INVISIBLE MULTIPLE WATERMARKING WITH MINIMUM DISTORTION USING DWT-DCT-CDMA

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Abstract- **with the advent of digital media copyright protection is main concern. To protect copyright of images DWT DCT image watermarking is used. In this CDMA approach of embedding watermark is taken so that maximum number of watermarks can be embedded in original image to increase its authenticity. After embedding PSNR values are calculated at each watermark embedding and a table is constructed showing PSNR at each level. At the receiver end retrieval of watermark is done by correlation of original image.**

Keywords: DWT DCT, CDMA, PSNR

I. INTRODUCTION

The fast development of the Internet in recent years has made it possible to easily create, copy, transmit, and distribute digital data. Consequently, this has led to a strong demand for reliable and secure copyright protection techniques for digital data. Digital watermarking has been proposed as valid solution for this problem. The purpose of the watermark is to embed some additional information about the digital data without visibly modifying it.

Watermark should be invisible and robust to different types of attacks like addition of noise, scaling of image, rotation of image etc. [1][2][3][4]. Depending on the energy distributed in an image, image can be broken into high energy frequency band, middle energy frequency band, and low energy frequency band. Watermarking can be categorised in various categories depending upon the type of watermark used and domain of watermarking. Watermark can be a logo or a sequence of numbers whereas based on domain watermarking can be categorised as spatial domain and transformed domain. Spatial domain is techniques are not resistant enough to image compression and other image processing. Transform domain watermarking schemes like those based on the discrete cosine transform (DCT) the discrete wavelet transform (DWT) typically provide higher image imperceptibility and are much more robust to image manipulations. In these domain watermark is placed in perceptually significant coefficients of the image. However, DWT has been used more frequently in digital image watermarking
due to its time/frequency decomposition characteristics, which resemble to the theoretical models of the human visual system. In this paper DWT and DCT both methods are combined to remove disadvantages of both methods. CDMA approach of watermarking is used[5]. A unique PN sequence is generated for each watermark so that when more than one watermark are embedded then retrieval becomes easy. In our paper result for four watermarks has been calculated. The size of watermark is biggest constraint in embedding maximum number of watermarks. The size of the watermark must go on decreasing as the number of watermark increase.

II. WATERMARK EMBEDDING

We start the watermarking process by applying DWT to the host image, and afterwards performing the DCT to the selected DWT sub-bands. The agreement adopted by many DWT-based watermarking methods, is to embed the watermark in the middle frequency sub-bands HLX and LHX is better in perspective of imperceptibility and robustness. The watermark embedding procedure is represented in Figure 1, followed by a detailed explanation.

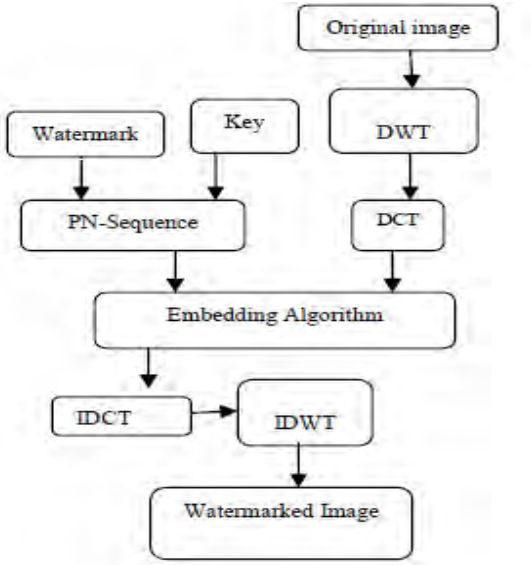

Figure 1. Joint DWT-DCT watermark embedding procedure.

Step 1: Take the message and reformulate the message into sequence of 1 and 0.
Step 2: Take the key and generate a PN sequence by that key. This PN sequence is kept same during all embedding process.
Step 3: Generate two highly uncorrelated PN sequence pn_sequence_1 andpn_sequence_0.
Step 4: Perform DWT on the host image to decompose it into four non-overlapping multi resolution coefficient sets: cA1, cH1, cV1 and cD1.
Step 5: Choose blocksize and a midband coefficients matrix for DCT. In our paper blocksize of 8 is chosen and a midband matrix of 8*8 is chosen from literature review.
Step 6: Now perform DCT on cH1and embed both PN sequence with a gain factor 'k' depending on the bit value of message. The algorithm for embedding pn sequence is shown as

$$X' = \begin{cases} X + \alpha * PN0 & watermark\_bit = 0 \\ X + \alpha * PN1 & watermark\_bit = 1 \end{cases}$$

Step 7: Now perform IDCT on cH1.
Step 8: Repeat step6 and 7 for cV1.
Step 9: Perform IDWT on updated values of cA1, cH1, cV1, cD1 and name this image as watermarked image.
Step 10: PSNR, Image fidelity and Normalized cross correlation is found out to determine robustness and image quality of watermarked image.
Step 11: Now follow steps from 1 to 10 for embedding next watermark using separate key for PN sequence. The size of watermark is determined by hit and trial method and that comes less than the previous watermark size.
Step 12: Number of watermarks embedded depends upon retrieval process because watermark should be retrieved properly that is without any distortion.

III. WATERMARK RETRIEVAL

The watermark extraction procedure is shown in Figure 2, and described in details in the following steps. The joint DWT-DCT algorithm is a blind watermarking algorithm, and thus the original host image is not required to extract the watermark.

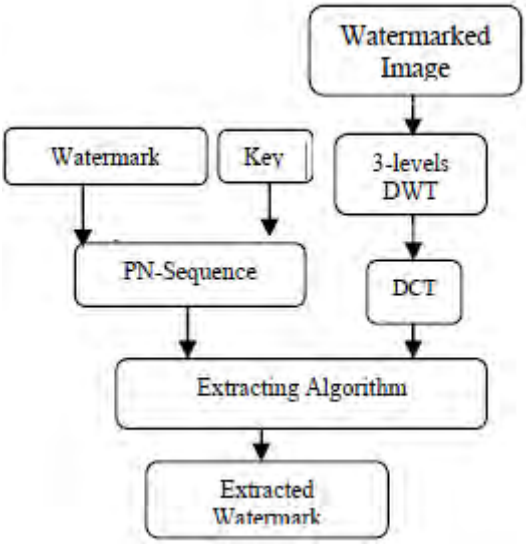

Figure 2: Watermark Extraction Procedure

Step 1: Steps from 1 to 5 of embedding process are same using same key for PN sequence generation.
Step 2: Now perform DCT on cH1 and generate a sequence at condition where midband matrix element is 1. Correlate that sequence to pn_sequenc_0 and to pn_sequence_1.
Step 3: Repeat the step 2 with cV1.
Step 4: Take the mean of correlation value for pn_sequence_1 of cH1 and cV1 and correlation value for pn_sequence_0 of cH1 and cV1.
Step 5: If correlation value for 0 is greater than the correlation value of 1, put the message vector element equal to 0 otherwise 1.

```
correlation_0>correlation_1
        message_vector = 0
Otherwise
        message_vector = 1
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Step5: Reshape the message vector and that will be similar to message embedded.
Step6: Same steps are repeated for next watermark message retrieval.

IV. RESULT

Watermarked image and retrieved watermark for 4 different messages of decreasing size along with salt and pepper noise embedded is shown in figure 4. The original Watermark for two images is shown in figure 3.

Figure 3: Original Watermarks

As is clear from figure 3 and figure 4 the watermark extraction is only possible for two watermark message embedded. If third watermark is embedded then at retrieval a distorted form of watermark is retrieved. Table for different PSNR values, Image Fidelity values and normalised cross correlation for different watermark messages is shown in table 1. Table 2 shows the comparison of DWT, DCT and DWT-DCT. Table2 clearly depicts which drawbacks DWT-DCT is removing of DCT and DWT.

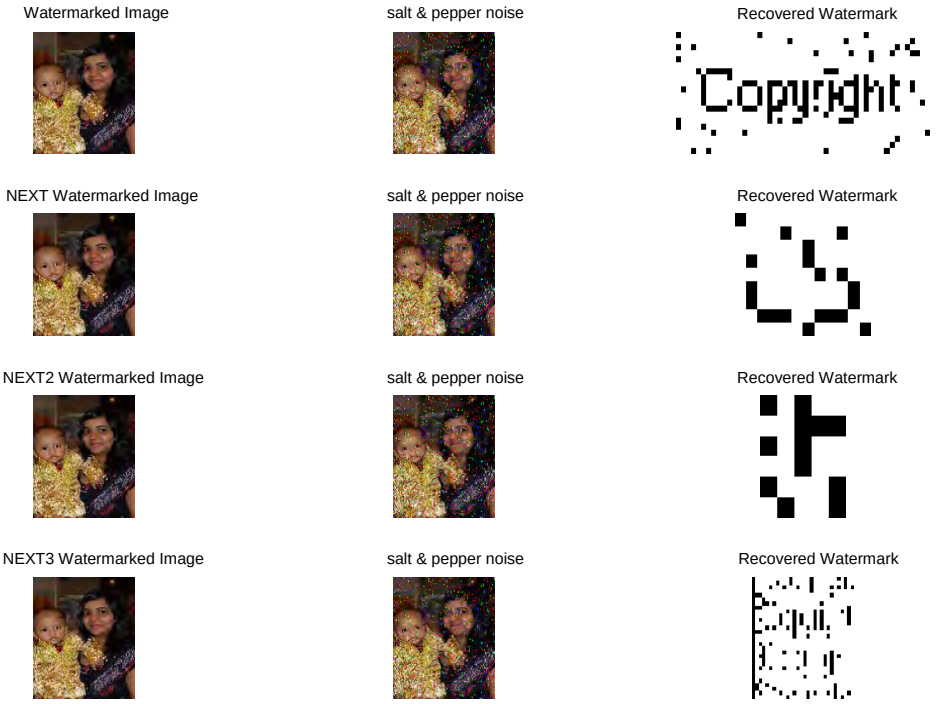

Figure 4: Watermarked Image for 4 Different messages and Retrieved Watermarks Along With Salt and Pepper Noise in the Watermarked Image.

Table 1: Parameters for different watermarked Images

	PSNR	Image Fidelity	Normalized Cross Correlation
1st Watermarked Image	38.7382	-6.7647e-004	1.0000
2nd Watermarked Image	39.1471	-6.1447e-004	1.0005
3rd Watermarked Image	39.3033	-5.9006e-004	1.0010
4th Watermarked Image	37.1151	-9.6923e-004	0.9990

Table 2: Comparison with DWT and DCT

	PSNR	Image Fidelity	Normalized Cross Correlation
DWT-DCT	38.7382	-6.7647e-004	1.0000
DWT	27.6289	-0.0059	1.0000
DCT	44.6791	-1.1730e-004	1.0000

V. CONCLUSION

DWT-DCT watermarking is improvement in recent methods. Watermarked image \by this method is more robust and image quality is improved. Using CDMA approach number of watermark embedded into is found out. Maximum of two watermarks of decreasing size are embedded depending upon retrieval condition. This method is suitable for every type of colored image too. In this paper results are calculated fro colored bmp image.

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