International Journal of Scientific & Engineering Research, Volume 5, Issue 5, May-2014
ISSN 2229-5518

DIGITAL WATER MARKING USING DWT AND DCT

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Abstract: - Digital watermarking plays an important role for protecting the digital contents from unauthorized copying. With the exponential growth of the internet and high speed networks operating through the world it's a challenging job to protect copyright of an individual creation. The digital watermarking provides a valuable solution to protect the copyright and authenticate the ownership of intellectual property. This paper introduces the digital image watermarking performance in imperceptibility for combined DCT-DWT watermarking algorithm. This paper also shows the comparative analysis of DCT,DWT and combined DCT-DWT watermarking algorithms.The implementation of DCT-DWT watermarking algorithm shows good imperceptibility against common signal processing attacks.

Keywords: - Digital Watermarking, Imperceptibility, DCT, DWT.

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1 Introduction

Digital watermarking is defined as a process of embedding data (watermark) into a multimedia object to help to protect the owner's right to that object. It is a concept closely related to steganography, in that they both hide a message inside a digital signal. However, what separates them is their goal. Watermarking tries to hide a message related to the actual content of the digital signal, while in steganography the digital signal has no relation to the message, and it is merely used as a cover to hide its existence.

Every watermarking system has some very important desirable properties. Some of these properties are often conflicting and we are often forced to accept some trade-offs between these properties depending on the application of the watermarking system.

1. Effectiveness. This is the probability that the message in a watermarked image will be correctly detected. We ideally need this probability to be 1.
2. Transparency: closeness of cover-image and the watermarked one.
3. Payload size. Every watermarked work is used to carry a message. The size of this message is often important as many systems require a relatively big payload to be embedded in a cover work. There are of course applications that only need a single bit to be embedded. The false positive rate is also very important to watermarking systems. This is the number of digital works that are identified to have a watermark embedded when in fact they have no watermark embedded. This should be kept very low for watermarking systems.
4. Robustness is crucial for most watermarking systems. There are many cases in which a watermarked work is altered during its lifetime, either by transmission over a lossy channel or several malicious attacks that try to remove the watermark or make it undetectable. A robust watermark should be able to withstand additive Gaussian noise, compression, printing and scanning, rotation, scaling , cropping and many other operations.

Watermarking has two main stages, embedding and extracting. In watermark embedding, there have been different types of algorithms based on Discrete Cosine Transform (DCT), Discrete Fourier Transforms (DFT), Discrete Wavelet Transforms (DWT), or a combination of all above. Watermark extraction can be based on the correlation of the watermarked data and the original data or it can be directly done on the watermarked data which is called blind extracting.

A serious problem with watermarking technology is the insufficient robustness of existing watermarking algorithms against geometrical distortions for example translation, rotation, scaling, cropping, change of aspect ratio and shearing. These geometrical distortions cause the loss of geometric synchronization that is necessary in watermark detection and decoding. Vulnerable to geometric distortion is a major weakness of many watermarking methods.

Digital Image Watermarking domains are spatial domain and frequency (Transform) domain. The spatial domain algorithms are so simple to implement but the problems are Low watermark information hiding capacity Less PSNR, Less Correlation between original and extracted watermark and less security and the watermark can be damaged easily.LSB Least Significant Bit insertion is an example of spatial domain watermarking. The frequency domain algorithm can resist attacks such as common image processing operations i.e. watermark information can't be damaged easily The transform domain algorithm mainly includes DWT, DFT, DCT and SVD,WHT etc. Quality of watermarking scheme is commonly determined by the four factors robustness, imperceptibility, capacity, and blindness. Good quality watermarking scheme should have maximum PSNR, ideally Correlation Factor equals to 1 and should have maximum watermark information hiding capacity. Watermark must be highly robust to distortion introduced during either normal use (unintentional attack), or a deliberate attempt to disable or remove the watermark present (intentional, or malicious attack). Unintentional attacks involve transforms that are commonly applied to images during normal use, such as addition of noise, cropping, resizing, contrast enhancement, filtering etc. In order to be successful, the watermark should be invisible and Robust to premeditated or spontaneous modification of the image. Among the transform domain method, the discrete cosine Transform (DCT) technique is important because DCT is used in many image process and compression standards such as JPEG. This makes the DCT domain watermarking schemes have the ability to survive the digital image compression method, such as JPEG. DC values are adapted to embed watermarking in transparency.

DWT is used frequently in digital image watermarking due to its Multiresolution property i.e. time (space)/frequency decomposition characteristics, which resemble to the theoretical models of the human visual system. This paper presents the DCT and DWT digital watermarking algorithm in comparison with combined DCT-DWT digital watermarking algorithm on the basis of robustness and imperceptibility.

2 Methodology

2.1 DWT Digital Watermarking

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 analysed DWT is a hierarchical sub-band system. Wavelet transform decomposes an image into a set of band limited components which can be reassembled to reconstruct the original image without error. Since the bandwidth of the resulting coefficient sets is smaller than that of the original image, the coefficient sets can be down sampled without loss of information. Reconstruction of the original signal is accomplished by up

International Journal of Scientific & Engineering Research Volume 5, Issue 5, May-2014
ISSN 2229-5518

sampling, filtering and summing the individual sub bands. 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 coefficient sets, a lower resolution approximation image (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components. The sub-band LL represents the coarse-scale DWT coefficients while the coefficient sets LH, HL and HH represent the fine-scale of DWT coefficients. To obtain the next scale of wavelet coefficients, the sub-bands are further processed until some final scale N is reached.

Fig. 1 Original Image

Fig.2 First Level Decomposition of Original Image.

Due to its excellent spatial-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 coefficient sets LL and therefore embedding watermarks in these coefficient sets may degrade the image significantly. Embedding in the low frequency coefficient sets, however, could increase robustness significantly. On the other hand, the high frequency coefficient sets HH include the edges and textures of the image and the human eye is not generally sensitive to changes in such coefficient sets. This allows the watermark to be embedded without being perceived by the human eye. The agreement adopted by many DWT-based watermarking methods, is to embed the watermark in the middle frequency coefficient sets HL and LH is better in perspective of imperceptibility and robustness. [1]

According to the character of HVS, human eyes is sensitive to the change of smooth district of image, but not sensitive to the tiny change of edge, profile and streak. Therefore, it's hard to conscious that putting the watermarking signal into the big amplitude coefficient of high-frequency band of the image DWT transformed. Then it can carry more watermarking signal and has good concealing effect. The decomposing process of delamination DWT for image frequency is alike the signal disposing process of HVS. By using the characters of delamination DWT, the concealing and the robustness of watermark can be balanced. Then it became the main choice of watermark embedding in transformed domain. [2]

2.2 DCT Digital Watermarking

With an input image, x, the DCT coefficients for the transformed output image, y, are computed according to Equation.1 shown below. In the equation, x, is the input image having N x M pixels, x (m, n) is the intensity of the pixel in row m and column n of the image, and y (u, v) is the DCT coefficient in row u and column v of the DCT matrix. [4]

$$y(u,v)=\sqrt{\frac{2}{N}}\sqrt{\frac{2}{M}}\alpha_u\alpha_v\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}\{x(m,n)\cos\frac{(2m+1)u\pi}{2M}\cos\frac{(2N+1)u\pi}{2N} \quad \text{……………………(1)}$$

The image is reconstructed by applying inverse DCT

$$X(m,n)=\sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\{\alpha_u\alpha_v\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}y(u,v)\cos\frac{(2M+1)u\pi}{2M}\cos\frac{(2N+1)\mu\pi}{2N}\} \quad \text{…………………….(2)}$$

In general, watermarking scheme adopting the 8 ×8 block-based DCT showed superiority to the whole image-based DCT in the sense of robustness except for the resizing. The block-based DCT transform divides image into non-overlapping blocks and applies DCT to each block. An image divided into 8×8 blocks. Each of these 8 × 8 blocks of the original image is mapped to the frequency domain. This results in giving three frequency coefficients sets: low frequency sub-band, mid-frequency-sub-band and high frequency sub-band. DCT-based watermarking is based on two facts. The first fact is that much of the signal energy lies at low-frequencies sub-band which contains the most important visual parts of the image. The second fact is that high frequency components of the image are usually removed through compression and noise attacks. The watermark is therefore embedded by modifying the coefficients of the middle frequency sub-band so that the visibility of the image will not be affected and the watermark will not be removed by compression.[1]

2.3 combined DCT-DWT Digital Watermarking

Transform domain watermarking schemes based on the discrete cosine transform (DCT) the discrete wavelet transform (DWT) provide higher image imperceptibility and are much more robust to image manipulations. The DCT domain watermarking schemes have the ability to sustain the digital image compression method, such as JPEG. The wavelet transform has several advantages: The DWT is a multi-resolution description of an image: the decoding can be processed sequentially from low resolution to higher resolutions. The DWT is closer to human visual system than DCT. Hence, the artefacts introduced by wavelet domain coding with high compression ratio are less annoying than those introduced at the same bit rate by DCT. In the DWT-DCT method, the most proper sub-bands are selected to take these benefit of DWT in case of robustness and imperceptibility. Then, the block based DCT is applied on these selected band to embed watermark in middle frequencies of each block to improve further robustness of watermarked image against different attacks. By combing the two common frequency domain methods, we could take the advantageous of both two algorithms to increase robustness and imperceptibility. Improvement in the performance in DWT-based digital image watermarking algorithms could be achieved by combing DWT with DCT. Two transforms are combined to make up for the disadvantages of each other, so as to increase the effectiveness of watermarking algorithm.[1]

The comparative results regarding the PSNR values for different attacks is the main goal behind this paper. The combine transform gives the better results against the only DCT, only DWT watermarking algorithms.

International Journal of Scientific & Engineering Research Volume 5, Issue 5, May-2014
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3 Evaluation Techniques

- Imperceptibility

Imperceptibility means that the perceived quality of the host image should not be distorted by the presence of the watermark. The watermark should be imperceptible to human observation while the host image is embedded with secret data. In this paper we employee the PSNR to indicate the transparency degree. The PSNR describe below Where x i,j and x^ i,j are the gray-scale values of host and watermarked images and N x N is the size of image respectively.

$$PSNR = 10\log_{10}\frac{255^2}{\frac{1}{M*N}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left(X_{i,j}-\hat{X}\right)}$$

……………………..(3)

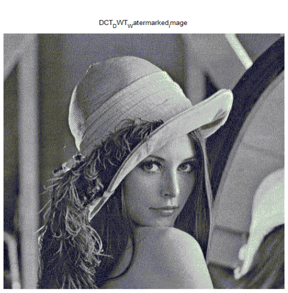
The performance evaluation of the methods is done by measuring their imperceptibility. The Peak Signal-to-Noise Ratio (PSNR) measures the fidelity between the original image and the watermarked image. A larger PSNR indicates that the watermarked image more closely resembles the original image meaning that the watermarking method makes the watermark more imperceptible. Generally, if PSNR value is greater than 35dB the watermarked image is within acceptable degradation levels, i.e. the watermarked is almost invisible to human visual system..In order to investigate the imperceptibility of the watermarking scheme, the watermarked image was attacked by various signal processing technique, such as Additive Gaussian noise, Additive salt noise, image rotating, and cropping etc.

4 Experiments Results

The original image size is 512*512 and the watermark size is 20*50.

(a) (b)

Fig.1 (a)Original Image (b)Original Watermark



(a) (b)

Fig.2 (a)Watermarked Image (b)Extracted Watermark

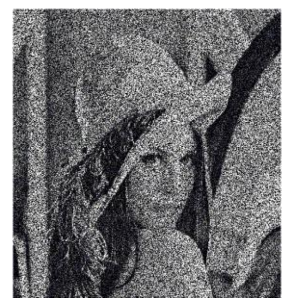
Original image	**PSNR**
Lena	**38.0186**

Table 1. PSNR value of original image

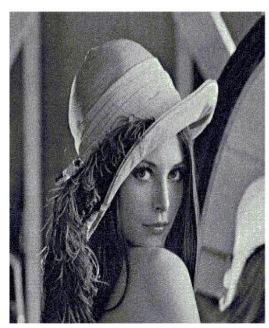
	Attacks	**DCT**	**DWT**	**DCT-DWT**
1	**Salt &Pepper Noise(0.02)**	**21.9499**	**27.4744**	**31.277**
2	**Gaussian noise(0.001)**	**27.5444**	**28.8060**	**30.9882**
3	**Speckle Noise(2)**	**8.7687**	**27.7702**	**27.532**
4	**Cropping**	**8.9473**	**26.9199**	**26.948**
5	**Rotation**	**10.6267**	**28.2591**	**28.2725**

Table 2. Comparative results of PSNR values for different attacks

(a)



(b)



(c)

(d)

(e)

Fig 3. (a)salt & pepper noise at 0.02 b) gaussian noise at 0.001 (c) speckle noise at 2 (d) cropping image (e) rotation image. Combined DCT-DWT

International Journal of Scientific & Engineering Research Volume 5, Issue 5, May-2014
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5 Conclusion

The combine DWT-DCT digital image watermarking algorithm is evaluated in this paper. The watermark is embedded in the DCT coefficients of selected sub-band of DWT transformed of the original image. The experimental results shows that the imperceptibility of the watermarked image is acceptable. The result shows that the perceived quality of the watermarked image is good. The simulation results shows the different PSNR values of only DCT, only DWT and combine DCT-DWT watermarking algorithms for different attacks.

From the result it is noticed that the combine transform watermarking gives the better imperceptibility response against the individual transform watermarking.

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International Journal of Scientific & Engineering Research Volume 5, Issue 5, May-2014
ISSN 2229-5518