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Digital Image Watermarking Using DWT Based DCT Technique

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***Abstract*— The growing problem of the unauthorized reproduction of digital multimedia data such as movies, TV broadcasts, and similar digital products has triggered worldwide efforts to identify and protect copyright ownership of multimedia contents. In the last decade digital watermarking techniques have been devised to answer the ever-growing need to protect the intellectual property. There are various transformation techniques used for image watermarking Discrete Wavelet Transform (DWT) and discrete cosine transform (DCT) are two most popular technique used in watermarking algorithm from that two technique taking benefit from the advantages of both algorithms and make one hybrid technique.**

***Keywords*— Copyright, Watermark, DWT, DCT, Robust.**

I. INTRODUCTION

The daily need to create copy, transmit and distribute digital data as a part of widespread multimedia technology in internet era. Hence copyright protection has become essential to avoid unauthorized copy problem. Digital image watermarking provides copyright protection to image by hiding appropriate information in original image to declare rightful ownership [1]. Robustness, Perceptual transparency, capacity and blind watermarking are four essential factors to determine quality of watermarking scheme [2-3]. Watermarking algorithms are broadly categorized as Spatial Domain Watermarking and Transformed domain watermarking. In spatial domain, watermark is embedded by directly modifying pixel values of cover image. Least Significant Bit insertion is example of spatial domain watermarking. In Transform domain, watermark is inserted into transformed coefficients of image giving more information hiding capacity and more robustness against watermarking attacks because information can be spread out to entire image [1]. Watermarking is the process that embeds data called a watermark or digital signature or tag or label into a multimedia object such that watermark can be detected or extracted later to make an assertion about the object. Digital watermark is a sequence of information containing the owners copyright for the multimedia data. It is invisibly into other image so that it can be extracted later as an evidence of authentic owner. Usage of digital image watermarking technique has grown significantly to protect the copyright ownership of digital multimedia data as it is very much prone to unlawful and unauthorized replication, reproduction and manipulation. The watermark may be a logo, image or at any sequence. A typical good watermarking scheme should aim at keeping the embedded watermark very robust under malicious attack in real and spectral domain. Incorporation of the watermark in the image could be performed in various ways.

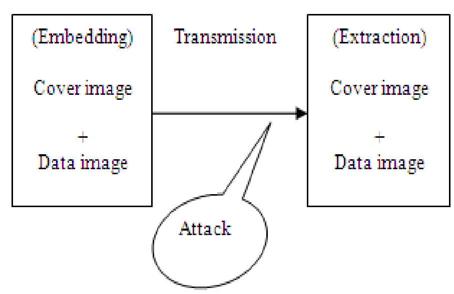

Fig. 1 General processes involved in a watermarking system

DISCRETE COSINE TRANSFORM (DCT)

Digital watermarking has been proposed as a viable solution to the need of copyright protection and authentication of multimedia data in a networked system, since it makes Possible to identify the owner, distributor or authorized consumer of a data. In this paper a new watermarking algorithm to add a code to digital images is presented: the method operates in the frequency domain embedding a pseudo-random sequence of real numbers in a selected set of DCT coefficients. Watermark casting is performed by exploiting the masking characteristics of the Human Visual System, to confirm watermark invisibility. The embedded information is extracted without resorting to the original image, so that the proposed technique gives a major improvement to methods relying on the comparison between the watermarked and original images. The popular block-based DCT transform segments image non-overlapping blocks and applies DCT to each block. This result in giving three frequency sub-bands: low frequency sub-band, mid-frequency sub-ban and high frequency sub-band. DCT-based watermarking is based on two different 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 component of the image are usually removed through compression and noise attacks. The watermark is 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 [4-7] as shown in blow fig 2.

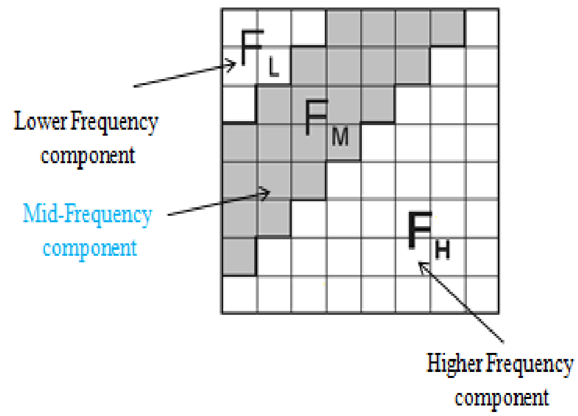

Fig. 2 Discrete wavelet transform

Advantages of DCT

1. Semantically meaningful watermark pattern.
2. Good perceptual invisibility.
3. Acceptable robustness.
4. Various user-selected options.
5. Reasonable complexity/execution time.
6. Fast and Suitable for robustness against JPEG compression.

Disadvantages of DCT

1. Block effect.
2. Effect of picture cropping.
3. One of the main problems and the criticism of the DCT is the blocking effect. In DCT technique images are broken into blocks 8x8 or bigger. The problem with these blocks is that when the image is reduced to higher compression ratios, these blocks become noticeable. This has been termed as the blocking effect.

II. DISCRETE WAVELET TRANSFORMS (DWT)

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 [5-6]. Then transform the coefficient of sub-image. After the original image has been applying DWT transformed, it is decomposed into four frequency region(districts) which is one low-frequency district(LL) and three high-frequency districts(HL,LH,HH). If the information of low-frequency district is DWT transformed the sublevel frequency region information will be obtained. A two-dimensional image after three-level DWT decomposed can be shown as Fig.3. Where, H represents high-pass filter, L represents low-pass filter. An original image can be made of frequency districts of HL1, LH1, and HH1. The low-frequency district information also can be decomposed into sub-level frequency district information of LL2, HL2, LH2 and HH2. By performing this original image can be decomposed for *n* level wavelet transformation.

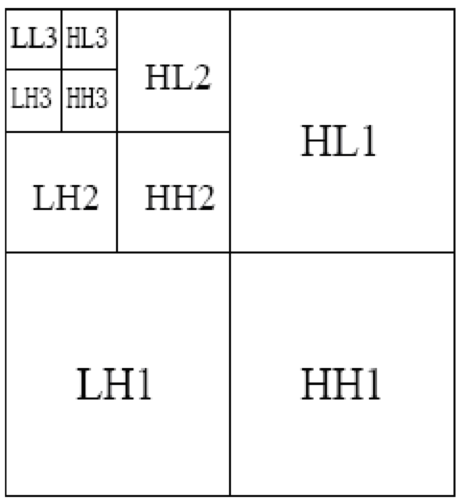

Fig. 3 Sketch Map of Image DWT Decomposed

The information of low frequency district is a image close to the original image. The frequency region of LH, HL and HH respectively represents the upright detail and the diagonal detail of the original image. Due to its excellent spatial domain frequency localization properties, DWT is very suitable to identify the areas in the host image where a watermark can be embedded effectively. This property allows the exploitation of the masking effect of the human visual system such that if a DWT coefficient is modified, only the area corresponding to that coefficient will be modified. Normally most of the image energy is concentrated at the lower level frequency sub-bands LLx and therefore embedding watermarks in these sub-bands may degrade the image. Embedding in the low frequency sub-bands could increase robustness significantly. In another way, 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 cases 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 upper-bands LHx and HLx where acceptable performance of robustness and imperceptibility can achieved. [8-13].

Advantages of DWT

1. Transformation of the whole image introduces inherent Scaling.
2.Better identification of which data is relevant to human Perception higher compression ratio.

Disadvantages of DWT

1. The cost of computing DWT as compared to DCT may be higher.
2. The use of larger DWT basis functions or wavelet filters produces blurring and noise near edge regions in images or video frames
3. Longer compression time.

III. THE COMBINED DCT-DWT ALGORITHM

Watermark embedding algorithm

Step 1: Apply DWT technique to decompose the cover host image into four non-overlapping multi-resolution sub-bands: LL1, HL1, LH1, and HH1.

Step 2: Divide the sub-band HL1 (or HH1) into 16 x 16 blocks.

Step 3: Apply DCT watermarking to each block in the chosen sub-band.

Step 4: Re-formulate the grey-scale watermark image into a vector of zeros and ones.

Step 5: Generate two uncorrelated pseudorandom sequences. One sequence is used to embed the watermark bit 0 (PN_0) and the other sequence is sued to embed the watermark bit 1 (PN_1). Element`s number in each of the two pseudorandom pattern or sequences must be equal to the number of mid-band elements of the DCT-transformed DWT sub-bands.

Step 6: Embed the two pseudorandom sequences, PN_0 and PN_1, with a gain factor, in the DCT transformed 16x16 blocks of the selected DWT sub-bands of the host image. Embedding is not applied to all coefficients of the DCT block, but only to the mid-band DCT coefficients. If we donate X as the mid-band coefficients of the DCT transformed block, then embedding is done as given in below equations 1 and 2.

If the watermark bit is 0 then

$$\mathbf{X' = X + * PN\_0} \quad (1)$$

If the watermark bit is 1 then

$$X' = X + * PN\_1 \quad (2)$$

Step 7: Apply inverse DCT (IDCT) to each block after its mid-band coefficients have been modified to embed the watermark bits as described in the previous step.

Step 8: Apply the inverse DWT (IDWT) on the DWT transformed image, including the modified sub-band, to produce the watermarked original (host) image.

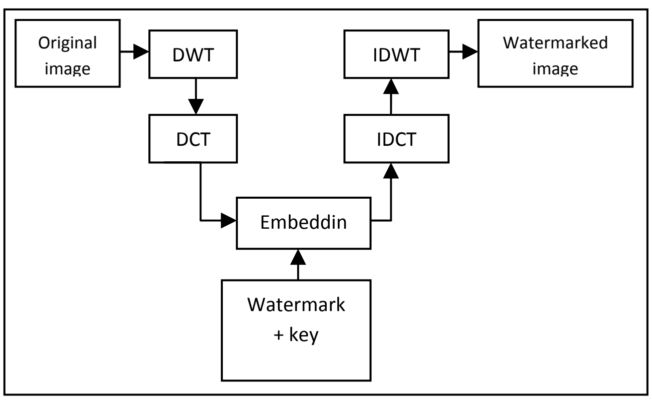

Fig. 4 Watermark embedding

The watermark Extraction algorithm

Step 1: Apply DWT to decompose the watermarked image into non-overlapping four multi-resolution sub bands: LL1, HL1, LH1, and HH1.

Step 2: Divide the sub-ban into 16x16 blocks.

Step 3: Apply Discrete wavelet transforms (DCT) to each block in the chosen sub-band and extract the mid-band coefficients of each DCT transformed block.

Step 4: Regenerate the two different pseudorandom sequences (PN_0 and PN_1) using the same seed used in the previous watermark embedding procedure.

Step 5: For each block in the sub-band, calculate the correlation between the mid-band coefficients and the two generated pseudorandom sequences (PN_0 and PN_1). If the correlation with the PN_0 was higher as compared to the correlation with PN_1, then the extracted watermark bit is considered as 0, otherwise the extracted watermark is considered as 1.

Step 6: Reconstruct the watermark using the extracted watermark bits, and compute the similarity between the original image and extracted watermarks.

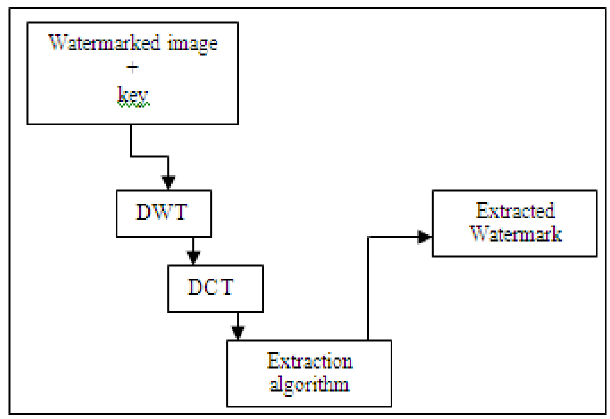

Fig. 5 Watermark Extractions

IV. CONCLUSION

From the above result analysis, the discrete wavelet transforms (DWT) and the discrete cosine transform (DCT) have been applied successfully on digital image watermarking. In this paper, we described a combined DWT-DCT digital image watermarking algorithm. Watermarking was done by embedding the watermark in DWT sub-bands of the host image, followed by the application of DCT on the selected DWT sub-bands. The combination of the two transforms improved (as shown in table I and II) the watermarking performance considerably when compared to the DWT and DCT Only watermarking approach.

V. FUTURE SCOPE

There is a scope of future work in developed technique, this technique is still applicable for images only but it technique can also developed for audio, videos because we know that audio is also represented in frequency component and video is a collection of image frame so watermarking can be inserted in that both and make audio and video watermarking effectively.

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TABLE I
RESULT ANALYSIS (EMBEDDING)

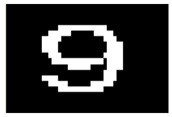
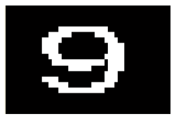
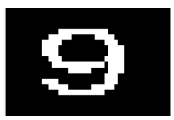
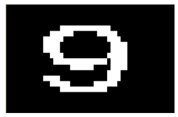
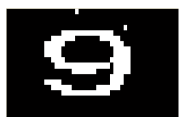
Sr. No	Original Image	Message Image	Watermarked Embedded image	Elapsed Time
1	Gray scale image leena.bmp 512 X 512 	Gray Scale nine.bmp image 50 X 20 	Gray Scale image Dctleena.bmp 512 X 512 	Embedding 2.85 sec
2	Gray scale image leena.bmp 512 X 512 	Gray Scale nine.bmp image 50 X 20 	Gray Scale image Dwtleena.bmp 512 X 512 	Embedding 31.64 sec
3	Gray scale image leena.bmp 512 X 512 	Gray Scale nine.bmp image 50 X 20 	Gray Scale image Dct-Dwtleena.bmp 512 X 512 	Embedding 3.4 sec

TABLE II
RESULT ANALYSIS (EXTRECTION)

Sr. No	Watermarked Embedded image	Extraction Result	Watermarked Extracted image	Elapsed Time	Remark
1	Gray Scale image Dctleena.bmp 512 X 512 	Extracted image Edctnine.bmp image 50X20 	Gray Scale image Edctleena.bmp 512 X 512 	Extraction 1.25 sec	Detect clearly
2	Gray Scale image Dwtleena.bmp 512 X 512 	Extracted image Edwtnine.bmp image 50X20 	Gray Scale image Edwtleena.bmp 512 X 512 	Extraction 45.3 sec	Detect Unclearl y
3	Gray Scale image Dct-Dwtleena.bmp 512 X 512 	Extracted image Edctdwtnine.bmp image 50X20 	Gray Scale image Edctdwtleena.bmp 512 X 512 	Extraction 2.2 sec	Detect Almost clearly