

Color image multiple watermarking scheme based on discrete wavelet transform

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Abstract - Digital Watermarking is an important technique in the area of information security. The proposed scheme is based on Discrete Wavelet Transform (DWT). The embedding and extraction process using multi-resolution analysis of wavelet Transform. A developed algorithm embeds the watermark, information without much distortion to the image and to extract the watermark, information in the absence of original image. The proposed method has good imperceptibility on the watermarked image, superior in terms of Peak Signal to Noise Ratio (PSNR).

Keywords - Correlation; Discrete Wavelet Transform; Multiple watermarking; PSNR.

I. INTRODUCTION

Digital watermarking technology has evolved very quickly these years. Digital watermarking is an important specialized area for the advancement of image processing technology. The image watermarking technique is one of the important techniques which are used for safeguarding the origins of the image by protecting it against Piracy. Digital watermarking is the process of embedding information into a digital image in a way that is difficult to remove.

Watermarking techniques can be broadly classified into two categories: spatial domain methods and transform domain methods. For transform domain schemes, the host image is first converted into frequency coefficients by a transformation method such as the discrete cosine transforms (DCT), discrete Fourier transforms (DFT) and discrete wavelet transforms (DWT). Among the transform domain watermarking techniques, wavelet transform based watermarking techniques are gaining more popularity. Numerable work relating to DWT watermarking method has been reported.

A detail survey on wavelet based watermarking techniques can be found in [1]. To elaborate suitability of wavelet transform for image watermarking, wavelet transform based image watermarking process, classification and analysis of wavelet based watermarking techniques is proposed in [2]. Digital watermarking on still images using Wavelet transform is proposed in [3]. Xia et al. [4] has proposed two-level decomposition using the Haar wavelet filters. Their method the pseudo Random Noise codes are only added to the large coefficients of the

high and middle frequency bands of the DWT transformed image. An image accreditation technique based on DWT by embedding digital watermarks in images is proposed in [5].

A novel image watermarking technique in the wavelet domain is suggested and tested in [6]. Their method to achieve more security and robustness, their techniques relies on using two nested watermarks that are embedded into the image to be watermarked. A primary watermark in form of a PN sequence is first embedded into an image (the secondary watermark) before being embedded into the host image. Peter et al. [7] has proposed three novel blind watermarking schemes to embed watermarks into digital images. The single watermark embedding (SWE) can embed one watermark bit sequence. The multiple watermark embedding (MWE) can use correlated keys to embed multiple watermark bit sequences simultaneously such that individual watermark bit sequence can be decoded or detected independently. The iterative watermark embedding (IWE) can embed watermark in a JPEG file and ensure it is detectable. Experimental results shows that the three proposed watermarking algorithms give watermarked images with good visual quality. Multiple watermarks can be used to address multiple applications or one application may be addressed several times [8]. Two visual watermarks are embedded in the DWT domain through modification of both low and high frequency coefficients are explained in [9]. A novel robust multiple watermarking techniques for color images in spatial domain are proposed in [10]. Their method the host image is divided into four different regions. An invisible watermarking technique is proposed in [11], to embed multiple binary watermarks into digital images based on the concept of Visual Cryptography (VC).

The performance of orthogonal and biorthogonal wavelet filters for image compression presented in [12]. They evaluated their method by objectively and subjectively. A new color image watermarking scheme based on the color quantization technique is proposed in [13]. Experimental results are shown to demonstrate the validity of the proposed scheme, which can be applied to other multimedia applications that are based on the color quantization technique. A grayscale visual watermark image is inserted into the host color image using the Haar Wavelet Transform, where the copyright of Watermark is printed in [14]. A new robust watermarking scheme is proposed in

[15], which provides a complete algorithm that embeds and extracts the watermark information effectively.

In this paper a watermarking technique is proposed, to directly embed multiple watermarks into a single image. The watermark embedding process the multiple watermarks are embedded into original image. The extraction processes recover the watermark from the watermarked image. The experimental results have shown this scheme has preferable performance of imperceptibility. This paper is organized as follows; the suggested technique (Discrete Wavelet Transform) is proposed in section II. The multiple watermarking is explained in section III. The Proposed algorithms for watermark embedding are explained in section IV. The Proposed algorithms for watermark extraction are explained in section V. The discussions are presented in section VI. Finally, concluding remarks are given in section VII.

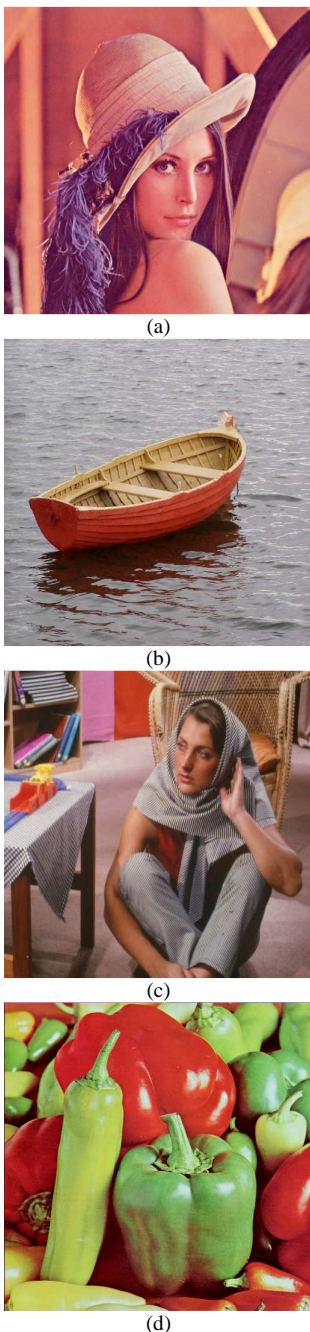


Fig. 1. Original Images (a) Lena (b) Boat (c) Barbara (d) Peppers

II. THE SUGGESTED TECHNIQUE

An image watermarking algorithm that operates on the wavelet domain is suggested here. It features imperceptibility on the watermarked image as well as robustness of extracted watermark. A gray scale watermark image is inserted into the original color image using the daubechies Wavelet Transform. Fig.1 shows the set of original images 512×512 size of Lena, Boat, Barbara and Peppers as the color images.

The proposed scheme is based on two-dimensional DWT, each level of produces four bands of data, one corresponding to the approximation sub-band (LL), and three other corresponding to horizontal (HL), vertical (LH), and diagonal (HH) sub-bands. The decomposed image shows an approximation image in the lowest resolution low pass band. The low pass band can further be decomposed to obtain another level of decomposition. Fig. 2 shows the two level decomposition of Lena image.

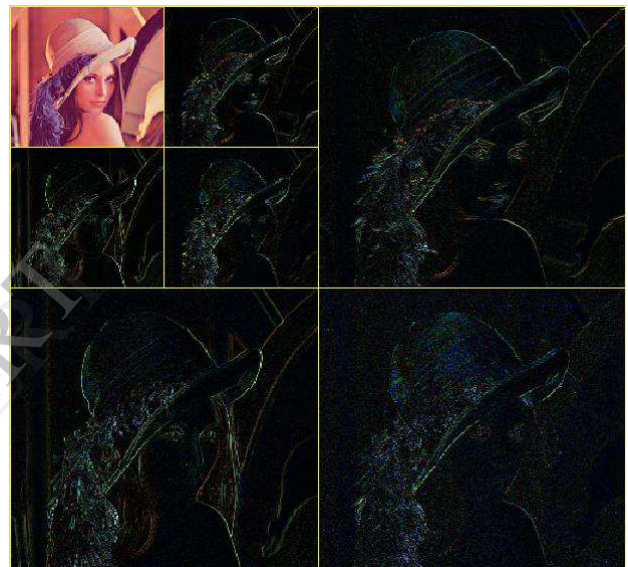


Fig. 2. Two level wavelet Decomposition of Lena image

III. MULTIPLE WATERMARKING

Most watermarking algorithms support single watermark embedding, but there are great limitations when single watermarking algorithms are tried into practical applications in few rare situation, like when multiple users share the copyright, it is need to support multiple users to embed their watermarks synchronously. This highlights the need for multiple watermarking. To advocate several goals one might wish to embed multiple watermarks into the same image so as to achieve the “robustness” to large range of image processing operations.

Fig. 3 shows 32×32 size gray scale logo is used as watermark image, such as watermark 1 and watermark 2.



Fig. 3. (a) Watermark 1 (b) Watermark 2

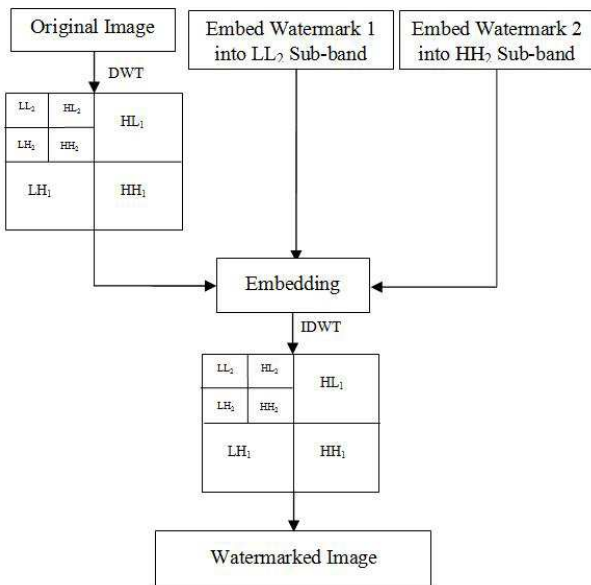


Fig. 4. Watermark Embedding Process

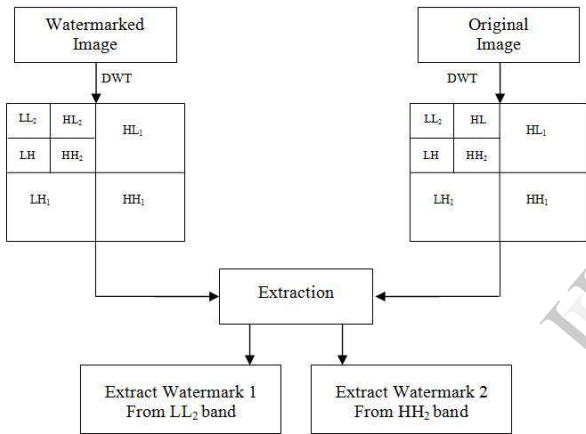


Fig. 5. Watermark Extraction Process

IV. THE EMBEDDING ALGORITHM

The proposed method embeds multiple watermarks by decomposing the original image. The watermark used for embedding is a binary logo image, which is small compared with the size of the original image. The block diagram of watermark embedding process is shown in Fig. 4.

The original image is decomposed by 2-levels using DWT. The watermark W_1 is embedded in LL_2 sub-band and the watermark W_2 is embedded in HH_2 sub-band. The watermarked image can be obtained by the following equation.

$$WI(i, j) = I(i, j) + \alpha \times w(i, j) \tag{1}$$

Where, WI = watermarked image,

w = watermark,

I = cover Image and



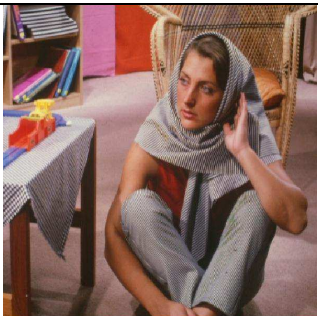
α = scaling factor which determine the strength of watermark.

The inverse wavelet transform is performed to get the watermarked image. To evaluate the performance of watermarking technique is the peak signal to noise (PSNR). Peak Signal to Noise Ratio (PSNR) is used to measure quality of watermarked image, it is given by









$$PSNR(dB) = 10 \log_{10} \frac{255^2}{MSE} \tag{2}$$

The TABLE I shows the imperceptibility evaluation of watermarked images on Lena, Boat, Barbara and Peppers images and lists the PSNR value for image quality. Fig. 6. shows comparison of PSNR for various test images.

TABLE I WATERMARKED IMAGES ON LENA, BOAT, BARBARA AND PEPPERS IMAGES AND ITS IMAGE QUALITY (PSNR)

Images	Watermarked Images	PSNR in db
Lena		54.9412
Boat		54.9391
Barbara		54.9391

Peppers		54.3031
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Lena		0.9354		0.9796
Boat		0.9399		0.9780
Barbara		0.9348		0.9781
Peppers		0.9322		0.9787

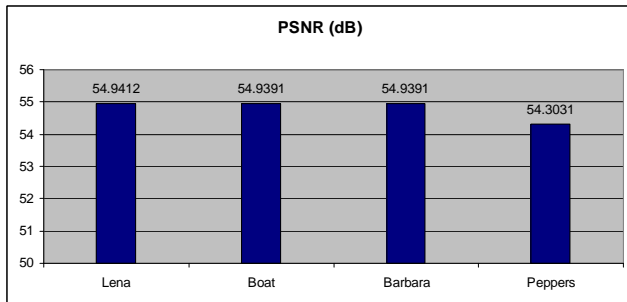


Fig. 6. Comparison of PSNR for various test images

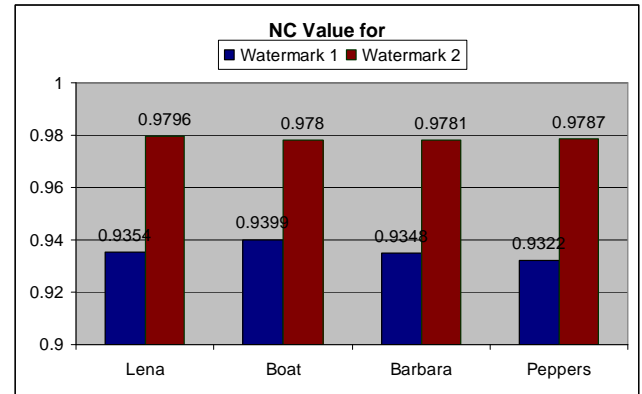


Fig. 7. Comparison of NC values for Extracted Watermark 1 and Extracted Watermark 2

V. THE EXTRACTION ALGORITHM

The watermark extraction processes are the inverse process of watermark embedding, shown in Fig. 5. Thus the watermark can be recovered exactly from the watermarked image by recovery process.

The watermarked image and the original image is decomposed by 2-levels, using Discrete wavelet transform. The watermark W_1 and W_2 can be extracted from the watermarked image sub-bands LL_2 , and HH_2 respectively. Then it is divided by the watermark strength factor α . This is summarized as follows,

$$w'(i, j) = (W(i, j) - I(i, j)) / \alpha \quad (3)$$

Normalized Correlation is used to measure the quality of watermark after recovery. The NC between the embedded watermark $W(i, j)$ and the extracted watermark $W'(i, j)$ is defined as

$$NC = \frac{\sum_{i=1}^H \sum_{j=1}^L W(i, j) \times W'(i, j)}{\sum_{i=1}^H \sum_{j=1}^L [W(i, j)]^2} \quad (4)$$

The TABLE II shows the extracted watermarks on Lena, Boat, Barbara and Peppers images and lists the values of Normalized Correlation. Fig. 7. shows comparison of NC values for extracted watermark 1 and watermark 2.

TABLE II. EXTRACTED WATERMARKS ON LENA, BOAT, BARBARA AND PEPPERS IMAGES AND ITS NC VALUES

Images	Watermark 1		Watermark 2	
	Extract from LL_2 band	NC	Extract from HH_2 Band	NC
Lena	0.9354	0.9354	0.9796	0.9796
Boat	0.9399	0.9399	0.9780	0.9780
Barbara	0.9348	0.9348	0.9781	0.9781
Peppers	0.9322	0.9322	0.9787	0.9787

VI. DISCUSSIONS

In this paper, the multiple watermarking scheme is proposed based on discrete wavelet transform for color images. The proposed algorithm uses daubechies wavelet which has the property of regularity when compared to other wavelet transform. The proposed method is two level of decomposition. The multiple watermarks are embedded in original image, to achieve better visual quality on watermarked image. The advantage of the proposed method has preferable performance of imperceptibility and used as the color images of Lena, Boat, Barbara and Peppers images.

VII. CONCLUSION

In this paper, we proposed a multiple watermarking scheme on DWT. In the embedding process, the multiple watermarks are embedded to original image. In the extracting process, the original watermark is retrieved from the watermarked image. The proposed method has good imperceptibility on the watermarked image and superior in terms of Peak Signal to Noise Ratio (PSNR). As a future initiative, to achieve a high robustness for geometric, non geometric and common image processing attacks.

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