DWT (Discrete Wavelet Transform) is a widely used technique for digital image watermarking due to its ability to analyze the image at different resolutions.

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Abstract:
The proliferation of digitized media due to the rapid growth of networked multimedia systems, has created an urgent need for copyright enforcement technologies that can protect copyright ownership of multimedia objects. Digital image watermarking is one such technology that has been developed to protect digital images from illegal manipulations. In particular, digital image watermarking algorithms which are based on the discrete wavelet transform have been widely recognized to be more prevalent than others. This is due to the wavelets' excellent spatial localization,and multi-resolution characteristics, which are similar to the theoretical models of the human visual system. In this paper, we describe an imperceptible and a robust DWT digital Image Watermarking algorithm.The algorithm watermarks a given digital image using a Discrete Wavelet Transform.

Keywords:
Digital watermarking, Discrete Wavelet Transform(DWT), Peak Signal to Noise Ratio, Scaling Factor, Gaussian Noise, Salt and Pepper.

I. Introduction

Nowadays protecting the copyright of the digital media has become an important topic due to digital media can be copied and modified easily. Many watermarking techniques have been proposed to solve the copyright protection problem for multimedia images.The spatial and transform domains are two common methods for image watermarking. Embedding the watermark into the transform-domain generally helps to increase the imperceptibility, security, and robustness. Therefore, at present, most of image watermarking methods are in the transform domain, where DFT [1], DCT [2],DWT [3] are three main transform methods used. In terms of the extracting scheme,watermarking algorithms are also divided into two groups: blind and non-blind watermarking. In a non-blind watermarking the original image is necessary for the watermark extraction whereas in a blind watermarking the original image is not needed for watermark extraction.

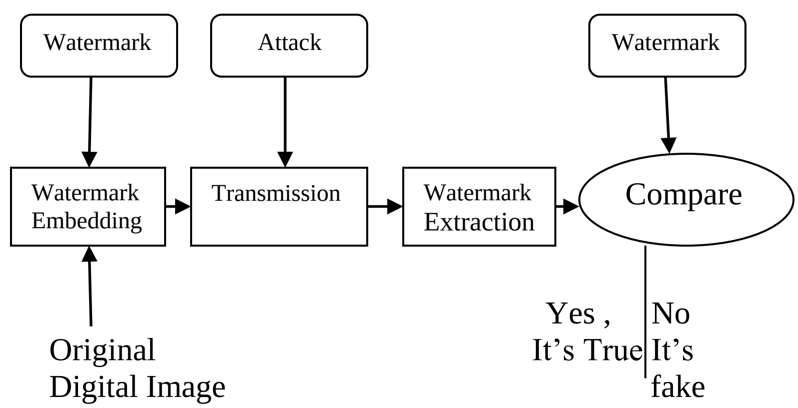

Fig. I Digital image Watermarking

The embedding and detecting procedure for watermarking technique based on DWT transform.[4]Computing PSNR function (peak single-to-noise ratio)based on scaling factor of the resultant watermarked images from the techniques DWT for the purpose of measuring the distinctive distortion between the cover image and the watermarked image.[5]□Applying the checkmark software by means of MSE function for the original watermarks and extracted watermarks from the DWT technique.[5]

II. Proposed Watermarking Scheme

Nowadays, most watermarking algorithms use wavelet and quantization techniques; use of wavelet domain watermarking has the advantage of making the watermark robust against many of the distortions that change high frequency components of image such as compression and low-pass filtering, however it cannot resist the attacks such as cropping that destroy a whole region of the watermarked image because each pixel of watermark is usually embedded only in one region of the host image.[8,9]

Wavelets are special functions which, in a form analogous to sines and cosines in Fourier analysis, are used as basal functions for representing signals. For 2-D images, applying DWT corresponds to processing the image by 2-D filters in each dimension. The filters divide the input image into four non-overlapping multi-resolution sub-bands LL1, LH1, HL1 and HH1. [7]The sub-band LL1 represents the coarse-scale DWT coefficients while the sub -bands LH1, HL1 and HH1 represent the finescale of DWT coefficients. To obtain the next coarser scale of wavelet coefficients, the sub-band LL1 is further processed until some final scale N is reached. When N is reached we will have 3N+1 sub-bands consisting of the multi-resolution sub-bands LLN and LHx, HLx and HHx where x ranges from 1 until N.[7]

Due to its excellent spatio-frequency localization properties, the DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. In particular, this property allows the exploitation of the masking effect of the human visual system such that if a DWT coefficient is modified, only the region corresponding to that coefficient will be modified. In general most of the image energy is concentrated at the lower frequency sub-bands LLx and therefore embedding watermarks in these subbands may degrade the image significantly. Embedding in the low frequency sub-bands, however, could increase robustness significantly. On the other hand, the high frequency sub-bands HHx include the edges and textures of the image and the human eye is not generally sensitive to changes in such sub-bands. This allows the watermark to be embedded without being perceived by the human eye. The compromise adopted by many DWT-based watermarking algorithm, is to embed the watermark in the middle frequency sub bands LHx and HLx where acceptable performance of imperceptibility and robustness could be achieved.[4]

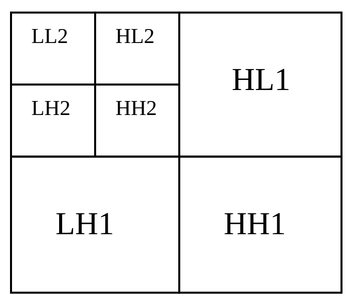

Fig. II Sketch Map of Image DWT Decomposed

II.I Embedding Technique for DWT

This technique will decompose the cover image of the two dimensional DWT into four frequency bands through the first pass as (LL_1), (LH_1), (HL_1)

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and (HH_1) frequency coefficients. The frequency bands where it has the lowest resolution of the 1^{st} pass (LL1) can be also decomposed into a 2^{nd} level (pass). [6] Secondly, we are to apply the Gaussian Noise and can insert the watermark signature into the reset of the available frequency bands which include the high frequency coefficients without dealing with (*LL*) regions from all over the passes (levels). We must add the signal of the bands where the large frequency components to the signal of the Gaussian Noise and modifying them without moderating the original signal which resides in the (*LL*) band; thereafter, the watermarked image would be performed appropriately.[5]

Cover Image

Test Image

Watermarked Image

Fig. III Embedding Technique for DWT

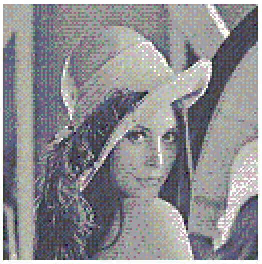
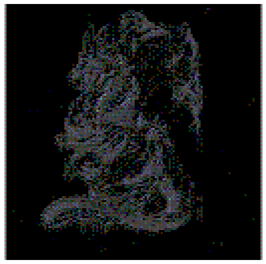
II.II Extraction Technique for DWT

In contemplation of achieving this procedure, we should have the cover image and the watermarked image readily applicable. Consequently, the DWT decoding technique will decompose those two images into four frequency bands through the 1^{st} pass as described previously.Afterward, we are to select for instance one of those bands where the large frequencies reside through one of the levels (passes) in the decomposed cover image and the decomposed watermark. Let's suppose the selected band from both decomposed images is (HH_1), we have then to compare the difference of the frequency coefficients in those bands of the decomposed images and examine their cross correlation. Subsequently, if the cross correlation has detected a peak, then the watermark signature will be extracted; if not, then the same operation will continue on comparing the rest of the other bands consist the high frequency components from both of the decomposed images and investigate their cross correlation until the peak is detected; correspondingly, the watermark signature will be latterly recovered.[4]

Watermarked Image

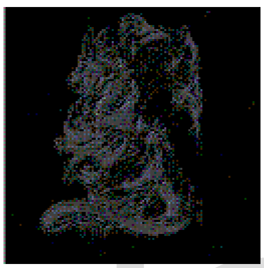
Retrieved Image

(No Attack)

Watermarked Image Retrieved Image

(Gaussian Noise)

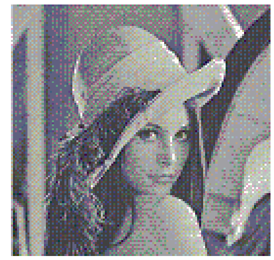
Watermarked Image Retrieved Image

(Salt and Pepper)

Fig. IV Extraction Technique for DWT

III. Performance Evaluation

For testing the performance of this algorithm, the experiments is simulated with the software MATLAB. In the following experiments, the gray-level image with size of 384*384 “Lena” is used as host image to embed watermark. Another binary image with size of 196*210 “key” is as the watermark. In order to test the performance, the watermarked image suffers some different signal attacks, which includes filer, sharp enhancing, adding salt noise, image compression, image cutting and rotation. The simulation results, including the watermarked image and distilled watermark under different kinds of signal attack [9], The exact PSNR values of the processings are shown in Tab. I. Simulation results suggest that this watermark algorithm can be robust against many common different types of attacks such as adding salt and pepper noise, image compression, Gaussian noise.


(a)

(b)

(c)

(d)

(a) Original Image

(b), (c), (d) Watermarked Image with different Scaling Factor

Fig. V Attack-Gaussian Noise


(e)

(f)


(g)


(h)

(e)Original Image

(f), (g) ,(h) Watermarked Images With Different Scaling Factor

Fig.VI Attack-Salt and Pepper

Table I
The parameter values of attacked watermark image

Scaling Factor	Gaussian Noise (PSNR)	Scaling Factor	Salt & Pepper (PSNR)
(0.02,0.002)	38.6813	(0.02)	36.6744
(0.05,0.005)	38.6808	(0.05)	36.6700
(0.08,0.008)	37.6807	(0.08)	35.6671
(0.5 , 0.05)	37.6816	(0.11)	35.6647
(0.9 , 0.09)	37.6823	(0.14)	35.6630

IV. Conclusion

In this paper, we proposed a watermarking scheme based on discrete wavelet transform that based on scaling factor. By using the block technology, watermarking signal is embedded into the high frequency band of wavelet transformation domain. The simulation results suggest that this watermarking system not only can keep the image quality well, but also can be robust against many common image processing operations of compression , salt and pepper noise,gaussion noise and so on. This algorithm has strong capability of embedding singal and anti-attack.

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