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Discrete Wavelet Transform Based Optoelectronic Water Mark Technology

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ABSTRACT
An Optoelectronic watermark technology plays a vital role in Authentication and in enhancement of invisible watermark code display or to extract the invisible watermark code from the object image. By using this technique the image can be watermarked and it can extract the higher resolution image. A flat-panel display is used to demonstrate the invisible data hidden behind the watermark codes embedded into the object image by use of the installer. The variation of the prototype for taking out the watermark codes is made by using viewer. The Discrete Wavelet Transform and Inverse Discrete Wavelet Transform (DWT/IDWT) scheme is used in 3-level watermarking. The 3-level DWT is used to display the invisible hidden watermark code and extract the image with better quality with limited execution time. The performance can be analyzed by the PSNR value and MSE value of the object image. Watermark technique is used to increase the Security, Robustness, Payload and Quality. This technology finds excessive application in Business and Industry.
Keywords- *DWT/IDWT; watermark extraction; optoelectronic watermark technology.*

1. INTRODUCTION

A Watermark is used to identify the image or pattern in the paper that appears as various shades of lightness/darkness which is viewed by transmitted light (or when viewed by reflected light, atop a dark background), caused by thickness or density variations. Watermarks have been used on postage stamps, currency, and other government documents to discourage counterfeiting. The process of hiding digital information in a carrier signal is known as "Watermarking" [9]. Traditional watermarks may be applied to visible media (like images or video), whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models.

In watermark there are Geometric distortions that are simple and effective attacks rendering many watermarking methods useless. This make detection and extraction of the embedded watermark difficult or even impossible by destroying the synchronization between the watermark reader and the embedded watermark [1-4]. There are few criteria which is to be considered mainly they are capacity, Payload, Transparency, Computational complexity, Robustness [2]. To overcome all these criteria optoelectronic watermark technology is used.

The objective of optoelectronic watermark technology is for authenticating and to enhance the invisible watermark code display or to extract the invisible watermark code from the object image [5]. It is used in electronic devices and systems for source detect and control light, usually considered a sub-field of photonics. The current studies are to propose a series of new display systems of huge size built with optoelectronic watermark technology combined with one or more smart phones [6-8]. The main objective of this project is to minimize the difficulty in process of watermark extraction which is termed as computational complexity by using the suitable watermark technique and the algorithm [4]. Discrete Wavelet Transform (DWT) is used for its robustness against various attacks. It is operated in real time while maintaining the good perceptual visual quality measured in terms of PSNR [3].

2. PROPOSED SYSTEM

The process of watermark extraction is used to minimize the difficulty which is termed as computational complexity. The Discrete Wavelet Transform (DWT) is used to view the invisible hidden watermark code.

2.1 Block Diagram

The input image is termed as the original image. The image which is used to hide the input image is termed as watermark image. Original information of the input image is hidden by this watermark image. A watermarking algorithm is used to hide the input image with the watermark image.3-level DWT watermarking algorithm is used. Final output image obtained after using watermarking algorithm is termed as the watermarked image.

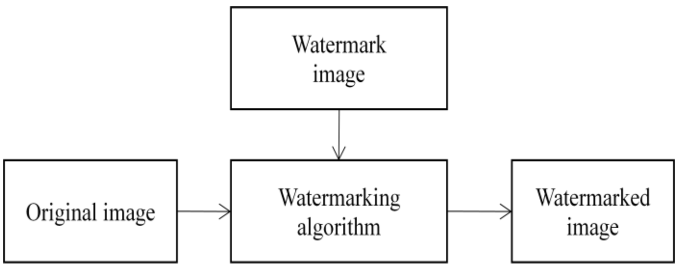


Fig.1 Block diagram

A 2D or 3D image is used as a input image. This image is embed with the watermark code in form of an image using Inverse Discrete Wavelet Transform (IDWT).This converts the visible watermark code pattern to invisible watermark code pattern. In order to segregate or to extract that data or image from this watermark code the Discrete Wavelet Transform (DWT) is used.

2.2 3 -level wavelet transform

The DWT splits the signal into high and low frequency parts. The low frequency part contains coarse information of signal while high frequency part contains information about the edge components. 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 is first performed in 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 DWT on 2 level it is performed by DWT on LL1 & for 3Level decomposition the DWT is applied on LL2 & finally the 4 sub band of 3 level that are LL3, LH3, HH3, HL3 is obtained.

2.3 Watermark Embedding

3 level DWT is applied on input image. It decomposes the image into sub-image. The approximation looks as if like the original image. At the same manner 3 level DWT is applied to the watermark image. Then alpha blending technique is used to insert the watermark in the input image.

In this technique the decomposed components of the input image and the watermark are multiplied by a scaling factor and are added. Since the watermark is embedded in low frequency approximation Component of the input image so it is detectable in nature or visible. Alpha blending: formula of the alpha blending the watermarked image is given by WMI=x*(LL3) +y*(WM3) WM3 = low frequency approximation of Watermark, LL3 = low frequency approximation of the original image, WMI=Watermarked image, x, y-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.

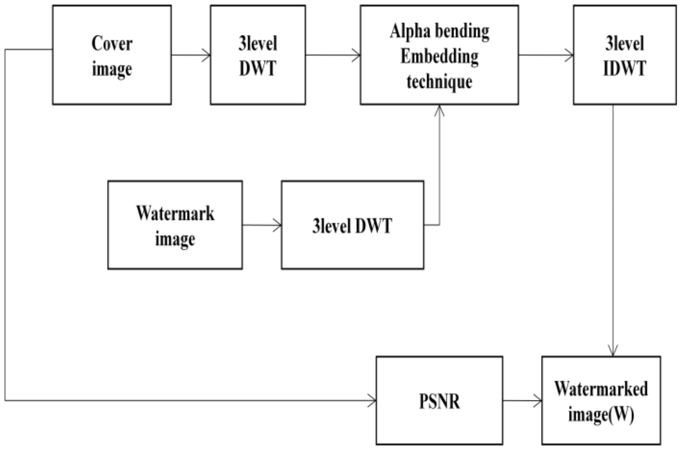


Fig.2 Watermark embedding process by 3-level DWT

2.4 Watermark Extraction

To implement this technique a gray scale images of bike as original image and the cherry's image as watermark is used. Both the images are of equal size of 256X256. For embedding of watermark in the original image the Value of scaling factor x is varied from 0.2 to 2 by keeping x constant and best result is obtained for x=0.99 & y=0.009.

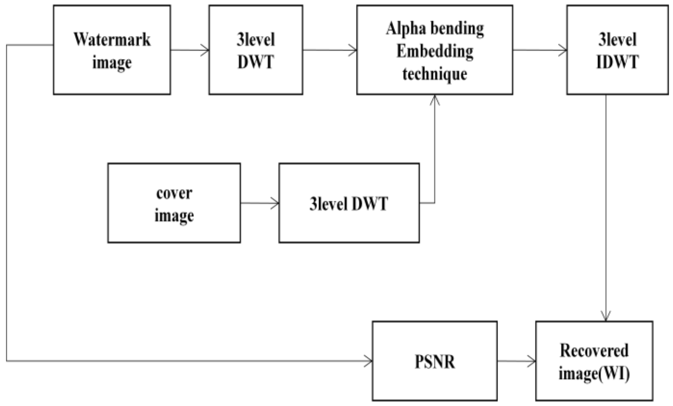


Fig.3 Watermark extraction process by 3-level DWT

As the value of k is decreased further to 0.2 the watermarked image becomes darker and finally become invisible and when the value of x is further increased above 2 the value of PSNR gets decreased & the value of MSE gets increased. This can be viewed by the watermarked image using discrete wavelet transform for different value of x & y in fig 3.6.4 (a)-(c) and the value of PSNR & MSE in table I accordingly.

For the process of recovering of the watermark from the watermarked image the value of x and y are same as for embedding. In this Method it is considered as that the original image & value of x are known for extraction. Recovered image using 1, 2 and 3 level discrete wavelet transform are independent of scaling factor which are shown in fig 5

(a) Original image (b) Watermark image

Fig.4 Original and Watermark image

Best result for watermarked image & recovered image is obtained at x= 0.99 & y=0.009.

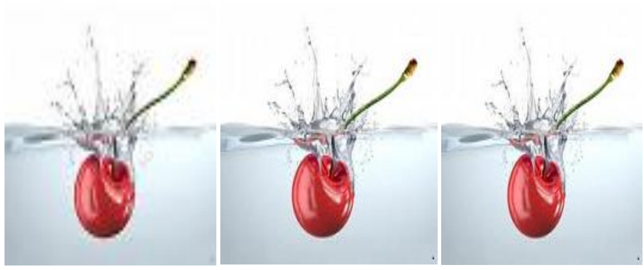
(a) x=1.5,y=0.009 (b) x=0.98,y=0.009 (c) x=0.78,y=0.009

Fig.5 Watermarked images using 3-level DWT for various values of Scaling factor x

In this process first the 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. According to the formula of the alpha blending the recovered image is given by

$$RW = (WMI - x*LL3).$$

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



(a)for x=1.5,y=0.009 (b) for x=0.98,y=0.009 (c) for x=0.78,y=0.009

Fig.6 Recovered images using 3-level DWT for various values of Scaling factor x and y.

After extraction process, 3-level Inverse discrete wavelet transform is applied to the watermark image coefficient to generate the final watermark extracted image. Fig. 6 shows the watermark extraction process.

3. EVALUATED PARAMETERS

The Peak Signal to Noise Ratio (PSNR) is used to estimate the quality between the original image and the watermarked image. The technique shows efficient extraction of Watermark with higher PSNR value of embedded image. If PSNR value is higher than certain threshold, it represents original watermarked image and tested watermarked image are almost identified. However, if PSNR value is lower than certain threshold, it means that tested watermarked image suffer from attach. PSNR value is most easily defined via the Mean Squared Error (MSE) value. Given a noise free m x n Monochrome Image I and its noisy approximation X.

MSE is defined as

MSE= $1/mn \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [\, I(i,j) - k(i,j)]^2$

The PSNR is defined as:

$$PSNR = 10.\log_{10}(MAX_I^2/MSE)$$
$$= 20.\log_{10}(MAX_I/\sqrt{MSE})$$
$$= 20.\log_{10}(MAX_I) - 10.\log_{10}(MSE)$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255.

4. SIMULATION RESULTS

The input or cover image (bike) fig: 7 is done with the 3-level DWT and it is embedded with the watermark image which is used here as cherry fig:8. After applying watermark embedding technique the 3-level DWT watermarked image Fig:9 Finally watermark extraction technique is used. Simulated output of extracted image is obtained in the following representation.

Fig.7 Simulation output of 3-level DWT of cover image

Fig.8 Simulation output of 3-level DWT watermark image

Fig.9 Simulation output of the extracted image

Fig.10 Simulation output of 3-level DWT watermarked image

5. RESULT ANALYSIS

Comparison of PSNR and MSE for watermark embedding image and watermark extracted image is given in table 1 and table 2.

TABLE 1

TEST IMAGE		PSNR	MSE
Cover image	Watermark image		
BIKE	CHERRY	186.5979	7.9674e - 009
DOG	LENA	197.7288	2.5792e - 009

TABLE 2

TEST IMAGE		PSNR	MSE
Cover image	Watermark image		
BIKE	CHERRY	2.6480	50.9813
DOG	LENA	11.4409	16.5037

6. CONCLUSION

In this project from the obtained results it is observed that the Performance of proposed method is better in terms of PSNR value and execution times and it is found that 3-level DWT method produces better result. The hidden invisible watermark code is extracted with better quality and made visible. The higher PSNR value indicates better perceptual quality of image.

PSNR value is always desirable without trade off in image quality. In this project the PSNR value is improved by limited execution duration. Experiment result, shows that the quality of the watermarked image and the recovered watermark are dependent only on the scaling factors k and q and also indicate that the 3-level DWT provide better performance than 1-level and 2-level DWT. Analysis of the result is given by the table 1 and table 2 in chapter 4 (comparison of PSNR and MSE for watermark embedding image and watermark extracted image).

It is mostly used in usage specific requirements, copyright protection, finger printing, and multimedia authentication. Application can be improved by combining the proposed technique with other algorithm to achieve better performance and further reduce the execution time value in dealing with images and video with more complex background for surveillance and biometric applications.

The security level in commercial products can be enhanced by the implementation of optoelectronic watermark technique with 3-level DWT algorithm. It can also be used in business and industry. The efficiency of the algorithm can be inferred from measuring the PSNR embedding value.

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