without the use of original image.

➤ *Semi-Blind Watermarks*

Some information's are needed to detect the embedded information to image.

➤ *Non-Blind Watermarks*

These are more robust to blind watermark. Original signals are needed to find the embedded information to the image.

2.4. According to User Authorization

➤ *Public Watermark*

In this watermarking process user are authorized to detect the information of image

➤ *Private Watermark*

Users are not authorized to detect the information into the images. Private watermarking is more robust than the public watermarking.

2.5. According to Domain

➤ *Spatial Domain*

Spatial domain modifies the pixels of randomly selected subsets of images. It directly inserts data into the host image .Example of its algorithms is SSM Modulation based technique and LSB (least significant bit).

➤ *Frequency Domain*

This is also called transform domain. Some examples of transform domain methods are DCT, and DWT. Frequency domain are more robust than the spatial domain.

Hence frequency domain is widely used watermarking technic.

Table 1. Comparison Between Spatial and Frequency Domain

| S.no. | Factors | Spatial domain | Frequency domain |
|-------|--------------------------|------------------------|-----------------------|
| 1 | Cost | Very Low | Very High |
| 2 | Robustness | Fragile | More Robust |
| 3 | Perceptually | Highlycontrollable | low control |
| 4 | Computational complexity | Low | high |
| 5 | Time consumption | Less | more |
| 6 | Application | Authentication purpose | Copy right protection |

3. DISCRETE WAVELET TRANSFORM

Wavelet Transform has become one of the most important and powerful tools of signal representation. It has been used in image and signal processing and data compression.

The DWT processes the image by dividing it into four non-overlapping Multi resolution sub-bands LH, LL, HL, HH. The sub-band LL represents the coarse-scale DWT coefficient while the sub-bands LH, HL, HH represent the fine- scale of DWT coefficient. To obtain the next wavelet coefficients, the sub-bands LL are further decomposed and dividing into four non-overlapping sub-bands. This process is repeated many times.

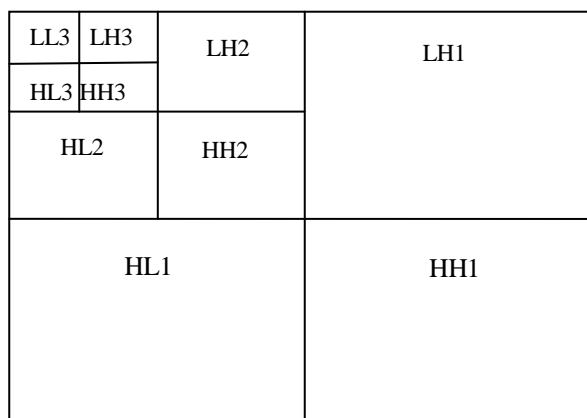


Fig1. Decomposed image by using DWT.

In wavelet transform domain high frequency parts represent detailed information of image edges, contour and texture and so on. Embedding watermarking in this place cannot be easily detected as people are not easily conscious of it. But after processing or attacking it has poor stability.

Low frequency coefficients are nearly unchanged to common attack so that watermarking information in low frequency coefficients has better robustness. to achieve good balance between robustness and invisibility goes for embedding a watermark in second level high frequency sub-bands.

wavelet decomposition can be expressed given below:

$$CI_j = cI_{j+1} + cD_{j+1}^{(h)} + cD_{j+1}^{(v)} + cD_{j+1}^{(d)}$$

The next step is decomposition of cI_{j+1} . after j decomposition steps, decomposed image are obtained in the next form (Fig.1).

4. WATERMARKING EMBEDDED ALGORITHM

The proposed method embeds watermark by decomposing the host image using discrete wavelet transform. For this process firstly apply 3 levels DWT on host image, then decomposes the image into sub-image.

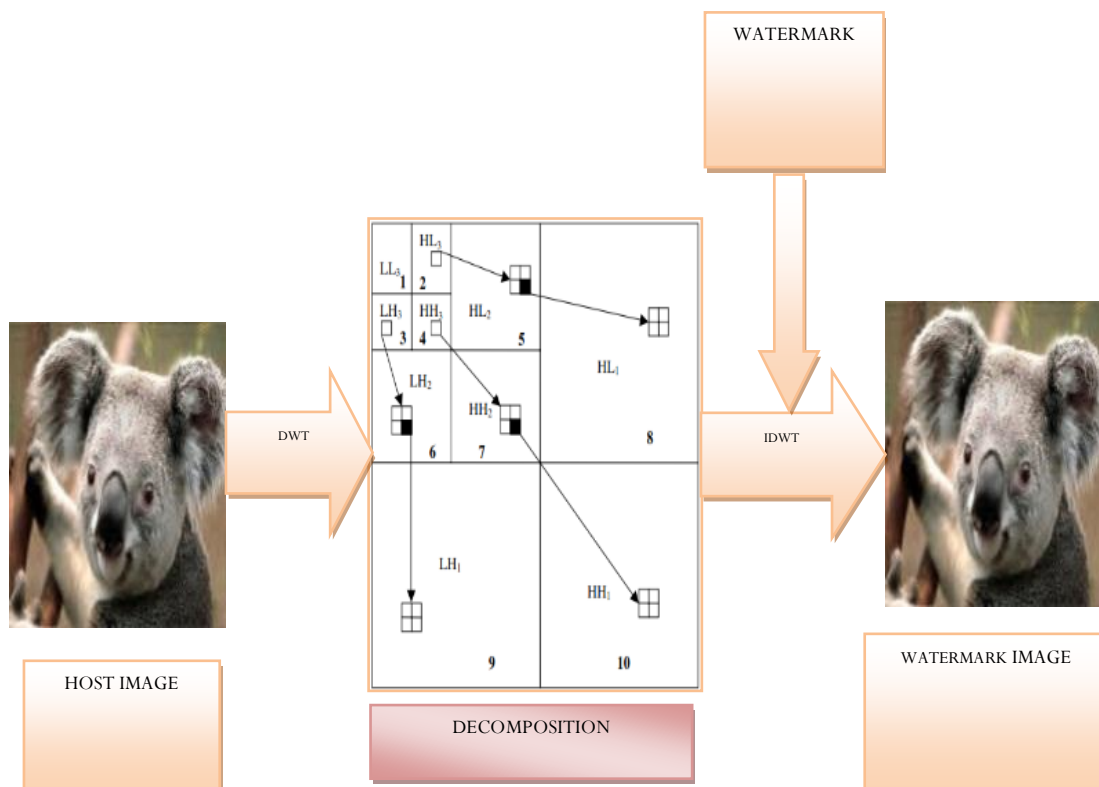


Figure2. Watermark Embedding

Steps of Embedding Watermark

Step1: Decomposition of image into discrete wavelet domain with multiple levels. Three levels are selected for this paper.

Step2: Decompose the watermark image into discrete wavelet domain.

Step3: Select LH3 level and split LH3 sub-image into sub- blocks.

Step4: Transform every sub-block into transform domain. Then embed the watermark into image.

Step5: Inverse DWT is applied to obtain the watermark image.

Flow diagram for steps of embedding process is shown in figure 3. Alpha blending techniques are used for inserting watermark into the host image and for decomposition haar wavelets are used.

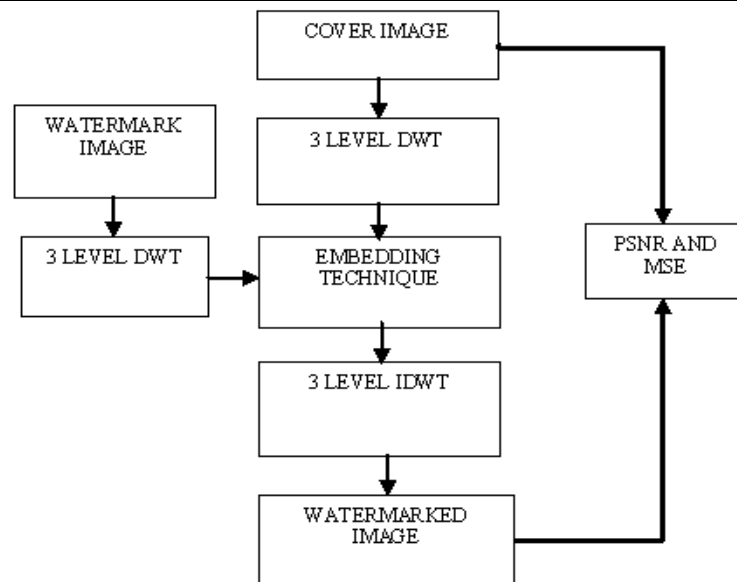


Figure3. Flow Diagram

5. WATERMARKING EXTRACTION

The watermark extraction is the reverse process of watermark extraction. For this 3 level DWT are applied to watermarked image and cover image to obtain the watermark into the images.

In this process Inverse discrete wavelet transform is applied to the watermark image to generate the final watermark image.

6. WATERMAK ALGORITHM BASED ON DWT

In this paper two types of watermarking algorithms based on DWT are proposed. Watermark embedding and extractions are done by these methods.

➤ *Alpha Blending Technique*

This technic embeds or extracts the watermark into image. Two scaling factors are used for multiplying the decomposed image into the watermark image.

Formula for watermark embedding-

$$WMI = K * (LL3) + Q * (WM3)$$

Formula for watermark extraction-

$$RW = \frac{(WMI - K * LL3)}{Q}$$

Where WMI is the watermark image and Q, K are scaling factor

➤ *CDMA-Dwt Watermarking*

To detect the watermark pseudo-random sequence same as CDMA are generated and correlation with the two bands is determined. Threshold between two points are determined if threshold exceeds than the watermark should be detected.

7. PERFORMANCE EVALUATION

➤ *PSNR and MSE Calculation*

Two commonly employed measures to evaluate the imperceptibility of watermarked image is the peak signal to noise ratio and mean square value.

Assuming that the original image X and the watermarked image X' both have image size MxN. Then mean square error between original and watermarked image is given by:

$$MSE = \frac{1}{M \cdot N} \sum_{i=1}^M \sum_{j=1}^N (X(i, j) - X'(i, j))^2$$

PSNR can be calculated by:

$$\text{PSNR} = 10 \cdot \log_{10} \left(\frac{\text{MAX}^2}{\text{MSE}} \right)$$

Where MAX is maximum possible pixel value of the image [10]. Quality of image is measured using peak signal to noise ratio and mean square value. Lower the value of MSE lower the error and better picture quality [4].

➤ *SNR (Signal to Noise ratio)*

SNR measures the sensitivity of the image. It measures the signal strength relative to the background noise. It is calculated by the formula given below

$$\text{SNR} = 10 \text{Log}_{10} \left(\frac{P_{\text{signal}}}{P_{\text{noise}}} \right)$$

8. CONCLUSION

In this paper different aspect for digital watermarking like overview, categories, techniques, applications are presented. This Paper proposes classification of the digital watermarking in the aspects of robustness, application, perceptivity, domain, and detection process. This paper also explains the DWT and its embedding and extraction process in detail. Steps of embedding algorithm are explained and with the help of flow diagram overall watermarking procedure are proposed. Two DWT based watermarking algorithm are also proposed. Aim of this paper is to give the complete information about watermarking and discrete wavelet transform approach.

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