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Research Paper

GENERIC APPROACH FOR INVISIBLE WATERMARKING

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In this paper generic image watermarking technique is used for the copyright protection of gray scale images based on 2-level Discrete Wavelet Transform (DWT). In this technique a multi-bit watermark is embedded into the low frequency sub-band of a cover image by using alpha blending technique. The insertion and extraction of the watermark in the grayscale cover image is found to be simpler than other transform techniques. The proposed method is compared with the 1-level DWT based image watermarking methods by using statistical parameters such as Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). The results demonstrate that the watermarks generated with the proposed algorithm are invisible and the quality of watermarked image and the recovered image are improved.

Keywords: Alpha blending, Discrete wavelet transform, MSE, PSNR

INTRODUCTION

Digital watermarking methods for images are usually categorized into two types: invisible and visible. The first type aims to embed copyright information imperceptibly into host media such that in cases of copyright infringements, the hidden information can be retrieved to identify the ownership of the protected host. It is important for the watermarked image to be resistant to common image operations to ensure that the hidden information is still retrievable after such alterations (Bo Shen *et al.*, 1998; and Juan *et al.*, 2009). Methods of the second type, on the other hand, yield visible watermarks which are generally clearly visible after common image operations are applied. In addition, visible watermarks convey ownership information directly on the media and can deter attempts of copyright violations (Schynde *et al.*, 1994; Frank and Martin, 1999; and Robert and Shanmugapriya, 2009).

Embedding of watermarks, either visible or invisible, degrade the quality of the host media

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in general. A group of techniques, named reversible watermarking, allow legitimate users to remove the embedded watermark and restore the original content as needed (Nikolaidis and Pitas, 1998; and Jobin and Varghese, 2011).

Discrete Wavelets Transform (DWT) is the most effective and easy to implement techniques in watermarking (Kundur and Hatzinakos, 1998; Xiang *et al.*, 1998; Evelyn *et al.*, 2008; Akhil and Agya, 2011; Nilanjan *et al.*, 2011; and Vaishali and Sachin, 2011). DWT has been used in digital image watermarking more frequently due to its excellent spatial localization and multi-resolution characteristics. The biggest issue in DWT-based image watermarking is how to choose the coefficients to embed the watermark. The most common approaches include modifying the largest DWT coefficients in all decomposition levels or quantizing certain DWT coefficients in different levels and scales. This paper contributes to the implementation of 2-level DWT based image watermarking, in which the watermark is embedded in the image using the alpha blending technique.

Compared with their invisible counterparts, there are relatively few mentions of lossless visible watermarking in the literature. Several lossless invisible watermarking techniques have been proposed in the past. The most common approach is to compress a portion of the original host and then embed the compressed data together with the intended payload into the host. Another approach is to superimpose the spread-spectrum signal of the payload on the host so that the signal is detectable and removable. A third approach is to manipulate a group of pixels as a unit to embed a bit of information.

PROPOSED DWT TECHNIQUE

Firstly the gray scale host image is taken and 2D 2-level Discrete Wavelet Transform (DWT) is applied to the image which decomposes image into low frequency and high frequency components. In the same manner 2D 2-level DWT is also applied to the watermark image which is to be embedded in the host image. The wavelet used here is the wavelets of daubecheis (Kundur and Hatzinakos, 1998). The technique used here for inserting the watermark is alpha blending (Akhil and Agya, 2011; and Nilanjan *et al.*, 2011).

Watermark Embedding

In this technique the decomposed components of the host image and the watermark are multiplied by a scaling factor and are add-ed. Since the watermark embedded in this paper is perceptible in nature or visible, it is embedded in the low frequency approximation component of the host image.

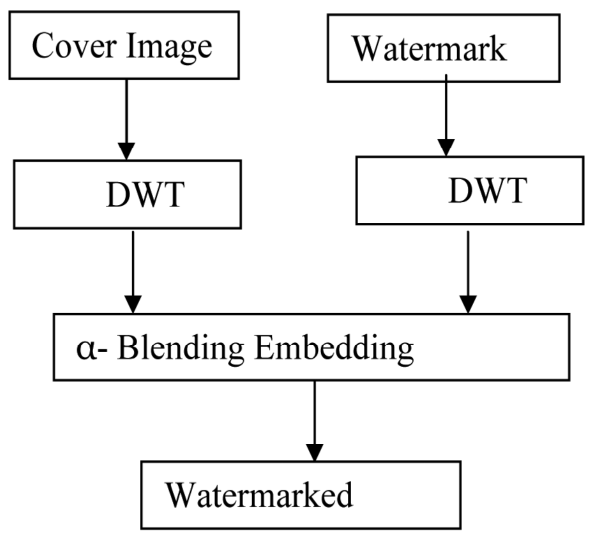
According to the formula of the alpha blending (Akhil and Agya, 2011) the water-marked image is given by

$$WM1 = k*(LL2) + q*(WM2)$$

Where $WM1$ = low frequency component of watermarked image, $LL2$ = low frequency component of the original image obtained by 2-level DWT, $WM2$ = low frequency component of Watermark image, and k, q = Scaling factors for the original image and water-mark respectively.

After embedding the cover image with watermark image, 2-level Inverse discrete wavelet transform is applied to the watermarked image coefficient to generate the final secure watermarked image. Figure 1 shows watermark embedding process.

Figure 1: Watermark Embedding Technique



Watermark Extraction

In this process firstly 2-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.

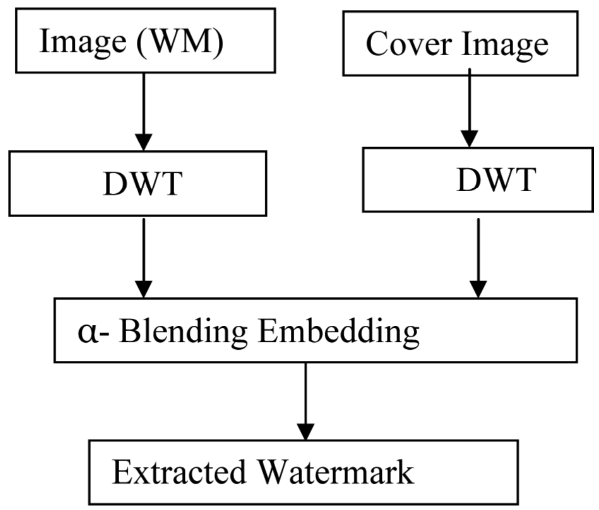
According to the formula of the alpha blending the recovered image is given by

$$RW = (WM1 - K * LL2)$$

Where RW = Low frequency approximation of Recovered water-mark, $LL2$ = Low frequency approximation of the original image, and $WM1$ = Low frequency approximation of watermarked image.

After extraction process, 2-level Inverse discrete wavelet trans-form is applied to the watermark image coefficient to generate the final watermark extracted image.

Figure 2: Watermark Extraction Technique



EXPERIMENTAL RESULTS

In our experimental results for DWT watermarking we have used grayscale images Lena as original image and the cameramen's image as the water-mark. Both the images are of equal size of 256 × 256.

We measure the quality of watermarked images in terms of Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). In ideal case PSNR should be infinite and MSE should be zero. But it is not possible for watermarked image. So, large PSNR and small MSE is desirable. To see that if the recovered watermark is identical to the one that is embedded we calculate only MSE. In this case it should be zero.

DWT

The original image and the watermark image are shown in Figures 3 and 4.

For embedding of watermark in the original image the value of scaling factor k is varied from 0.2 to 0.9 by keeping q constant and best result is obtained for k = 0.98 for both 2 level

Figure 3: Original Image

Figure 4: Watermark Image

and 1-level DWT. As the value of k is decreased further to 0.1 the watermarked image becomes darker and finally becomes invisible.

For the process of recovering the watermark from the water-marked image the value of k is kept constant at 0.009 and q is

Figure 5: Watermarked Images Using 2-Level DWT for Various Values of Scaling Factors k

for k = 0.6, q = 0.009 | for k = 0.78, q = 0.009 | for k = 0.98, q = 0.009 | for k = 1.5, q = 0.009

Figure 6: Recovered Images Using 2-level DWT for Various Values of Scaling Factors q

for k = 0.009, q = 0.6 | for k = 0.009, q = 0.78 | for k = 0.009, q = 0.98 | for k = 0.009, q = 1.5

varied from 0.1 to 0.9. For the higher values of *q* the watermark becomes almost invisible and as the value of *q* is reduced best result is obtained, and if *q* is further reduced the recovered water-mark becomes darker and PSNR decreases.

The values of the MSE and PSNR are calculated for various values of the scaling factors *k* and *q* for both 1-level DWT and 2-level DWT.

From Tables 1 and 2, it can be observed that the value of PSNR is higher in case of 2-level DWT as compared to 1-level DWT for both the watermarked and recovered image. Thus the performance of the proposed 2-level algorithm is better than that of the performance of 1-level DWT.

Table 1: Comparison of 1-Level DWT and 2-Level DWT for Watermarked Image in Terms of MSE and PSNR

S. No.	Scaling Factor		Level 1		Level 2	
	Q	k	MSE	PSNR	MSE	PSNR
1.	1	0.009	8.1844	39.0351	5.113	41.07
2.	0.8	0.009	10.1178	38.1139	6.570	39.98
3.	0.6	0.009	12.4938	37.1978	8.649	38.90
4.	0.4	0.009	16.2390	36.0590	11.440	37.57
5.	0.2	0.009	25.5112	34.0975	17.720	35.67

Table 2: Comparison of 1-Level DWT and 2-Level DWT for Recovered Image in Terms of MSE and PSNR

S. No.	Scaling Factor		Level 1		Level 2	
	Q	k	MSE	PSNR	MSE	PSNR
1.	0.9	0.009	Min	Max	Min	Max
2.	0.8	0.009	0.011	67.4930	0.0050	Max
3.	0.6	0.009	0.560	50.6470	0.0856	58.840
4.	0.4	0.009	4.423	41.9104	0.9781	48.260
5.	0.2	0.009	16.230	36.0612	7.1019	39.654

CONCLUSION

In this thesis, an image watermarking technique based on a 2-level discrete wavelet transform has been implemented. This technique can embed the invisible watermark into salient features of the image using alpha blending technique. Experiment results shows that the quality of the watermarked image and the recovered watermark are dependent only on the scaling factors *k* and *q*. Experiment results also shows that 2-level DWT provide better performance than 1-level DWT. All the results obtained for the recovered images and the watermark are identical to the original images

FUTURE SCOPE

Watermarking is an emerging research area for copyright protection and authentication of electronic documents and media. Most of the research is going on in this field, spatially in the field of image watermarking. The reason might be that there are so many images available at Internet without any cost, which needs to be protected.

The watermarking technique given in this paper can be further improved to increase the hiding capacity of images without affecting the imperceptibility of the images.

The other future scope is that DWT technique can be enhanced to embed colored nested watermark in colored image.

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