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Comparison of Successive and Segmented Watermarking Techniques for Colour Images

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ABSTRACT
The successive and segmented watermarking techniques are in the division of multiple watermarking techniques. The proposed method, comparison of multiple watermarking techniques by using discrete wavelet transforms. In successive watermarking technique, the watermarks are embedded one after the other. In segmented watermarking technique, one watermark is embedded into odd-numbered rows and another watermark is embedded into even-numbered rows. The extraction process multiple watermarks are extracted from the watermarked images. The proposed scheme shows good performance on original colour images in terms of imperceptibility. The segmented watermarking has better visual quality on watermarked image when compared with successive watermarking.

Keywords
Multiple Watermarking, DWT, Segmented watermarking, Re-watermarking, PSNR.

1. INTRODUCTION
Digital watermarking technology has evolved very quickly these years. Digital watermarking is an important specific area for the advancement of image processing technology. A variety of invisible watermarking schemes have been reported in recent years which can be broadly classified in two categories: spatial-domain and frequency-domain technique [1]. Spatial domain watermarking slightly modifies the pixels of one or two randomly selected subsets of an image. The watermarking scheme based on the frequency domains can be classified into the Discrete Fourier Transform, Discrete Cosine Transform and Discrete Wavelet Transform methods.

Most watermarking algorithms supports one watermark embedding, but there are great restrictions when one 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. The three main categories of multiple watermarking techniques are composite, successive and segmented watermarking. In composite watermarking, all watermarks are combined into a single watermark which is subsequently embedded in one single embedding step. The segmented watermarking, the host data is partitioned into disjoint segments a priory and each watermark is embedded into its specific share [2]. The successive watermarking, watermarks are embedded one after the other. This approach is also denoted Re-watermarking in literature [3].

In this paper a digital image multiple successive and segmented watermarking scheme based on wavelet transform is proposed. In the proposed method, the PSNR and image quality are degraded with every one new watermark embedded into image. This paper is organized as follows; a literature survey is discussed in section 2. The multiple watermarking techniques are explained in section 3. The proposed algorithms for watermark embedding and extraction process are explained in section 4. Conclusion of the present work is given in section 5.

2. A BRIEF LITERATURE SURVEY
The Multi Resolution Analysis (MRA) represents and analyzes signals (images) at different frequencies with different resolutions [4]. Digital watermarking using biorthogonal wavelet transform are presented in [5]. Their method is robust against several attacks. Sheppard et al. [6] distinguish three main categories of multiple watermarking techniques: The categories are composite, successive and segmented watermarking.

The classical robust watermarking techniques for multiple re-watermarking are discussed [7]. Their method focused on a comparison of the usefulness of blind and non-blind algorithms. Glen E. Wheeler et al. [8] proposed weighted segmented watermarking of still images in which segments are formed by dividing the image into square blocks, each of which contains one contributor's watermark. If a watermark is present in one or more segments of the work, the owner of that watermark is reported to be an owner of the work as a whole by an arbiter. Nantha Priya et al. [9] proposed the segmented image is modelled as mixture generalized Gaussian distribution and this model is the basis of mathematical analysis of various aspects of the watermarking processes such as probability of error, embedding strength adjustment. A new approach to image watermarking in wavelet domain is presented in [10]. Their method to hide the watermark data in blocks of the block segmented image.

3. MULTIPLE WATERMARKING
Fig.1 shows 512 × 512 size original colour image is used as Barbara image and 32 × 32 size gray scale logo is used as watermark images, such as watermark1 and watermark2.

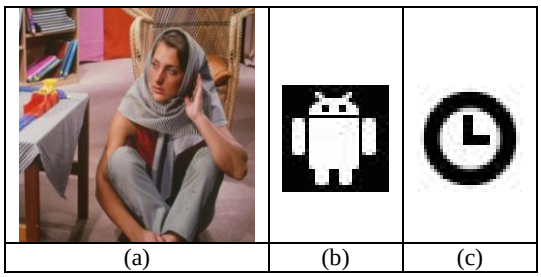

Fig 1. (a) Barbara image (b) Watermark1 (b) Watermark2

The proposed method uses multiple successive and segmented watermarking techniques for embedding and extraction. The successive watermarking method is to embed the watermarks one after other, from the watermarked images the watermarks are extracted from one after other. Fig. 2 shows the block diagram of multiple successive watermarking by using two watermarks.

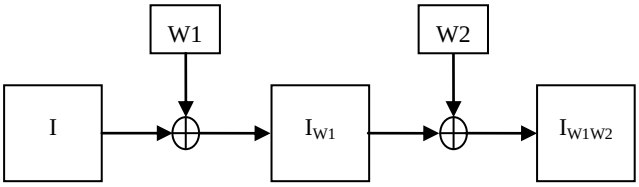

Fig. 2. Multiple Successive Watermarking

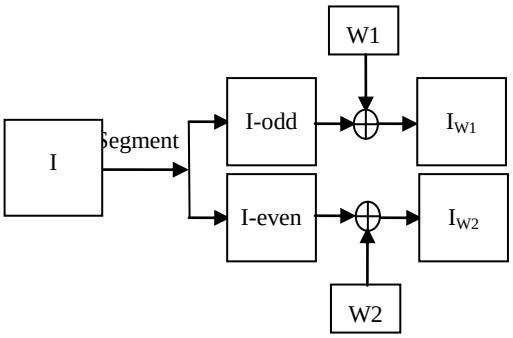

Fig. 3. Multiple Segmented Watermarking

In segmented watermarking method, the original image is partitioned into disjoint segments a priory and each watermark is embedded into its specific share. The proposed method one watermark is embedded into odd-numbered rows and other watermark is embedded into even-numbered rows. The name is also called interleaved watermarking. Fig. 3 shows the block diagram of multiple segmented watermarking by using two watermarks. Fig. 4 shows the multiple segmented watermarking of odd-numbered rows and even-numbered rows images.

Fig 4. (a) Odd-numbered rows image (b) Even-numbered rows image

4. PROPOSED SCHEME

The proposed method is embedding of multiple watermarks by decomposing the original image using discrete wavelet transform. The watermarks used for embedding is a binary logo image, which is very small compared with the size of the original image. Table 1 shows the steps for watermark embedding are briefly listed for successive and segmented watermarking as follows,

Table 1. The steps for embedding process of successive and segmented watermarking

Method 1 **Successive watermarking technique**
1. The original image is decomposed by two levels by using discrete wavelet transform. 2. The watermark1 is embedded into the colour original image in LL_2 sub band, by the following equation $$I_{W_1}(i,j) = I(i,j) + \alpha \times W1(i,j) \quad (1)$$ Where, I_{W1} = Watermarked Image1 W1 = Watermark1 I = Original Image and α = Scaling factor which determine the Strength of watermark. 3. The inverse wavelet transform is performed to get the watermarked image1 4. Similarly, the watermark2 is embedded into the watermarked images1, to get the watermarked image2.

Method 2 **Segmented watermarking technique**
1. The original image is segments into odd-numbered rows and even-numbered rows images. 2. The odd-numbered rows and even-numbered rows images are decomposed by two levels by using discrete wavelet transform. 3. The watermark1 is embedded into odd-numbered rows image of LL_2 sub band and the watermark2 is embedded into even-numbered rows image of LL_2 sub band, by the following equation

$$I_{W1}(i,j) = I_{odd}(i,j) + \alpha \times W1(i,j) \quad (2)$$

$$I_{W2}(i,j) = I_{even}(i,j) + \alpha \times W2(i,j) \quad (3)$$

where,

I_{W1} = Odd watermarked Image

I_{W2} = Even watermarked Image

W1 = Watermark1

W2 = Watermark2

I_{odd} = Odd-numbered rows image

I_{even} = Even-numbered rows image

α = Scaling factor which determine the Strength of Watermark.

4. The inverse wavelet transform is performed to get the odd watermarked image and the even watermarked image.

The performance of watermarking technique can be evaluated by peak signal to noise Ratio (PSNR). The PSNR is used to measure the quality of watermarked image, which is given by

$$PSNR(dB) = 10 \log_{10} \frac{255^2}{MSE} \quad (4)$$

Table 2 shows the imperceptibility evaluation of watermarked images on Barbara images and lists the PSNR value for image quality of successive and segmented watermarking. Fig. 5. Shows the comparison of PSNR value for successive and segmented Watermarking. The proposed method segmented watermarking is to achieve better visual quality on watermarked images when compared with successive watermarking.

Table 2. PSNR Values for Watermarked Images of Successive and Segmented Watermarking

Multiple Watermarking Techniques	**Watermarked images PSNR (dB)**	
	Watermarked Image1	Watermarked Image2
Successive Watermarking		
	PSNR = 68.9184	PSNR = 63.6349
Segmented Watermarking	Odd watermarked Image	Even Watermarked Image
		
	PSNR = 68.9184	PSNR = 67.2108

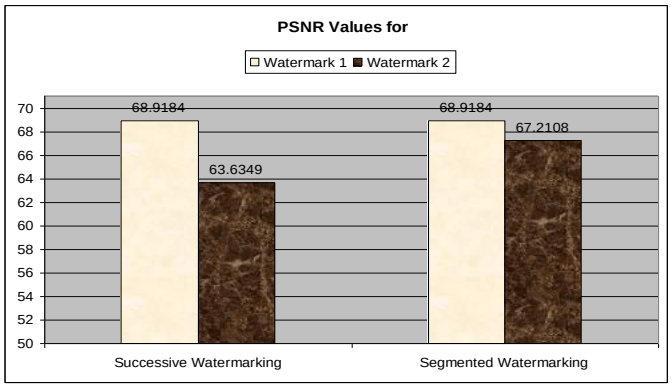

Fig. 5. Comparison of PSNR for Successive and Segmented Watermarking

The watermark extraction processes are the inverse process of watermark embedding. Table 3 shows the steps for watermark extraction are briefly listed for successive and segmented watermarking as follows,

Table 3. The steps for extraction process of successive and segmented watermarking

Method 1
Successive watermarking technique

1. The watermarked image2, watermarked image1 and original image is decomposed by two levels by using discrete wavelet transform
2. The watermark2 can be extracted from the watermarked image2 and watermarked image1 in LL_2 sub band. Then it's divided by the watermark strength factor α is given as follows,

$$W1(i,j) = I_{W1}(i,j) - I(i,j)) \Big/ \alpha \quad (5)$$

3. The watermark1 is extracted from the watermarked image1 and original image by repeating the above steps.

Method 2
Segmented watermarking technique

1. The odd watermarked image, odd-numbered rows image, even-numbered rows image and the even watermarked image is decomposed by two levels by using discrete wavelet transform.
2. The watermark1 can be extracted from the odd watermarked image and odd-numbered rows image in LL_2 sub band. Then it's divided by the watermark strength factor α is given as follows,

$$W1(i,j) = I_{W1}(i,j) - I_{odd}(i,j)) \Big/ \alpha \quad (6)$$

3. The watermark2 can be extracted from the even watermarked image and even-numbered rows image in LL_2 sub band. Then it's divided by the watermark strength factor α is given as follows,

$$W2(i,j) = I_{W2}(i,j) - I_{even}(i,j)) \Big/ \alpha \quad (7)$$

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

$$NC = \frac{\sum_{i=1}^{H}\sum_{j=1}^{L} W(i,j) \times W'(i,j)}{\sum_{i=1}^{H}\sum_{j=1}^{L} [W(i,j)]^2} \quad (8)$$

Table. 4. NC values for extracted watermarks images of successive and segmented watermarking

Multiple Watermarking Techniques	**Extracted watermarks**	
Successive Watermarking	Watermark1	Watermark2
		
	NC = 1	NC = 1
Segmented Watermarking	watermark1	Watermark2
		
	NC = 1	NC = 1

The Table 4 shows the extracted watermarks on Barbara images and lists the values of Normalized Correlation.

5. CONCLUSION

In this paper, a successive and the segmented watermarking techniques are proposed. The embedding and extraction process using multi-resolution analysis of wavelet transform for colour images. In the embedding process, the multiple watermarks are embedded into the original image and the extracting process; the original watermarks are extracted from the watermarked images. The segmented watermarking vividly shows achieve better visual quality on watermarked image when compared with successive watermarking. As a future initiative, to compare a composite watermarking and to achieve a high robustness for geometric, non geometric and common image processing attacks.

6. REFERENCES

7. Cox, I.J., Miller, M.L., Bloom, J.A., 1999, Digital Watermarking, Morgan Kaufmann.
8. Raj J. Jaiswal and Nitin N. Patil, "Multiple watermarking for text documents: a review", World Journal of Science and Technology, 2012, 176-179.
9. Daniel Mark, Andreas Uhl, and Hartmut Wernisch. Experimental Study on Watermark Interference in Multiple Re-Watermarking, Carinthia Tech Institute (CTI), Salzburg University, Austria.
10. Gonzalez, R.C., and Woods, R.E., 2002, Digital Image Processing, Prentice Hall, USA.
11. Suhad Hajjara, Moussa Abdallah and Amjad Hudaib. "Digital Image Watermarking using Localized Biorthogonal Wavelets", European Journal of Scientific Research, 2009, Vol. 26, No.4, 594 – 608.
12. Sheppard, N. P., Shafavi-Naini, R., and Ogunbona, P., 2001, On multiple watermarking. In Proceedings of the ACM Multimedia and Security Workshop (MMSW).
13. Mascher – Kampfer, A., Stogner, H., and Uhl, A., 2006, Multiple re-watermarking scenarios. In Proceedings of the 13th International Conference on Systems, Signals, and Image Processing (IWSSIP).
14. Wheeler, GE., Sheppard, NP., and Safavi-Naini, R., 2004, Weighted Segmented Digital Watermarking, Third International Workshop on Digital Watermarking. (IWDW).
15. Nantha Priya, N.R., and Lenty Stuwart, S., "Robust Feature Based Image Watermarking Process", International Journal of Computer Applications, 2010, Volume 4.
16. Hamed Dehghan and Ebrahim Safavi, S., 2010, Robust Image Watermarking in the Wavelet Domain for Copyright Production, In Proceedings of the ICEE.