Comparison of Digital Image Watermarking method 3 Level DWT & DWT-DCT on the Basis of PSNR

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Abstract: ***The authenticity & copyright protection are two major problems in handling digital multimedia .The Image watermarking is most popular method for copyright protection by discrete Wavelet Transform (DWT) which performs 3 Level Decomposition of original (cover) image and watermark image is embedded in Lowest Level (LL2) sub band of cover image. Inverse Discrete Wavelet Transform (IDWT) is used to recover original image from watermarked image. And Discrete Cosine Transform (DCT) which convert image into Blocks of M bits and then reconstruct using IDCT. In this paper we have compared watermarking using DWT & DWT-DCT methods performance analysis on basis of PSNR, Similarity factor of watermark and recovered watermark.***

Keywords: DCT, DWT, Original Image, Watermark, Watermarked Image.

1. Introduction

The success of the Internet and digital consumer devices has profoundly changed our society and daily lives by making the capture, transmission, and storage of digital data extremely easy and convenient. However, this raises a big concern is how to secure these data and preventing unauthorized use. This issue has become problematic in many areas. For example the music and video industry loses billions of dollars per year due to illegal copying and downloading of copyrighted materials from the Internet. As a solution, Digital watermarking is used very frequently. Hence, digital watermarking becomes very attractive research topic. Digital watermarking is a technology that creates and detects invisible markings, which can be used to trace the origin, authenticity, and legal usage of digital data. Ideally, they should be hard to notice, difficult to reproduce, and impossible to remove without destroying the medium they protect. In the future the main development of digital watermarking is like this: copyright protection, pirate tracking, copying protection, image authentication, cover-up communication. [1]

Robustness means that the watermark is able to withstand with some changes in the watermark-embedded signal; while imperceptibility represents the invisibility to human eyes, or for audio clips, the inaudibility to human ears. A good watermark algorithm should be by all means is simultaneously robust and imperceptible.

Commonly used frequency-domain transforms include the Discrete Wavelet Transform (DWT), the Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT). However, DWT [2] has been used in digital image watermarking more frequently due to its excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical models of the human visual system[3]. Further performance improvements in DWT-based digital image watermarking algorithms could be obtained by combining DWT with DCT[4]. The idea of applying two transform is based on the fact that combined transforms could compensate for the drawbacks of each other, resulting in effective watermarking. The digital image watermarking algorithm based on combining two transforms; DWT and DCT. Watermarking is done by altering the wavelets coefficients of carefully selected DWT sub-bands, followed by the application of the DCT transform on the selected sub-bands.

2. Discrete Cosine Transforms

Discrete cosine transform (DCT) is widely used in image processing, especially for compression. Some of the applications of two-dimensional DCT involve still image compression and compression of individual video frames, while multidimensional DCT is mostly used for compression of video streams. DCT is also useful for transferring multidimensional data to frequency domain, where different operations, like spread-spectrum, data compression, data watermarking, can be performed in easier and more efficient manner[3]. A number of papers discussing DCT algorithms is available in the literature that signifies its importance and application.

The discrete cosine transforms is a technique for converting a signal into elementary frequency components[4] . It represents an image as a sum of sinusoids of varying magnitudes and frequencies. With an input image, x, the DCT coefficients for the transformed output image, y, are computed according to Eq. 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.[5]

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

Where alpha u and alpha v are given by:

$$\alpha_u = \begin{cases} \frac{1}{\sqrt{2}} & u=0 \end{cases} \qquad U=1,2,\ldots.N-1 \tag{2}$$
$$\alpha_v = \begin{cases} \frac{1}{\sqrt{2}} & v=0 \end{cases} \qquad V=1,2,\ldots\ldots N-1$$

The image is reconstructed by applying inverse DCT operation according to Eq. 2

$$y(u,v)= \sqrt{\frac{2}{M}}\sqrt{\frac{2}{N}}\,\alpha_v \sum_{U=0}^{M-1}\sum_{V=0}^{N-1} x(m,n)\cos\frac{(2n+:}{2N} \tag{3}$$

The popular block-based DCT transform segments image non-overlapping blocks and applies DCT to each block. These results in giving three frequency sub-bands: 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[5]. 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.

3. Discrete Wavelet Transform (DWT)

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image .It is useful for processing of non –stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process Wavelets are created by translations and dilations of a fixed function called mother wavelet.DWT is the multireslution description of an image the decoding can be processed sequentially from a low resolution to the higher resolution [10]. The DWT splits the signal into high and low frequency parts. The high frequency part contains information about the edge components, while the low frequency part. The high frequency components are usually used for watermarking since the human eye is less sensitive to changes in edges .In two dimensional applications, for each level of decomposition, we first perform the DWT in the vertical direction, followed by the DWT in the horizontal direction After the first level of decomposition, there are 4 sub-bands: LL1, LH1, HL1, and HH1 . for each successive level of decomposition, the LL sub-band of the previous level is used as the input . To perform second level decomposition, the DWT is applied to LL1 band which decomposes the LL1 band into the four sub –To perform third decomposition, the DWT is applied to LL2 band which decompose this band into the four sub-band –LL3, LH3 HL3, HH3. This results in 10 sub-band per component. LH1, HL1, and HH1 contain the highest frequency band. The three-level DWT decomposition is shown in Fig.1. DWT is currently used in a wide variety of signal processing applications, such as in audio and video compression, removal of noise in audio, and the simulation of wireless antenna distribution [8]. Wavelets have their energy concentrated in time and are well suited for the analysis of transient, time-varying signals. Since most of the real life signals encountered are time varying in nature, The Wavelet Transform suits many applications very well.

4. Proposed Watermarking Technique

4.1 Algorithm for DWT Color Image Watermarking:

4.1.1 Watermark Embedding

Watermark Embedding Process consist of decomposing Original 256×256 image into 3-level sub bands using DWT which generate Four sub-bands (LL, LH, HL, HH)) has selected for watermark embedding as it contain maximum energy .The Watermark of 128×128 is embedded into LL2, Obtained image is called Watermarked Image.

4.1.2 Watermark Extraction

Watermark extraction is a process of removing watermark from watermarked image its opposite process of Watermarking Inverse Discrete Wavelet Transform is used for Extraction of Watermark with haar(h)filter as shown in Figure (1).The Watermarked image is again decomposed using level 3 IDWT then DWT of image is obtained, DWT image is compared with Original image and watermark is extracted from watermarked image.

4.2 Algorithm for DWT-DCT watermarking

In this algorithm for watermark embedding and extraction two popular methods are combined DWT - DCT this method is explained below:

4.2.1 Watermark Embedding:

Watermark Embedding Process in DWT-DCT method is somehow same as DWT method of decomposing Original 256×256 image into 3-level sub bands using DWT which generate Four sub-bands (LL, LH, HL, HH) and other sub band (LL1,LH1,HL1.HH1)and other sub band(LL2,LH2,HL2,HH2) out of which LL2 (Lowest Level) has selected for watermark embedding as it contain maximum energy .The DCT of Watermark 128×128 is calculated and then DCT transformed watermark is embedded into LL2, then Inverse DWT is calculated of obtained image, obtained image is called Watermarked Image, in order to convert time to obtain watermark.

4.2.2. Watermark Extraction

Watermark extraction is a process of removing watermark from watermarked image its opposite process of Watermarking Inverse Discrete Wavelet Transform is used for Extraction of Watermark with haar(h)filter as shown in Figure (1).The Watermarked image is again decomposed using level 3 IDCT then DWT of image is obtained, DWT image is compared with Original image and watermark is extracted from watermarked image. For extracting watermark DWT of watermarked image is calculated and as this detection is non blind detection original and watermarked are correlated so obtain Watermark.

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4.4 Parameters Used:

For analysis of Best method out of DWT & DWT-DCT we have used PSNR and MSE

4.4.1.Mean Square Error(MSE): f(i,j) is pixel value of original image f'(i,j) of watermarked image and its logarithmic unit is dB Given by Formula:

$$MSE = \frac{1}{M*N} \sum_{i=1}^{N} \sum_{j=1}^{M} [(f(i,j) - f'(i,j))] \quad (4)$$

4.4.2. Peak Signal to Noise Ration (PSNR): PSNR is the ratio between the maximum possible powers of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel (dB) scale.

$$PSNR = 10\log\left(\frac{MSE}{MSE}\right)db \quad (5)$$

5. Experiment Results

1. DWT Method

The watermark Embedding and Extraction process has been shown in figure(1),Algorithums for watermark Embedding use original colour image and watermark image is also colour image(128×128) called "watermark ".the scaling factor (α) of DWT lies between 0.01 to 0.09.

Original image (256×256)

watermark image (128×128)

Figure1: Input image of DWT Method

Figure (1) shows the original image (colour)which is 256×256.the watermark used for embedding .the watermark image of size 128×128.which embedded in to LL2 sub band after decomposing.

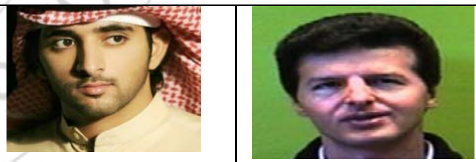
Watermark image

Extracted watermark

Figure 2: watermark image &extracted watermark

2. DWT –DCT Method

The watermark Embedding and Extraction process has been shown in figure(5),Algorithms for watermark Embedding use original color image and watermark image is also color image(128×128) called "watermark ".the scaling factor (α) of DWT lies between 0.01 to 0.09.



Original image (256×256)

Watermark image (128×128)

Figure 3: Input image of DWT –DCT Method

The watermark image of size 128X128.which than this watermark is DCT transformed & embedded in to L_L2 sub band after decomposing. DCT transformed & The watermarked image & extracted watermark is shown in fig(6).

 Watermark image	 Extracted watermark

Figure 4: watermarked i mage &extracted watermark

Table.1 Comparison of DWT& DWT-DCT Method using Different Parameters

SNo	Orginal Image Size	Watrmark Image Size	Dwt Method		Dwt-Dct Method	
			PSNR	MSE	PSNR	MSE
1	256× 256	128× 128	24.156	249.70	34.650	24.97
2	128× 128	64× 64	26.036	161.95	35.800	17.10
3	64 ×64	32× 32	26.362	150.26	36.362	15.02

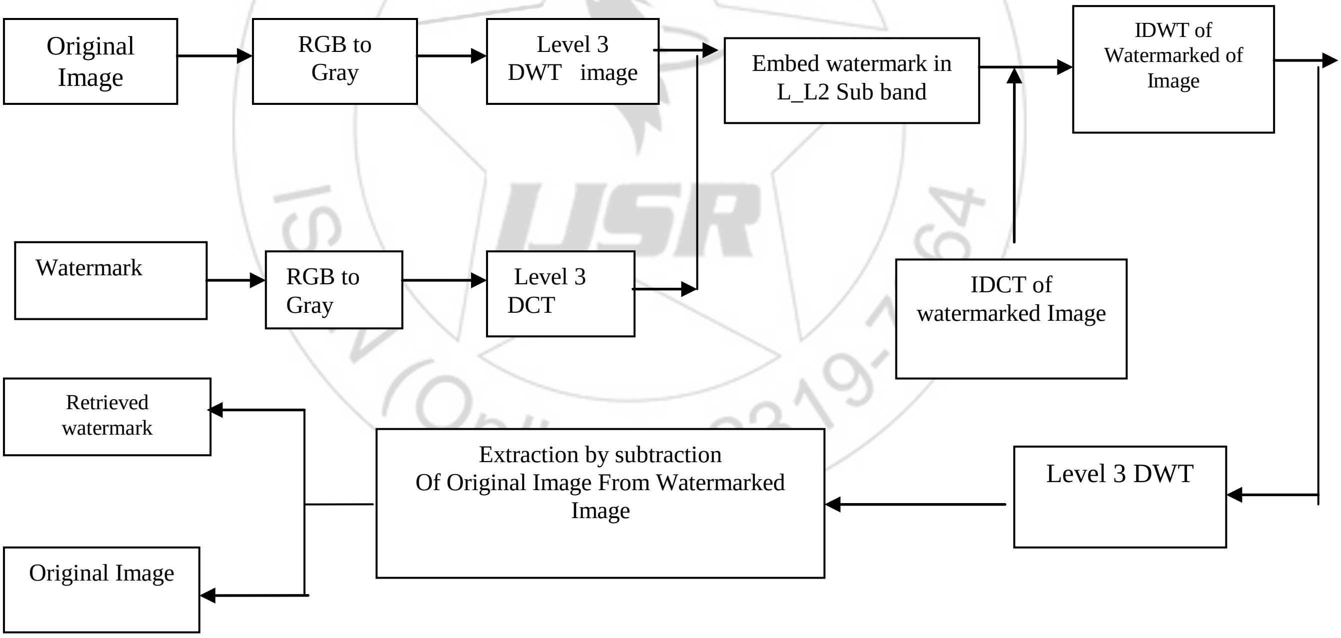


Figure 5: Watermark Embedding &Extraction Using DWT algorithm

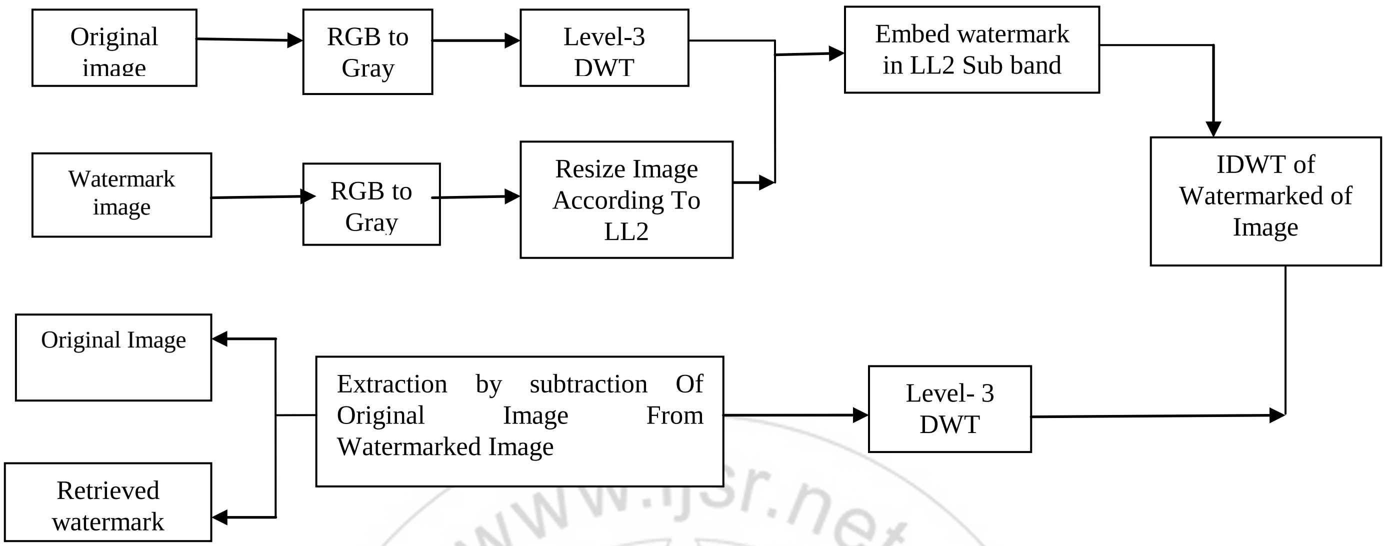


Figure 6: Shows Watermark Embedding &Extraction Using DWT-DCT Algorithm

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