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AN IMPROVED STUDY OF DIGITAL WATERMARKING FOR IMAGES USING DWT-SVD ALGORITHMS

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ABSTRACT

Protection of digital multimedia content has become an important issue for content owners and service providers are protection of digital media content. An invisible signature that is embedded inside an image to provide authenticity or proof of ownership is known as watermark. A digital watermark is covertly embedded in a noise tolerant signal such as audio, video or image data. It is typically used to identify ownership of copyright of such signal. To achieve this objective a hybrid image watermarking scheme based on value decomposition Singular Value Decomposition is proposed in this paper, making it a robust technique. To design a robust digital watermarking scheme in selecting watermark embedding position is a key to this procedure. In this paper, watermark is not embedded directly on the wavelet coefficients but rather than on elements of singular values of cover image of discrete wavelet transform sub-bands.

Keywords: Copyright, Discrete wavelet transform, image watermarking, ownership, robust, SVD

1. INTRODUCTION

Development of technology has lead us to sharing information’s at large bases. But with development also develops techniques to grab this through unlawful means leading to many negative issues such as pirates in digital world. Now a day’s many large corporations face t5hese threats (unwanted pirates) through illegal modification, copy and distribution to their digital worker. To avoid these alarming problems many ways techniques have been dealt with. Among these, digital marking was developed first during 1990’s. Digital watermarking and Data hiding have been applied in large ranges of digital media applications including copyright protection, copy control and authentication. These watermarks are inserted invisibly into another image so that it can be extracted later as an evidence of authentic owner. Watermarks can be embedded in pixel domain or a transform domain. In multimedia applications, embedded watermarks should be invisible, robust and have a high capacity (6).

The degree of distortion introduced by watermark and its effect on the viewers or listeners is referred as invisibility. Resistance of an embedded watermark against intentional attacks and normal A/V processes such as noise, filtering (Blurring, Sharpening etc), resampling, sealing, rotation, cropping and lossy compression. The

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amount of data that can be represented by an embedded watermark is known as capacity. The approaches used in watermarking still images include least significant bit(LSB) encoding, basic M-sequence, transform techniques and image adaptive techniques.

According to the location of watermark embedded, spatial (8,9) and transform domain (10,1) algorithms are divisions of digital watermarking. Algorithms based on spatial are to embed watermark directly into spatial domain, so algorithms are often weak to resist attacks and usually simple in computing. No doubt it is simple and easy to implement, it is less robust than frequency domain watermark embedding including discrete Fourier transform (DFT), discrete cosine transform (DCT) and Discrete wavelet transform (DWT).

In order to make it more robust and effective, we have used hybrid technique comprising of DWT and SVD based schemes.

The cover image is decomposed into four bands(LL,HH,LH and HL), SVD is applied to watermark and coefficients of cover image with the singular valves of the visual watermark are modified. The modification allows development of a watermarking scheme which is robust to a wide range f attacks in all frequencies.

2. DISCRETE WAVELET TRANSFORM

This technique is used to decompose image into four components namely LL,HL,LH and HH where first letter to applying either a low pass frequency operation or high pass frequency operations to the rows and second letter refers to the filter applied to the columns which is shown in fig1. The resolution level LL is lowest consisting of approximation part of original image. The remaining resolution levels consist of detailed arts and give vertical high (LH), horizontal high(HL) and high(HH) frequencies. In this proposed algorithm, watermark is embedded into the host image by modifying the coefficient of high frequency bands i.e HH sub band.

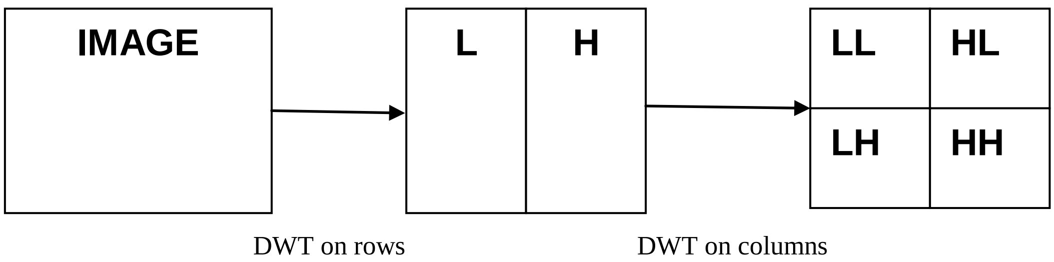

Fig 1. DWT decomposition

3. SINGULAR VALUE DECOMPOSITION

This mathematical approach provides an elegant way for extracting algebraic features from an image. The SVD matrix of an image has good stability where main features of SVD matrix of an image can be exploited in image watermarking with a small deviation added to the image does not result in large deviations(14,15). The same property of SVD matrix of an image when put to use produces watermark which can be embedded to this matrix without large variation in the obtained image.

4. PROPOSED ALGORITHM

The algorithm is to be applied in two phases, first phase carries out watermark embedding and then second phase is used for watermark extraction.

4.1 watermark embedding

1. Use two-level Haar DWT on original and watermarking image and apply SVD on both the images

$$A^K \equiv U^K S^K V^{KT} \quad , \quad K \equiv 1,2 \qquad (1)$$

Where 'K' represents one of two sub-bands

2. Modify the values and then apply SVD to them, respectively, i.e,

$$S^K + \propto W^K = CA_W \qquad (2)$$

$$S^K + \beta W^K = U^K W S^K W V^{KT} W$$

Where $\propto, \beta$ denotes the scale factor. The scale factor is the used to control the strength of watermark to be inserted.

3. Compute modified SVD with help of original and watermarked SVD components obtain two sets of modified DWT coefficients i.e

$$A^{*K} = U^K S^K W V^{KT} \qquad (3)$$

4. Reshape the image using SVD component.
5. Obtain watermarked image Aw by performing the inverse DWT.

4.2 watermark extraction

1. Use two-level Haar DWT to decompose the watermarked image and original image into four sub bands: LL, LH, HL, HH
2. Apply SVD to the original and watermarked image i.e

$$A^{*K} W = U^{*K} S^{*K} W V^{*KT} \quad , \quad K = 1, 2 \qquad (4)$$

Where k represents one of two sub bands.

3. Compute the modified SVD with help of original and watermarked SVD components

$$D^{*K} = U^K W S^{*K} W V^{*KT} \quad , K = 1, 2 \qquad (5)$$

Where k represents one of two sub bands

4. Reshape the image using SVD component.
5. Obtain the extracted image by performing the inverse DWT.

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5. EXPERIMENTAL RESULTS

In this experiment, MATLAB is used and various input images have been taken on which a watermark image has been embedded. Input image and watermark image is as shown. Then a watermarked image has been watermark has been extracted.

The PSNR and NC values of various images have been calculated and shown in table below.

5.1 Peak signal to noise Ratio (PSNR)

It is a metric which is used regularly the find the quality of watermarked image. It is calculated by the following formula

$$PSNR = 10 * \log(255 * 255 / MSE) / \log(10)$$

$$MSE = Sum(Sum(error * error) / (M * N)$$

5.2 Normalized correlation (NC)

It is am metrics used to find the quality of extracted watermark mage with respect to original watermark image It is found by using the following formula.

$$NC = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} w(i,j) w^{'}(i,j)}{\sqrt{\sum_{i=1}^{M} \sum_{j=1}^{N} w(i,j)\hat{}2} \sqrt{\sum_{i=1}^{M} \sum_{j=1}^{N} w^{'}(i,j)\hat{}2}}$$

Here, (i,j) is the original watermark, $w^{'}$ (i,j) is the extracted image

A: Input image

B: Watermarked image

C: Watermarked image

D: Extracted watermark

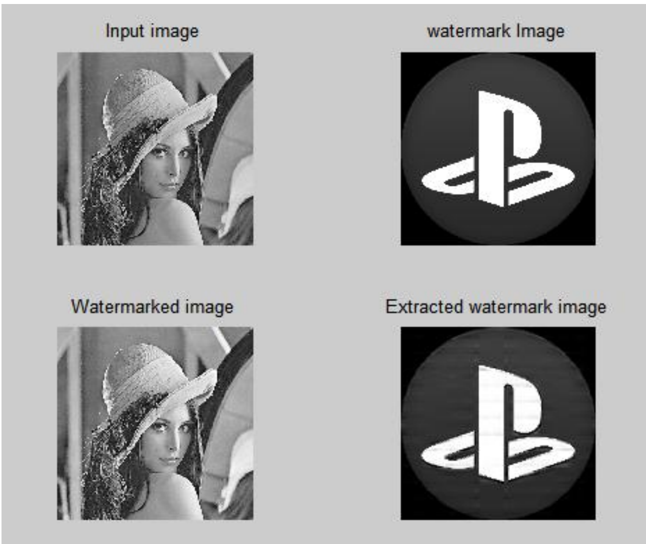

Fig 2 output 1

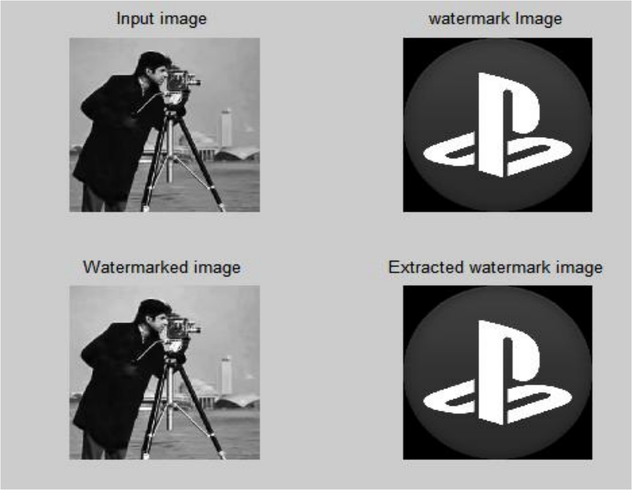

Fig 3 output 2

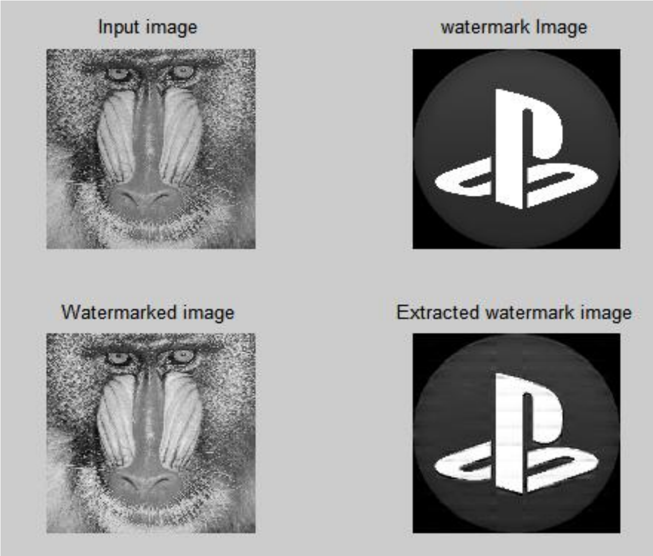

Fig 4 output 3

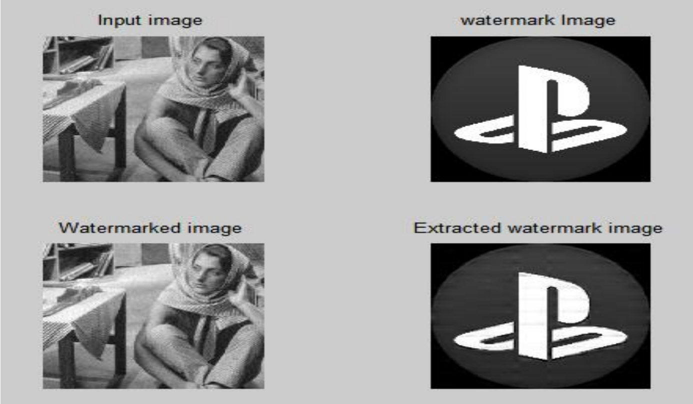

Fig 5 output 4

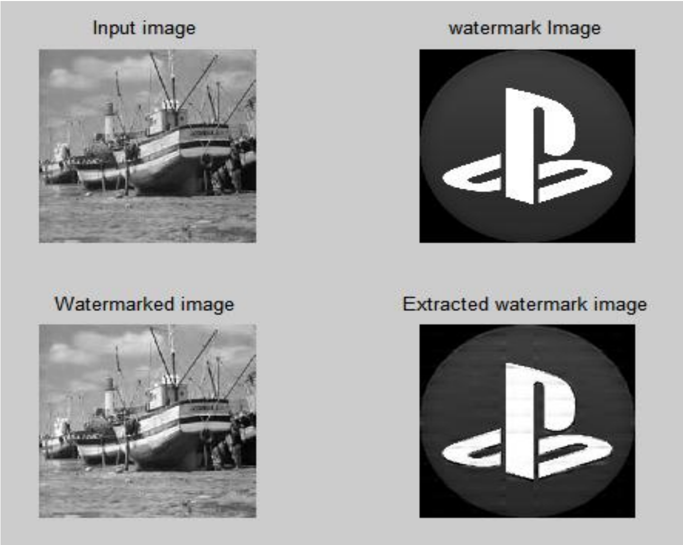

Fig 6 output 5

Table 1 PSNR table

Image/PSNR	Original PSNR	Watermark PSNR	Watermarked PSNR	Extracted PSNR
Lena	33.2593	35.3645	33.0516	290.3826
Baboon	33.0746	35.3645	33.0516	295.4298
Cameraman	33.7763	35.3645	33.0516	296.679
Boat	33.0315	35.0315	35.3645	288.3561
Barbara	33.4657	35.3645	33.0516	297.811

Table 2 NC table

IMAGE	NC VALUE
Lena	1
Baboon	1
Cameraman	1
Boat	1
Barbara	1

6. CONCLUSION

From the experimental results, it is concluded that algorithm is robust and give good results for PSNR and NC. The proposed techniques are based on the fusion method and have been assessed using a number of experiments. The main aim of the paper was to assess the performance of these techniques in terms of robustness of watermarked image under certain imperceptibility criterion. The method can embed the maximum amount of watermark while watermark is imperceptible. As experimental results have shown, the proposed algorithm achieves two important desirable watermarking characteristics, invisibility and robustness.

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