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A Novel Approach of Watermarking for Multiple Images with DWT-DCT

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Abstract
A novel approach is discussed, to embed the multiple images (more than one image) with single cover image. More than one image coefficients are can be effectively embedded into cover image coefficients. The 3 images (cover image, 2 watermark images) are transformed into wavelet coefficients. One of the coefficients of watermark images LLw1 & LLw2 & cover image LLc & HHc are follows DCT & embedding process respectively. The resultant cover image hiding multiple watermark images respectively. The quantitative & qualitative analysis is discussed with Normalized Correlation (NC), Mean square error (MSE) & Peak Signal to noise ratio (PSNR).

1. Introduction

Image watermarking is the technique of hiding secret information called watermark image with a cover image. The entire process can be done in two ways, like embedding & extraction. In the embedding process some private keys are used to embed the secret information into the cover image forms watermarked image, without altering the features & visibility of watermarked image. By taking that image at the receiver, the retrieving process can be done to extract the watermark image by maintaining the authenticity & robustness of the data is the process of extraction. Security, robustness, efficiency, capacity, perceptual transparency, payload of the watermark & authentication of digital data are some of the important requirements of watermarking system. Some of the main applications of watermarking technique are Ownership assertion, Transactional watermarks, Copy prevention or control, Fraud and tamper detection, broadcast monitoring & Covert communication. According to human perception there exist visible & invisible watermarking techniques. In visible watermarking technique, the watermark is clearly observable (visible) by the human eye, where as in invisible watermarking it is not perceptible to the human eye. The process of watermark embedding is either in spatial domain or in frequency domain. In spatial domain, the embedding can be done with the pixel values, due to this a simple noise can erase the entire watermark & offers less computation, weak robustness & security. The frequency domain embedding & extraction offers more robustness & high degree of complexity to the user. In this the embedding is completely depends on the transform coefficients of an image by using different transformation techniques like as DWT, SVD & DCT etc. Based on the required level of information for the detection process, the watermarking can be classified into three techniques which are blind (public), semi-blind & non blind (private) watermarking. In terms of extraction, blind watermarking does not requires cover image details & offers less robustness. Semi blind watermarking requires the watermarked features in the process of extraction of a watermark image. When compared to the above two, the non-blind watermarking is a more robust technique & requires a cover image details to extract the watermark image [1-6].

2. Literature review

Choudhary [6], proposed a 2-level DWT based watermarking technique. Based on the variable visibility factor the watermark is inserted into the low frequency component of the cover image, results are simulated & compared with 1-level DWT. Trambadia's [7] work proposed a comprehensive Invisible watermarking technique with FFT, DCT & DWT based on Arnold Transform (AT) scrambling. For achieving the better authenticity & robustness, here DWT based Arnold Transform is used when compared to the FFT & DCT. Mary Agoyi proposed a watermarking technique based on DWT, SVD & chirp z-transform for providing better perceptibility. The CZT–DWT–SVD technique is robust and imperceptible in terms of various signal processing operations & attacks. Salama [9] introduced a watermarking technique to improve robustness (Gama Correction, Histogram Equalization), imperceptibility & reduces execution time in comparison to DWT, DCT& hybrid fusion technique (HFT). In this 'IMD-WC-T' technique the DWT & DCT methods are combined to allow & exploit the derivable individual advantages from the usage of DWT & DCT methods separately. Mardolkar's [10] work discussed about an imperceptible and robust blind digital watermarking technique with the combination of DWT & DCT with low frequency watermarking to improve the imperceptibility & robustness. In this the watermarked image is adjusted in spatial domain by weighted correction with the combination of DWT & DCT, which is able to withstand a variety of common signal processing attacks. Sheth's, [11] showed about a secured digital watermarking technique which is more robust & efficient for the data validation. By using the combination of DWT, DCT methods along with cryptographic technique (Arnold Transform) the embedding of watermark is carried, by providing perception transparency & strong robustness to the watermarked image against various attacks. Yu Yang's [12] study discussed about a novel zero-watermarking algorithm based on DWT & DCT, which is strongly robust against all the common signal processing attacks and gives a zero bit error after attacks also.

3.Digital watermarking

A digital watermark is a kind of marker covertly embedded in a noise-tolerant signal such as an audio, video or image data. It is typically used to identify ownership of the copyright of such signal. "Watermarking" is the process of hiding digital information in a carrier signal; the hidden information should, but does not need to, contain a relation to the carrier signal. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owners. It is prominently used for tracing copyright infringements and for banknote authentication.

Fig 1: Image watermark

Example of a watermark overlay on an image; the logo of Wikipedia can be seen on the center to represent the owner of it.

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Like traditional physical watermarks, digital watermarks are often only perceptible under certain conditions, i.e. after using some algorithm. If a digital watermark distorts the carrier signal in a way that it becomes easily perceivable, it may be considered less effective depending on its purpose. Traditional watermarks may be applied to visible media (like images or video), whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models. A signal may carry several different watermarks at the same time. Unlike metadata that is added to the carrier signal, a digital watermark does not change the size of the carrier signal.

The needed properties of a digital watermark depend on the use case in which it is applied. For marking media files with copyright information, a digital watermark has to be rather robust against modifications that can be applied to the carrier signal. Instead, if integrity has to be ensured, a fragile watermark would be applied.

Both steganography and digital watermarking employ steganography techniques to embed data covertly in noisy signals. While steganography aims for imperceptibility to human senses, digital watermarking tries to control the robustness as top priority.

Since a digital copy of data is the same as the original, digital watermarking is a passive protection tool. It just marks data, but does not degrade it or control access to the data.

One application of digital watermarking is source tracking. A watermark is embedded into a digital signal at each point of distribution. If a copy of the work is found later, then the watermark may be retrieved from the copy and the source of the distribution is known. This technique reportedly has been used to detect the source of illegally copied movies.

4. Proposed Syste

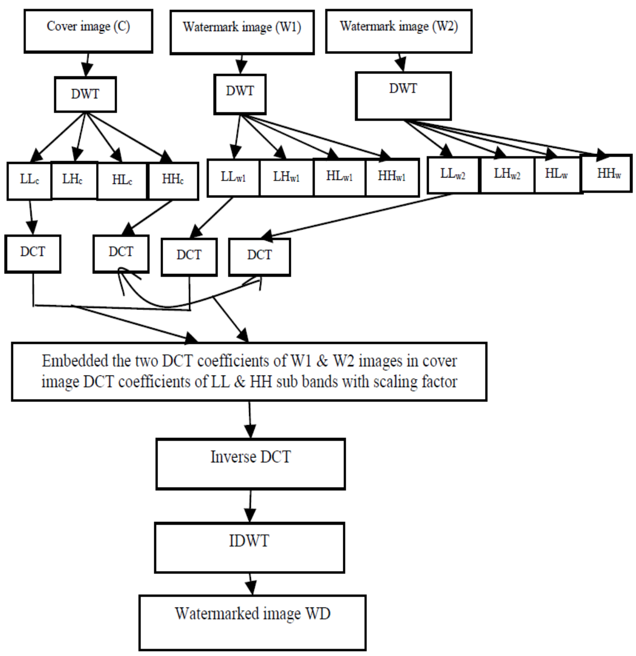

Fig. 2: Proposed system block diagram for Watermarking

4.1 Discrete Wavelet Transform:

The wavelet transform has gained widespread acceptance in signal processing and image compression. Recently the JPEG committee has released its new image coding standard, JPEG-2000, which has been based upon DWT. Wavelet transform decomposes a signal into a set of basic functions. These basis functions are called wavelets. Wavelets are obtained from a single prototype wavelet called mother wavelet by dilations and shifting [8]. The DWT has been introduced as a highly efficient and flexible method for sub band decomposition of signals. The 2DDWT is nowadays established as a key operation in image processing .It is multi-resolution analysis and it decomposes images into wavelet coefficients and scaling function. In Discrete Wavelet Transform, signal energy concentrates to specific wavelet coefficients. This characteristic is useful for compressing images [9]. Wavelets convert the image into a series of wavelets that can be stored more efficiently than pixel blocks. Wavelets have rough edges, they are able to render pictures better by eliminating the ―blockings‖. In DWT, a timescale representation of the digital signal is obtained using digital filtering techniques.

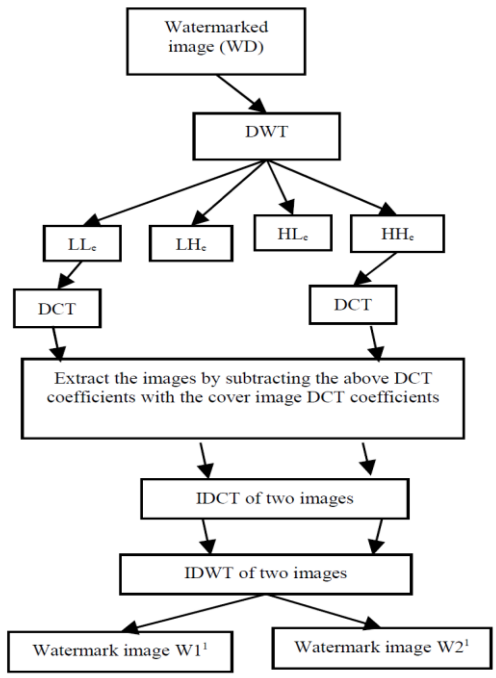

Fig. 3: DWT Image Watermarking

The signal to be analyzed is passed through filters with different cut-off frequencies at different scales. It is easy to implement and reduces the computation time and resources required [9]. A 2-D DWT can be seen as a 1-D wavelet scheme which transform along the rows and then a 1-D wavelet transform along the columns,. The 2-D DWT operates in a straight forward manner by inserting array transposition between the two 1-D DWT. The rows of the array are processed first with only one level of decomposition. This essentially divides the array into two vertical halves, with the first half storing the average coefficients, while the second vertical half stores the detail coefficients. This process is repeated again with the columns, resulting in four sub-bands (see Fig. 4) within the array defined by filter output. Fig. 4 shows a three- level 2- D DWT decomposition of the image.

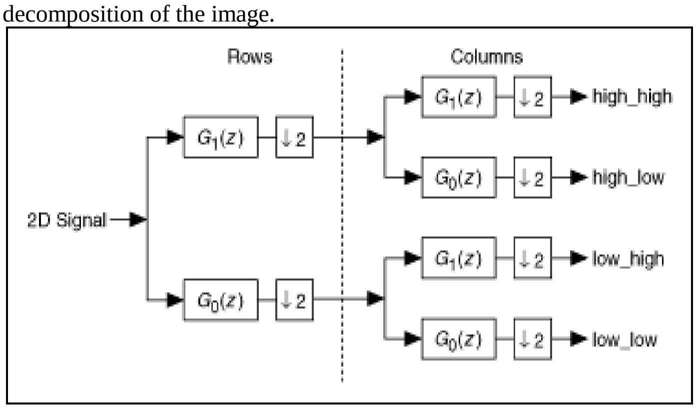

Fig. 4: DWT decomposition of the image

Image consists of pixels that are arranged in two dimensional matrix, each pixel represents the digital equivalent of image intensity. In spatial domain adjacent pixel values are highly correlated and hence redundant. In order to compress images, these redundancies existing among pixels needs to be eliminated. DWT processor transforms the spatial domain pixels into frequency domain information that are represented in multiple sub-bands, representing different time scale and frequency points. One of the prominent features of JPEG2000 standard, providing it the resolution scalability, is the use of the 2D-DWT to convert the image samples into a more compressible form. The JPEG 2000 standard proposes a wavelet transform stage since it offers better rate/distortion (R/D) performance than the traditional DCT.

4.2 Discrete Cosine Transform

A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies. DCTs are important to numerous applications in science and engineering, from loss compression of audio (e.g. MP3) and images (e.g. JPEG) (where small high-frequency components can be discarded), to spectral methods for the numerical solution of partial differential equations. The use of cosine rather than sine functions is critical for compression, since it turns out (as described below) that fewer cosine functions are needed to approximate a typical signal, whereas for differential equations the cosines express a particular choice of boundary conditions.

In particular, a DCT is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. The DCTs are generally related to Fourier series coefficients of a periodically and symmetrically extended sequence whereas DFTs are related to Fourier series coefficients of a periodically extended sequence. DCTs are equivalent to DFTs of roughly twice the length, operating on real data with even symmetry (since the Fourier transform of a real and even function is real and even), whereas in some variants the input and/or output data are shifted by half a sample. There are eight standard DCT variants, of which four are common.

The most common variant of discrete cosine transform is the type-II DCT, which is often called simply ‘the DCT’. Its inverse, the type-III DCT, is correspondingly often called simply "the inverse DCT" or ‘the IDCT’. Two related transforms are the discrete sine transform (DST), which is equivalent to a DFT of real and odd functions, and the modified discrete cosine transform (MDCT), which is based on a DCT of overlapping data. Multidimensional DCTs (MD DCTs) are developed to extend the concept of DCT on MD Signals. There are several algorithms to compute MD DCT. A new variety of fast algorithms are also developed to reduce the computational complexity of implementing DCT.

5. Results

Simulation Results are shown by figure 5 and figure 6, respectively.

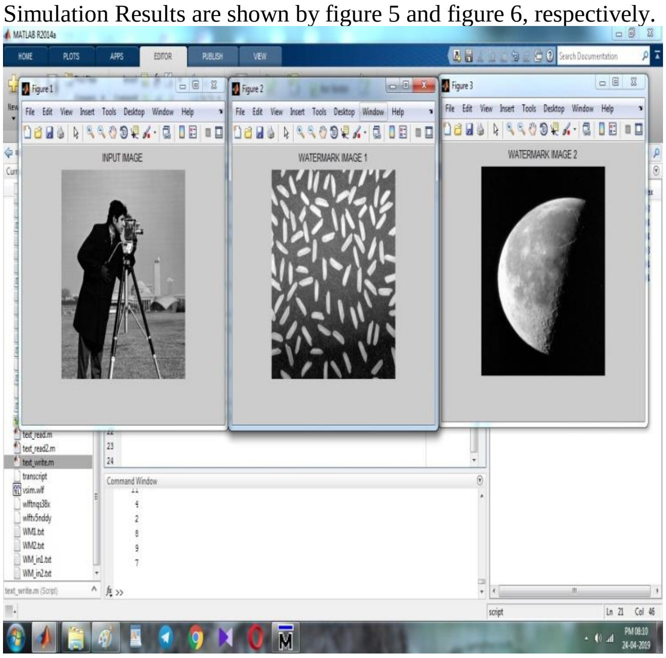

Fig.5: Input and output Images for watermarking

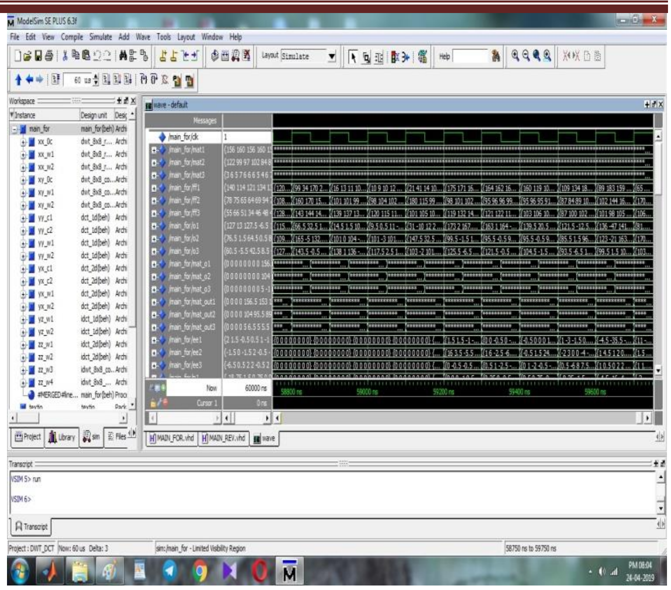

Fig.6: Proposed watermarking technique output waveform

6.Conclusions

Commonly used frequency-domain transforms include the Discrete Wavelet Transform (DWT), the Discrete Cosine Transform (DCT) and Discrete Fourier Transform (DFT). However, DWT 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 [8]. Further performance improvements in DWT-based digital image watermarking algorithms could be obtained by combining DWT with DCT [9]. 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. we described a 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.

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