A Robust Digital Watermarking Technique using DWT-DCT and Statics blocks

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Abstract

This paper introduces a method based on Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT), and the characteristics of the human visual system (HVS). In this method the watermark data is embedded into imperceptibles blocks[1], we used the entropy value to select the suitable blocks. Experimental results show that the visual quality of the watermarked image and the extracted watermark is good in spite of attacks.

Keywords: Watermarking image, DCT, DWT, HVS.

1. Introduction

A watermark is a form, image or text that is impressed onto paper, which provides evidence of its authenticity. Digital watermarking is an extension of this concept in the digital world. In recent years, the phenomenal growth of the internet has highlighted the need for mechanisms to protect ownership of digital media. In General, any watermarking technique is done either in Spatial or Frequency domain.

The Spatial domain methods are based on direct modification of the values of the image pixels, so the watermark has to be imbedded in this way. Such methods are simple and computationally efficient, because they modify the color, luminance or brightness values of a digital image pixels, therefore their application is done very easily, and requires minimal computational power.

The Frequency domain methods are based on the using of some invertible transformations like discrete cosine transform (DCT)[2], discrete Fourier transform (DFT), discrete wavelet transform (DWT)[3][4] etc. to the host image. Embedding of a watermark is made by modifications of the transform coefficients, accordingly to the watermark or its spectrum. Finally, the inverse transform is applied to obtain the marked image. This approach distributes irregularly the watermark over the image pixels after the inverse transform, thus making detection or manipulation of the watermark more difficult.

This paper introduces a comparative study of two algorithms based on Discrete Wavelet Transform (DWT), Discrete Cosine Transform (DCT), and the characteristics of the human visual system (HVS). In both algorithms the watermark data will be discrete Cosine transformed at first, to improve robustness and the capacity of hiding the watermark data.

2. Discrete Cosine Transform

With the character of discrete Fourier transform (DFT), discrete cosine transform (DCT) turn over the image edge to make the image transformed into the form of even function. It's one of the most common linear transformations in digital signal process technology. Two dimensional discrete cosine transform (2D-DCT) is defined as:

$$\mathrm{DCT}(i,j) = \frac{1}{\sqrt{2N}} B(i)B(j) \sum_{x=0}^{N-1}\sum_{y=0}^{N-1} M(x,y) \cdot \cos\left[\frac{(2x+1)}{2N} i\pi\right] \cos\left[\frac{(2y+1)}{2N} j\pi\right]$$

Where

$$B(u) = \begin{cases} \frac{1}{\sqrt{2}} & \text{if } u = 0 \\ 1 & \text{if } u>0 \end{cases}$$

M(x,y) is the original data of size $x \times y$

The corresponding inverse transformation (Whether 2D IDCT) is defined as:

$$M(x,y) = \frac{1}{\sqrt{2N}} B(i) B(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} DCT(i,j) . \cos\left[\frac{(2x+1)}{2N} i\pi\right] \cos\left[\frac{(2y+1)}{2N} i\pi\right] \mu$$

$$B(u) = \left\{ \begin{array}{ll} \frac{1}{\sqrt{2}} & \text{if } u = 0 \\ 1 & \text{if } u>0 \end{array} \right\}$$

The 2D-DCT can not only concentrate the main information of original image into the smallest low- frequency coefficient, but also it can cause the image blocking effect being the smallest, which can realize the good compromise between the information centralizing and the computing complication. So it obtains the widespreading application in the compression coding.

3. Discrete Wavelet Transform

Wavelet transform is a multi-scale signal analysis method, which overcomes the weakness of fixed resolution in Fourier transform (DFT). In the wavelet transform domain the general features and the details of a signal can be analyzed.

The basic idea of discrete wavelet transform (DWT) in image process is to multi-differentiated decompose the image into sub-image of different spatial domain and independent frequency district. Then transform the coefficient of sub-image. After the original image has been DWT transformed, it is decomposed into 4 frequency districts which is one low-frequency district (LL) and three high-frequency districts (LH,HL,HH).

4. Algorithm implementation:

The process of embedding data is described with these different steps:

Step1: applied the DWT method on original image.

Step2: dividing the sub bands into selectable blocks: the selection is done by calculate the maximum entropy value[4]; the goal of this selection is to detect region where there is more disorder of frequency to ensure a good imperceptibility.

Step3: applied the DCT method on the watermark image for more robustness.

Step4: The watermarked image is generated by embedding the set watermark transformed into blocks that are specified in step 2 then we applied IDWT.

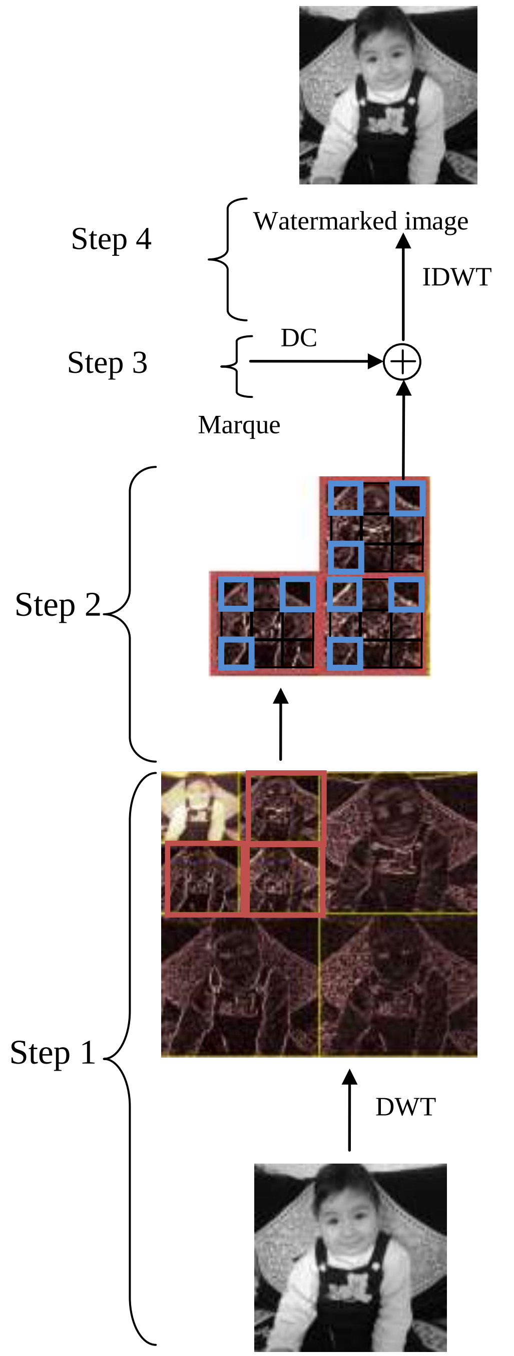

Figure1: Steps of Algorithm implementation

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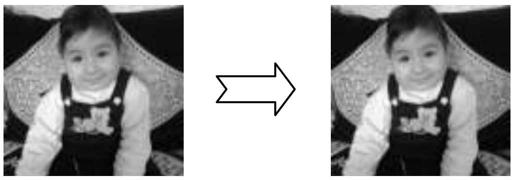
Experimental Results:

The proposed scheme has been tested using Matlab. The scheme has been evaluated on the different set of images. The proposed watermarking method increases the robustness of the watermark at the same time ensures the quality of the image.



Original image **watermarked image**

The results are also obtained by calculating the PSNR value.

The PSNR is a better test since it takes the signal strength into consideration. The values were used to evaluate the quality of the watermarked images.

$$PSNR = 10\log_{10}\left[\frac{R^2}{MSE}\right]$$

Where R represents maximum fluctuation or value in the image, its value is 255 for 8 bit unsigned number.
The MSE is obtained using the following equation:

$$MSE = \frac{\sum_{M,N}[I1(m,n) - I2(m,n)]^{2}}{M * N}$$

Where M and N are the number of rows and columns in the input images, respectively and I1 (m, n) is the original image, I2 (m, n) is the Watermarked image.

Number of block insertion	List of image test	PSNR value
	 Hanaa	49.87
	 Cameraman	50.29
1 block	 Lena	49.84
	 Baboon	48.98
	 Jetplane	49.43
	 Hanna	46.86
	 Cameraman	47.28
2 blocks	 Lena	46.83

	 Baboon	45.00
	 Jetplane	46.42
4 blocks	 Hanaa	43.85
	 Cameraman	44.27
	 Lena	43.82
	 Baboon	42.95
	 Jetplane	43.41

Table1: PSNR values of different test images and different insertion rate

Conclusions

This paper presents a robust watermarking scheme in DWT domain. We embedded the watermark into the appropriate blocks which has the high entropy value. The performance evaluation of this method is done by measuring their imperceptibility, transparency and robustness. The simulation results show that there is no perceptual distortion in the original and watermarked image.

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