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Robust Invisible Digital Image Watermarking using Discrete Wavelet Transform

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Abstract: **This paper describes a digital image watermarking scheme using discrete wavelet transform. In this scheme, digital image watermarking algorithm is based on the DWT coefficients. A defined algorithm does not change any information of the original image. It combines the information of low frequency DWT coefficients and the watermark image. This combination is used as key, which is used to for extraction of the watermark. Watermark extraction can be simply done because the proposed algorithm does not change any information of the original image. Quality of the original image remains unaffected.**

Keywords- Digital image watermarking, Discrete Wavelet transform, DWT coefficients, etc.

I. INTRODUCTION

Now-a-days, due to enormous use of digital contents in every field information handling on internet and multimedia network system is in digital form. Different theories for digital image watermarking are presented by different authors. The surveyed literature on digital image watermarking is as follows: The technique for robust watermarking of encrypted and compressed images is suggested by A. V. Subramanyam et al [1]. The proposed watermarking algorithm in this paper gives watermarking of JPEG 2000 compressed and encrypted images. This is advantageous in case of watermarking of compressed and encrypted images. Prof. Mahendra M. Dixit et al. [2] have suggested method of invisible image watermarking. Proposed algorithm uses variable scaling factor and combination of Discrete Wavelet Transform (DWT) and singular value decomposition (SVD). New method to improve robustness has been presented by Shakti Kundu et al [3]. This paper uses singular value of watermark image and singular value of 3rd-level DWT approximation matrix of original image are embedded. The genetic algorithm is used to optimize the scaling factor with which the watermark is embedded to host image. Under various attacks watermark robustness of watermarking has been defined. Jingbing Li et al. [4] give watermarking of medical images. The studied method uses Arnold transform and Discrete Wavelet Transform. The watermarking image is scrambled by Arnold transform to enhance its privacy. The scheme has benefits at visual invisibility and robustness. Neeraj Bhargava et al. [5] have presented digital image authentication using digital image watermarking. For authentication, watermarking of image is carried out using Discrete Wavelet Transform. Also it presents algorithm using Matlab. Discrete Wavelet Transform based digital image watermarking is done by GU Tianming Et Al [6]. In this article, an algorithm based on DWT coefficients is summarized also it presents basic procedure of watermark embedding as well as watermark extraction. An algorithm defined in this paper does not change any information of original image it will not affect the quality of original image. Vaishali Jabade et al. [7] give comparison of different techniques used for digital image watermarking. This paper elaborates suitability of wavelet transform for image watermarking, wavelet transform based image watermarking process, classification and analysis of wavelet based watermarking techniques. It also defines about Discrete Wavelet Transform; characteristics of Discrete Wavelet Transform. Feng Shi et al. [8] have suggested digital watermarking algorithm based on singular value decomposition and Discrete Wavelet Transform. For optimizing the image Arnold scrambling algorithm is used. By combining the characteristics of singular value decomposition and processing the singular decomposition of wavelet transform image enhances the digital watermark invisibility and robustness effectively. Chih-Chin Lai et al. [9] presents image watermarking technique to satisfy perceptibility and robustness. This is the basic paper that presents about the robustness scheme. This defines a hybrid technique based on Discrete Wavelet Transform and singular value decomposition. A new technique for increasing robustness of image watermarking is presented by Jiang-Lung Liu et al. [10]. This paper suggests robust watermarking scheme for copyright protection. Proposed method is based on Discrete Wavelet Transform and it achieves watermark embedding by taking difference values of original image and reference image to overcome weak robustness problem of embedding watermark.

II. PROPOSED WATERMARKING SCHEME

A. Watermark Embedding Process:

To embed watermark into the host image, some steps have to be followed. Steps are as shown in following figure 1:

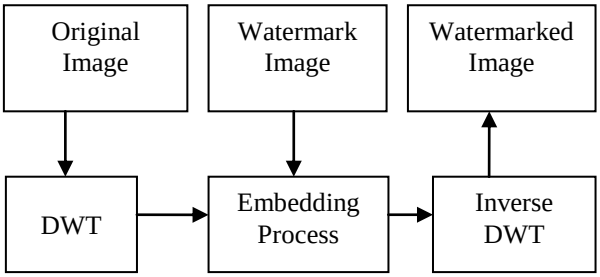

Fig. 1 Watermark embedding in wavelet domain

a. Original image is transformed into wavelet domain using Discrete Wavelet Transform. DWT decomposes the image into the sub-bands such as LL, HH, LH and HL. DWT coefficients are obtained from sub-bands.

b. Discrete Wavelet Transform decomposes an image as shown in the figure 2.

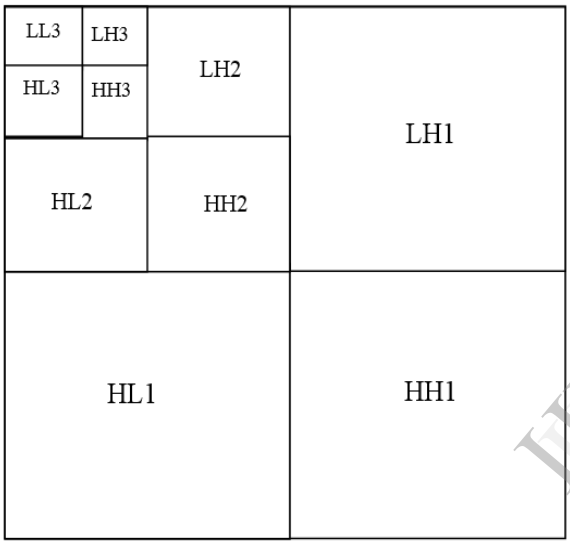

Fig. 2 DWT Decomposition of an Image using 3-Level Pyramid

c. After applying DWT, watermark image that has to be inserted to host image is selected and embedded into the host image along with key.

d. Then IDWT i.e. Inverse Discrete Wavelet Transform is to be taken and hence watermarked image will be obtained.

B. Watermark Extraction Process:

Watermarked image will be selected and decomposed into sub-bands using Discrete Wavelet Transform and DWT coefficients are obtained from sub-bands. Using key watermark image will be extracted

To extract watermark from the image, following steps are followed as shown in figure 3:

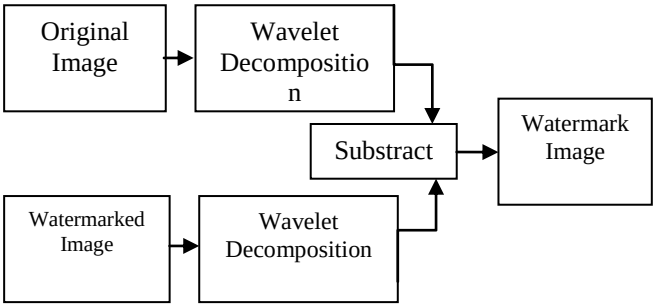

Fig. 3 Watermark extraction process

III. RESULTS AND DISCUSSION

Several tests are conducted to perform proposed approach using MATLAB platform. The gray level original image of size 256×256 and watermark image of size 128 ×128 are used. Fig. 4(c) shows watermarked image.

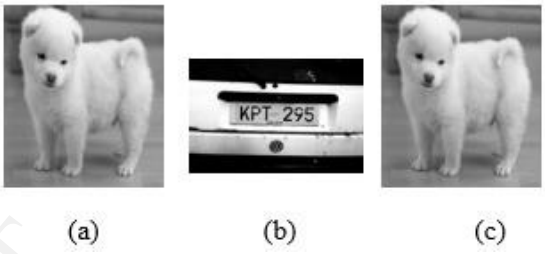

Fig.4 (a) 256x256Original image (b) Watermark image (c) Watermarked image

Extraction of watermark image from watermarked image is done as shown in Fig 5 (b) & (a) respectively. After watermark extraction process, original image is also obtained as shown in Fig. 5 (c). Contents of original image remain unchanged even if watermarking process is done.

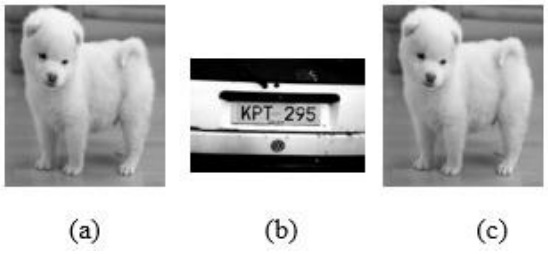

Fig.5 (a) Watermarked image (b) Watermark image and (c) Original image

Peak signal to noise ratio (PSNR) is used as a performance evaluation metrics for measure of quality of watermark image. PSNR is measured in decibels (dB).

$$\text{PSNR} = 10 \log_{10} \frac{255X255}{\text{MSE}} \text{(dB)} \qquad (1)$$

Where, Mean Square Error can be calculated as

$$\text{MSE} = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} [f(i,j) - f'(i,j)]^2}{M \text{ X } N} \qquad (2)$$

In this case, f is original image and f' is watermarked image. Table I show experimental results of watermark embedding and watermark extraction process.

Table I Experimental Results

Sr. No	Process	Mean Square Error (MSE)	PSNR(dB)
1.	Watermark Embedding	0.3532	52.65
2.	Watermark Extraction	22.4923	34.64

IV. CONCLUSION

Conclusions obtained are summarized as follows

a. Wavelet based digital image watermarking scheme by embedding watermark with low frequency area of wavelet domain has been proposed.
b. A digital image watermarking scheme using Discrete Wavelet Transform is implemented.
c. Watermark image is simply extracted because the proposed algorithm does not change any information of the original image. Quality of the original image remains unaffected.
d. Proposed digital image watermarking scheme has been implemented using Matlab software.

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