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Reusability of Patterns Using Discrete Wavelet Transformation in Watermarking

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Abstract
Digital image watermarking is hiding information in any form in original image without degrading its perceptual quality. Watermarking is done for copyright protection of the original data. In this paper, a hybrid and robust watermarking technique for copyright protection based on Discrete Cosine Transform and Discrete Wavelet Transform is proposed. Wavelet transform has been applied widely in watermarking research as its excellent multi-resolution analysis property. The watermark is embedded based on the frequency coefficients of the discrete wavelet transform. The robustness of the technique is tested by applying noise attacks on the host signal and here the host signal is the database set containing satellite images.

Keywords-Digital image watermarking; multi-resolution analysis; Discrete Cosine Transform; Discrete Wavelet Transform; Satellite images database

I. Introduction

Digital information is easy to distribute, duplicate and modify which leads to the need for copyright protection techniques. Digital watermarking technique is one of the solutions to avoid unauthorized copying or tampering of multimedia data. Recently many watermarking schemes have been proposed to address this problem [1]. Owing to the rapid advancement of the Internet and multimedia systems in distributed environments, the transfer of multimedia documents across the Internet by the digital data owners has become simple. Thus, there is a raise in concern over copyright protection of digital contents [7] [8]. Against this background, the data hiding technologies for digital data like digital watermarking have attracted enormous attention recently [9].Digital watermarking utilized in order to High Performance and Effective Watermarking Scheme for satellite images 284 avert unauthorized duplication or exploitation of digital images [10] [11].

The process of digital watermarking involves the modification of the original multimedia data to embed a watermark containing key information such as authentication or copyright codes. The embedding method must leave the original data perceptually unchanged. The major technical challenge is to design a highly robust digital watermarking technique, which discourages copyright infringement by making the process of watermarking removal tedious and costly [2].

Digital watermarking is a covert security feature for identity documents that enables trusted authentication of host image like the image of PAN card and other IDs. Watermarking involves the transformation of a digital artifact into another token of the same type [3]. Watermarking is done at the object-level. Almost all watermarking methods, which have been proposed today, can provide robust and secret watermark and against various attacks such as filtering, data compression, warping, cropping etc. The watermark is robust and secret due to the owner keeps the algorithm private [12].

Digital watermarking technology is emerging as a solution to a broad class of challenges. There has been great interest in applying watermark to digital multimedia data for copyright protection, image authentication and proof of ownership etc. Image watermarking is finding more and more support as a possible solution for the protection of intellectual property rights [13].

There are numerous digital image watermarking techniques in various domains which are broadly categorized as:

1. Spatial domain based watermarking techniques
2. Transform domain based watermarking techniques

Spatial domain based watermarking techniques are rarely preferred over transform domain based watermarking techniques because the watermark placed by them can be easily destroyed and modified by the attackers. Although in transform domain based techniques there are various other techniques available like DFT (Discrete Fourier Transform), DCT (Discrete Cosine Transform) [4].

Watermarking represents an efficient technology for ensuring data integrity and data-origin authenticity. Watermarking the process of embedding data into multimedia element can primarily for

copyright protection. Because of its growing popularity, the DWT is commonly used in the proposed watermarking scheme increase, area increases so power consumption. In any situation, satellite images ought to be kept unharmed and they should be checked for:

- Integrity: this verifies that unauthorized people have not modified the image.
- Authentication: this verifies whether the image certainly belongs to the right organization.

In this paper, we have presented an effective watermarking scheme for checking the integrity and authenticating satellite images using hybrid transform [14]. Our proposed scheme makes use of the Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) to form a hybrid transform. The Daubechies 4 wavelet transform is chosen for DWT in our watermarking scheme. The watermark embedding and extraction are performed in a frequency domain with the help of hybrid transform. Initially, the DCT is applied into the original image to block it into 8*8 matrix form and the resultant matrix is converted into hybrid transformed matrix with the aid of Daubechies 4 wavelet transform [6].

II. Previous Research

A DWT-SVD based secured image watermarking for copyright protection using visual cryptography was proposed by Sushila Kamble, Vikas Maheshkar, Suneeta Agarwal , Vinay K Srivastava[1]. They applied the singular value decomposition along with the Discrete Wavelet Transform. Since the technique utilizes the properties of both DWT and SVD the proposed technique was more robust against different attacks. The robustness of the technique was justified by giving analysis by the effect of attacks and still they were able to get good visual quality of the embedded watermark.

Digital Image Watermarking Based on Super-Resolution Image Reconstruction was proposed by Xiangbin Feng, Yonghong Chen, College of Computer Science & Technology, China [15].They proposed a novel robustness watermarking based on SRIR, this method was mainly applied to pre-process the original image. It also contains the results of tests performed showing the high robustness of the algorithm against the attacks of JPEG lossy compression and salt-and pepper noise, multiplicative noise, center cutting. In addition, it should be mentioned that the method with SRIR is extremely more robust against the attacks of JPEG lossy compression and salt-and-pepper noise than the traditional one.

III. Watermarking Process

A watermarking system is as communication system consisting of three main elements: an embedder, a communication channel and a detector. Watermark information is any new information embedded into the signal itself; at the receiving end this information is extractable by the detector. Watermark information is embedded within the host signal before the watermarked signal is transmitted over the communication channel, so that the watermark can be detected at the receiving end that is at the detector. In the watermarking system we can say that embedding and extraction are the two steps in the watermarking [5]. In embedding, some new information is embedded in to the original image using some key and at receiving end using the same key embedded information is extracted which shows the authentication of the original image [4].

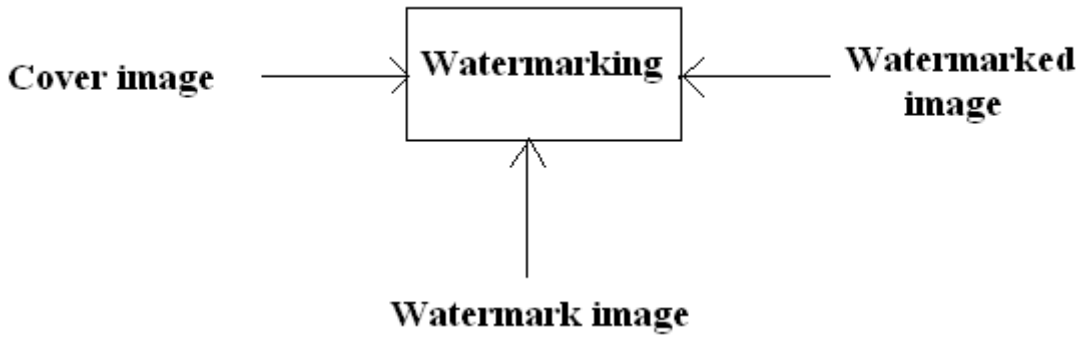


Fig.1 Block diagram of watermarking

3.1 Embedding Technique

The low frequency part contain the detail information of the image and high frequency part contain the approximate information of the image so for no change in the image we choose the high frequency part or smallest coefficients in the DCT matrix. The high frequency part is chosen in the DCT coefficient matrix of the original image which shows the approximate structure of the image [5].

IV. Hybrid (DCT-DWT)

Various watermarking algorithms that utilize either the DCT or the DWT exist in frequency domain. Major benefits of the hybrid approach DWT-DCT transform algorithm are as following:

- Improved Peak Signal to Noise Ratio (PSNR) when MSE and RMSE values in satellite images are greater.
- Produce an effective image watermarking.
- Combined transformations recompense the disadvantages of each other.

4.1 Discrete Cosine Transform

The Discrete Cosine Transform is a renowned coding technique employed in image and video compression algorithms. It is capable of carrying out de-correlation of the input signal in a data independent manner [6]. The DCT is a methodology for the transformation of a signal into elementary frequency components. The sequences of n real numbers $x1,\ldots..,\ xn$ are converted into the sequence of n complex numbers $f1,\ldots..fn$ by the DCT in accordance with the following formula:

$$f1=\Sigma_{n=1}^{k=0} xk \cos [\ \Pi /n\ j(k+1/2]$$

4.2 Discrete Wavelet Transform

In general, the multi-resolution wavelet transform can decompose a signal into low pass and high pass information. Since the high pass information usually represents features that contain sharper variations in time domain. This is a frequency domain technique in which firstly cover image is transformed into frequency domain and then its frequency coefficients are modified in accordance with the transformed coefficients of the watermark and watermarked image is obtained which is very much robust. DWT decomposes image hierarchically, providing both spatial and frequency description of the image [4]. It decompose an image in basically four spatial directions i.e, approximation, horizontal, vertical and diagonal in result separating the image into four different components namely LL, LH, HL and HH. Here first letter refers to applying either low pass frequency operation or high pass frequency operations to the rows and the second letter refers to the filter applied to the columns of the cover image.

- LL level is the lowest resolution level which consists of the approximation part of the cover image.
- Rest three levels i.e., LH, HL, HH give the detailed information of the cover image.

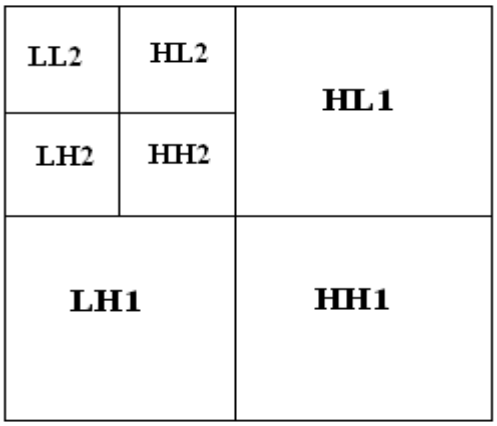
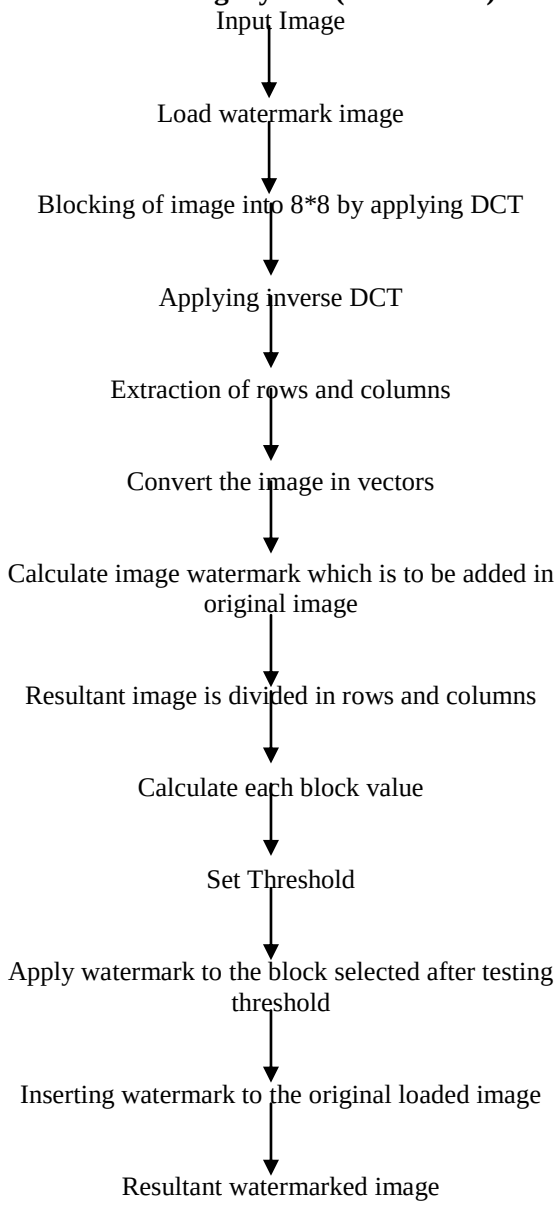


Fig 2- Two – Level DWT

V. Effective Watermarking Scheme using Hybrid (DCT-DWT)



VI. Result Analysis

To evaluate and compare the performance of three techniques i.e., median filter, applying DWT and DCT-DWT, three parameters are taken into consideration. These parameters are given by:

$$M.S.E = \frac{1}{n}\sum_{i=1}^{n}\left(X_i - X_i^*\right)^2$$

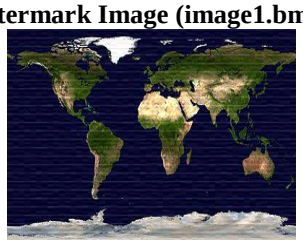
Using the value of mean square error, RMSE is calculated by considering the square-root value of MSE value and then PSNR (Peak Signal to Noise Ratio) for the images is calculated which gives the ratio of required signal to the noise content in the watermarked image. PSNR is calculated by the formula:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

To carry out the experiments MATLAB R2008a software is used. Results obtained are:

Original Image (image2.bmp)

Watermark Image (image1.bmp)



Watermarked Image

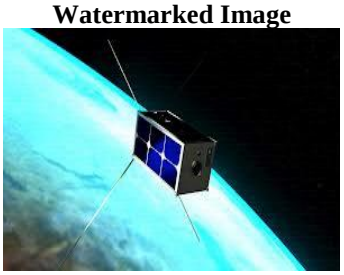


Table 1
Comparison between the MSE values using the three techniques

Image name	MSE Value using Median filter	MSE Value using DWT Filter	MSE Value using Watermark algorithm
image1.bmp	32.5818	17.0756	1.4641
image2.bmp	19.3256	15.8987	0.8393
image3.bmp	189.5386	20.2523	1.6718
image4.bmp	20.4806	18.9561	1.5313
image5.bmp	18.0187	17.0401	1.6957

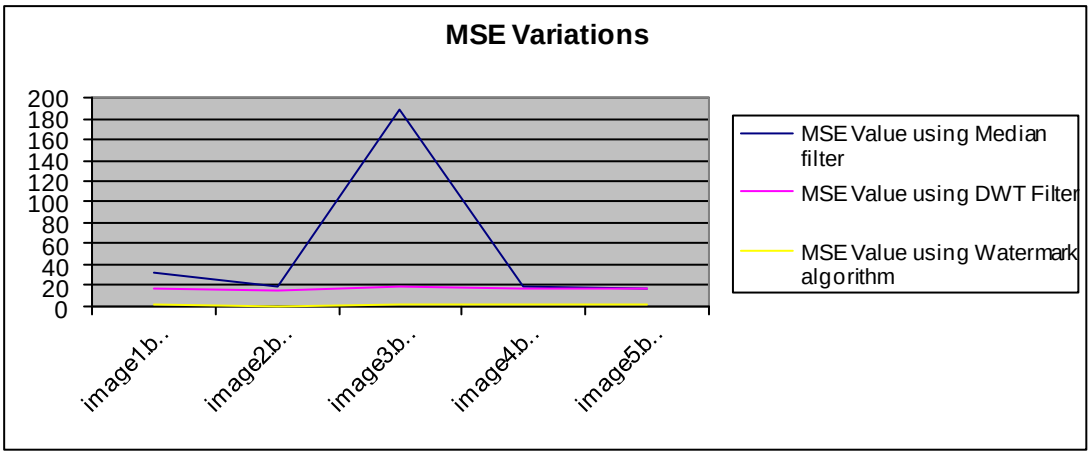


Table 2
Comparison between the RMSE values using the three techniques

Image name	RMSE Value using Median filter	RMSE Value using DWT Filter	RMSE Value using Watermark algorithm
image1.bmp	5.708	4.1323	1.21
image2.bmp	4.3961	3.9873	0.9161
image3.bmp	13.7673	4.5003	1.293
image4.bmp	4.5256	4.3539	1.2375
image5.bmp	4.2448	4.128	1.3022

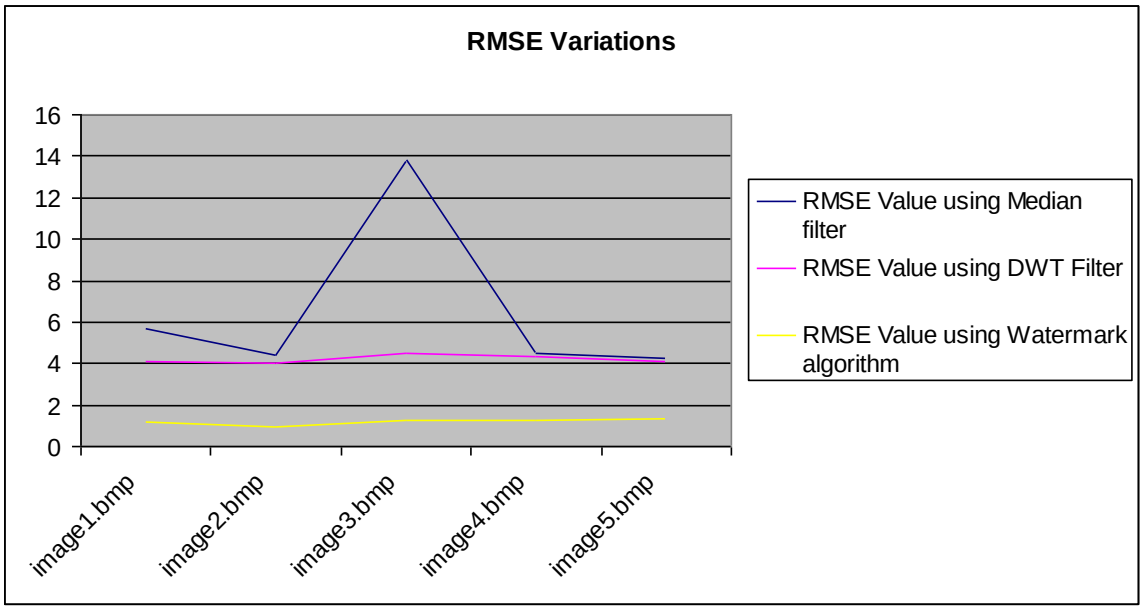
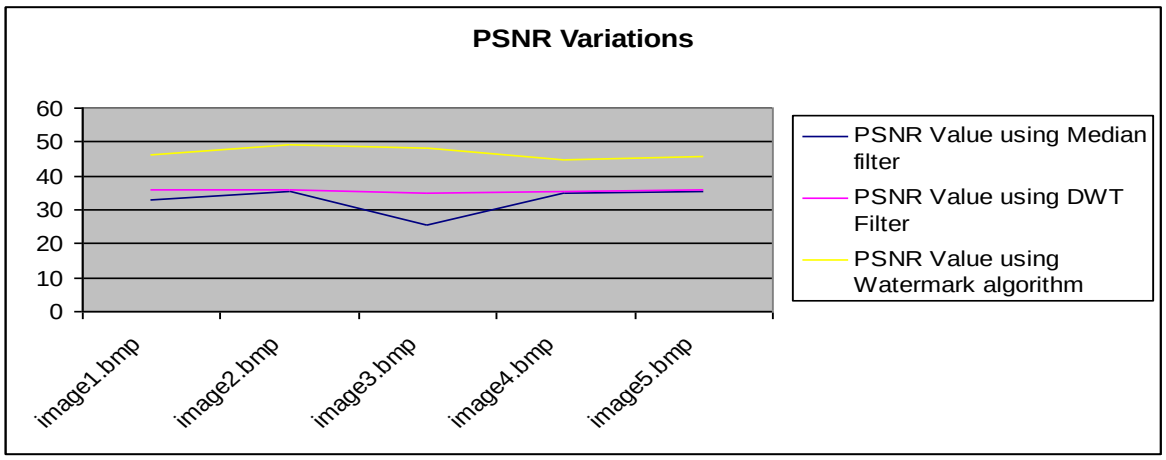


Table 3
Comparison between the PSNR values using the three techniques

Image name	PSNR Value using Median filter	PSNR Value using DWT Filter	PSNR Value using Watermark algorithm
image1.bmp	32.977	35.8074	46.3959
image2.bmp	35.2776	36.118	48.9743
image3.bmp	25.3722	35.0625	48.1611
image4.bmp	35.0047	35.3369	44.7914
image5.bmp	35.534	35.8015	45.923



VII. Conclusion

In this paper, an effective watermarking scheme is presented and implemented on the database containing satellite images. The proposed frequency domain watermarking scheme made use of hybrid approach, in which Discrete Cosine Transform is combined with Daubechies 4 wavelet transform. It is concluded that the MSE, RMSE and PSNR results produced by the hybrid approach (DCT-DWT) for watermarking gives enhanced results than the results produced when median filter is applied and analysis done when DWT is applied alone. As future work, various other methods such as LSB method, MSB block based methods may be used in hybrid approach with discrete wavelet transform to either embed or extract a watermark or both.

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