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Digital Image Watermarking in Multimedia Data Compressions Using Robust 3-Level Discrete Wavelet Transform

[1]K.Kamalanathan, [2]G.Nanjappan, [3]N.Rupavathi, [4]Dr.K.Ramesh, [5]R.Bhuvaneswari

[1]PG Scholar, Applied Electronics, Jayam College of Engineering and Technology, Dharmapuri, Tamilnadu, India
[2,3]Associate Professor, Dept. of ECE, Jayam College of Engineering and Technology, Dharmapuri, Tamilnadu, India
[4]Professor, Dept. of ECE, Jayam College of Engineering and Technology, Dharmapuri, Tamilnadu, India
[5]Assistant Professor, Dept. of ECE, Jayam College of Engineering and Technology, Dharmapuri, Tamilnadu, India

***Abstract* - Watermarking is the process of inserting predefined patterns into multimedia data in a way that the degradation of quality is minimized and remain at an imperceptible level. The operation of embedding and extraction of watermark are done in high frequency domain of Discrete Wavelet Transform (DWT) since small modifications in this domain are not perceived by human eyes. This watermarking scheme deals with the extraction of the watermark information in the absence of original image, hence the blind scheme was obtained. Peak Signal to Noise Ratio (PSNR) is computed to measure image quality. The experimental evaluation of the proposed method shows very good results in terms of robustness and transparency to various attacks such as median filtering, Gaussian noise, and JPEG compression. Our project introduces a discrete wavelet transform (DWT) digital watermark algorithm based on human vision characters. By using this technique watermarking signal is embedded into the high frequency band of wavelet transformation domain.**

Keywords: Digital Image, Watermarking, Multimedia, Data Compressions, 3-Level Discrete Wavelet Transform.

I. INTRODUCTION

Development of compression algorithms for multimedia data such as MPEG-2/4 and JPEG standards, and increase in the network data transmission speed have allowed widespread use of applications, which rely on digital data. In other words, digital multimedia data are rapidly spreading everywhere. On the other hand, this situation has brought about the possibility of duplicating and/or manipulating the data. To keep on with the transmission of data over the Internet the reliability and originality of the transmitted data should be verifiable. It is necessary that multimedia data should be protected and secured.

One way to address this problem involves embedding an invisible data into the original data to mark ownership of them. There are many techniques for information hiding, which can be divided into different categories such as convert channels, steganography, anonymity, and watermarking. Convert channels techniques were defined in the context of multilevel secure systems. Convert channels usually handle properties of the communication channels in an unexpected and unforeseen way in order to transfer data through the medium without detection by anyone other than the entities operating the covert channel. Steganography is about preventing the detection of an encrypted data, which has been protected by cryptography algorithms. Anonymity is a technique to find ways to hide the Meta content of transmitted messages such as sender and the recipients.

Digital watermarking has an extra requirement of robustness compared to steganography algorithms against possible attacks. It should be also noted that watermarking is not intended for protecting of the content of a message, and hence it is different from cryptography. In this thesis we focus on the robustness of the digital watermarking algorithms in the transform domain against common attacks.

Research Goals

Not all watermarking methods are suitable for a particular application. The suitability of a method depends on the type of data, the processing or transformations applied on data, the lossy or lossless type of compressions used, the key type used, etc. An objective and quantitative measurement on the suitability of each method for a given application is of great importance and usefulness. The project work will include the following steps:

- We study the main DCT and DWT watermark algorithms. The transform watermark algorithms are more robust than spatial domain.

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- We study different watermark attacks such as removal attacks, and geometric attacks.
- We implement several important transform watermark algorithms and we test their robustness using different attacks.

II. PROPOSED SYSTEM

In this system a 3 level DWT based image watermarking technique has been implemented. Here a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique which can be recovered by extraction technique. The technique used here for inserting the watermark is alpha blending. In this technique the decomposed components of the host image and the watermark are multiplied by a scaling factor and are added. In this process firstly 3-level DWT is applied to watermarked image and cover image which decomposed the image in sub-bands. After that the watermark is recovered from the watermarked image by using the formula of the alpha blending.

Proposed System Implementation

A 3 level DWT based image watermarking technique has been implemented. This technique can embed the invisible watermark into the image using alpha blending technique which can be recovered by extraction technique.

DWT is the multiresolution description of an image the decoding can be processed sequentially from a low resolution to the higher resolution. 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 two dimensional applications, for each level of decomposition, we first perform the DWT in the vertical direction, followed by the DWT in the horizontal direction. After the first level of decomposition, there are 4 sub-bands: LL1, LH1, HL1, and HH1. For each successive level of decomposition, the LL sub band of the previous level is used as the input. To perform second level decomposition, the DWT is applied to LL1 band which decomposes the LL1 band into the four sub- bands LL2, LH2, HL2, and HH2.

To perform third level decomposition, the DWT is applied to LL2 band which decompose this band into the four sub-bands – LL3, LH3, HL3, HH3. This results in 10 sub-bands per component. LH1, HL1, and HH1 contain the highest frequency bands present in the image tile, while LL3 contains the lowest frequency band. The three-level DWT decomposition is shown in Figure below.

DWT is currently used in a wide variety of signal processing applications, such as in audio and video compression, removal of noise in audio, and the simulation of wireless antenna distribution. Wavelets have their energy concentrated in time and are well suited for the analysis of transient, time-varying signals. Since most of the real life signals encountered are time varying in nature, the Wavelet Transform suits many applications very well.

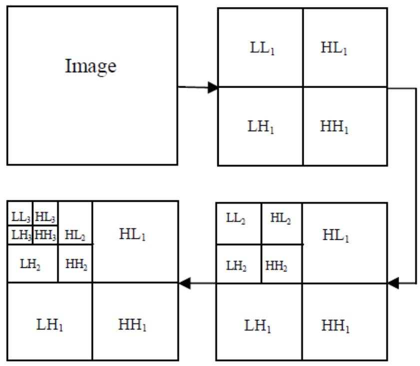

Figure 1: Level Discrete Wavelet Decomposition

The DWT Process

A signal is split into two parts of high frequencies and low frequencies. The part with the low frequencies is split again into two parts of high and low frequencies. The part with the high frequencies is basically the edge components of the signal. The DWT and IDWT for two dimensional images z[m,n]can be defined by:

DWTn [DWTm[x[m,n]]]

DWT Pyramid Decomposition

An image can be decomposed into a pyramid structure with various band information such as:

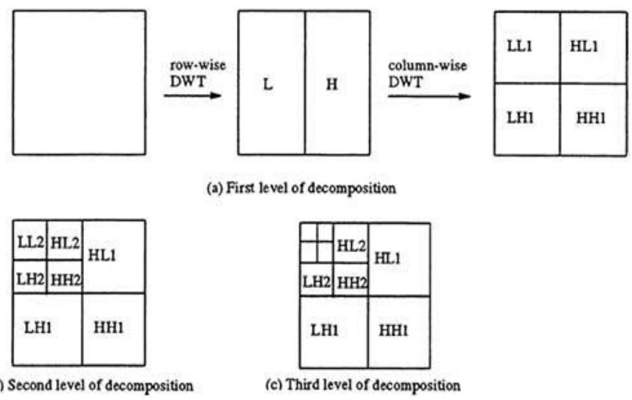

Figure 2: HH, LH, LL and HL frequency bands

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The host image and the watermark are transformed into the wavelet domain. In two dimensional applications, for each level of decomposition, we first perform the DWT in the vertical direction, followed by the DWT in the horizontal direction.

After the first level of decomposition, there are 4 sub-bands: LL1, LH1, HL1, and HH1. For each successive level of decomposition, the LL subband of the previous level is used as the input.

To perform second level decomposition, the DWT is applied to LL1 band which decomposes the LL1 band into the four sub- bands LL2, LH2, HL2, and HH2.

To perform third level decomposition, the DWT is applied to LL2 band which decompose this band into the four sub-bands – LL3, LH3, HL3, HH3.

This results in 10 sub-bands per component. LH1, HL1, and HH1 contain the highest frequency bands present in the image title, while LL3 contains the lowest frequency band.

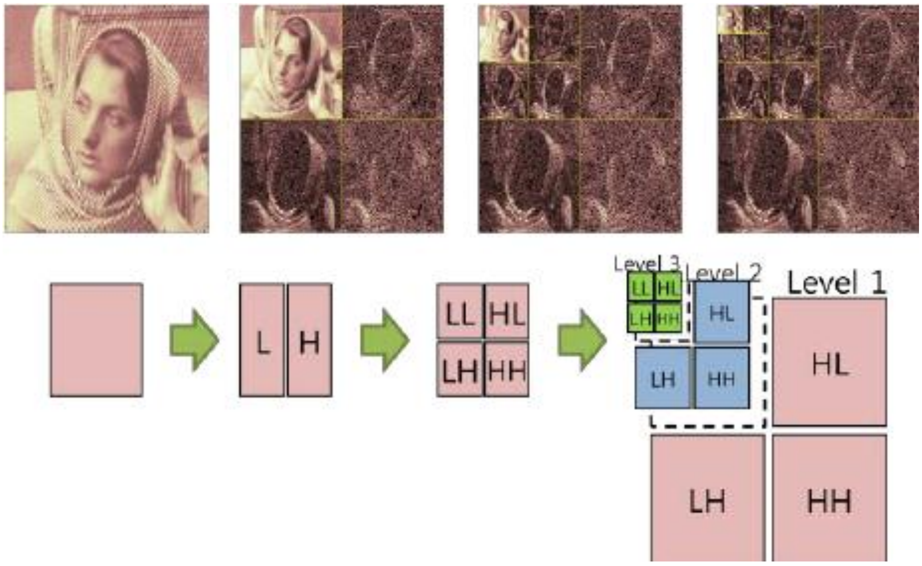

Figure 3: DWT pyramid decomposition of Image

III. WATERMARK EMBEDDING

For this process firstly we apply 3 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 3 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. Since the watermark embedded in low frequency approximation Component of the host image So it is perceptible in nature or visible.

Alpha blending: formula of the alpha blending the watermarked image is given by

WMI=k*(LL3) +q*(WM3) WM3 = low frequency approximation of Watermark,

LL3 = low frequency approximation of the original image, WMI=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.

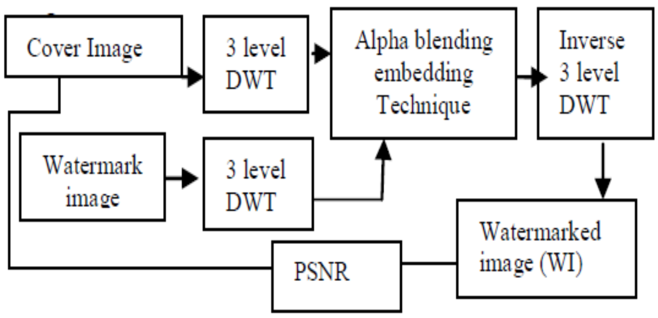

Figure 4: Watermark embedding process by 3 levels DWT

IV. WATERMARK EXTRACTION

For this firstly we applied 3 levels DWT to watermarked image and cover image which decomposed the image in sub-bands. After this we apply alpha blending on low frequency components.

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Alpha blending: Formula of the alpha blending extraction for Recover watermark is given by

$$RW = (WMI - k*LL3) /q$$

RW= Low frequency approximation of Recovered watermark, LL3=Low frequency approximation of the original image, And WMI= Low frequency approximation of watermarked image.

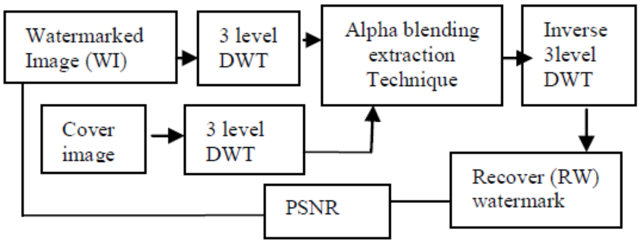

Figure 5: Watermark extraction process by 3 level DWT

After extraction process, Inverse discrete wavelet transform is applied to the watermark image coefficient to generate the final watermark extracted image. Fig. 4 shows the watermark extraction process.

V. CONCLUSION

An image watermarking technique based on a 3-level discrete wavelet transform has been implemented. This technique can embed the invisible watermark into salient features of the image using alpha blending technique. Here a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique which can be recovered by extraction technique. The reconstructed image quality of the watermark image is identical to the original images.

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