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A SEMI-BLIND WATERMARKING SCHEME USING HYBRID TRANSFORM AND EDGE DETECTION

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Abstract— In this paper, we present Discrete Wavelet Transform, Discrete Cosine Transform, and Semi-Blind Watermarking Scheme as edge detection methods. We used a grayscale image as a cover image and a watermark to hide the original. The cover photo contains multiple blocks. We count the edges in each block using a reference image as a guide. The reference image is subsequently translated to the wavelet domain. A DCT is applied to the reference image from the DWT decomposition. We are able to mask the watermark by fusing the singular values of the watermark with the singular values of the modified DCT coefficients. Strong robustness and imperceptibility against various attacks are features of the recommended approach.
Keywords— **DWT, DCT, SVD, Hybrid Transform, Edge detection.**

1. INTRODUCTION

Digital information can be distributed considerably more quickly and easily as a result of the network technology's rapid and widespread development. However, due to a lack of understanding of intellectual property, the problem of illicit reproductions and the dissemination of copyright for restricted material is becoming more significant. to preserve multimedia content's copyright and to lessen the need to duplicate and disseminate information that is protected by copyright. Fortunately, the digital watermarking method is the best option to safeguard the owners' whole information. Watermarking involves two steps. One is embedding; a watermark or signal is concealed as cover information inside multimedia material. The second is extraction, which is the secret signal or mark at the receiving end. When watermarking digital images, the added watermark shouldn't impair the original image's visual quality.

The first approach for removing the watermark involves directly altering the original cover-media. This method has the benefit of being quick and easy to compute, but it is not immune to several signal processing attacks [1, 2, and 3].The majority of watermarking techniques, including Fourier transformation, wavelet transformation, and singular value decomposition, embed the information data in the coefficients of transformation domain of the cover picture. The literature also includes hybrid domain transforms such as DCT-SVD [16,17, and 18] and DWT-SVD [19] that use Discrete Cosine Transform (DCT) [4,5,6,12, and 13], Discrete Wavelet Transform (DWT) [7,8,9,10, and 11], and Singular Value Decomposition (SVD) [14,15].

In this paper, we suggested a DWT-DCT-SVD-based ideal watermarking method. The remainder of the essay is structured as follows: Section 2 details our suggested method, and Section 3 lists the outcomes of the experiments. Although the end of section 4 is followed by references in section 5.

2. Proposed Algorithm

A. *Watermark embedding procedure*.

procedure for adding a watermark is shown in figure1.The original image is first divided into blocks of size p x p blocks using a ZIG_ZAG sequence represented by F1, where l is the number of blocks.
Step 1: Tally the number of edges on each block.
Step 2: Establish a cap on how many edges are allowed in each block. Significant blocks are those blocks that use the reference image, Fref, which has a size of n x n and have edges that are more than or equal to the threshold.
Step 3: Apply DWT on the reference image, as shown by the symbol fDWT,
Step 4: Apply DCT to the LH band of the DWT decomposition fDCT.
Step 5: Apply SVD to fDCT and is shown in equation 1

$$f_{DCT}^{SVD} = U_{DCT}^{SVD} * S_{DCT}^{SVD} * V_{DCT}^{SVD^T} \quad (1)$$

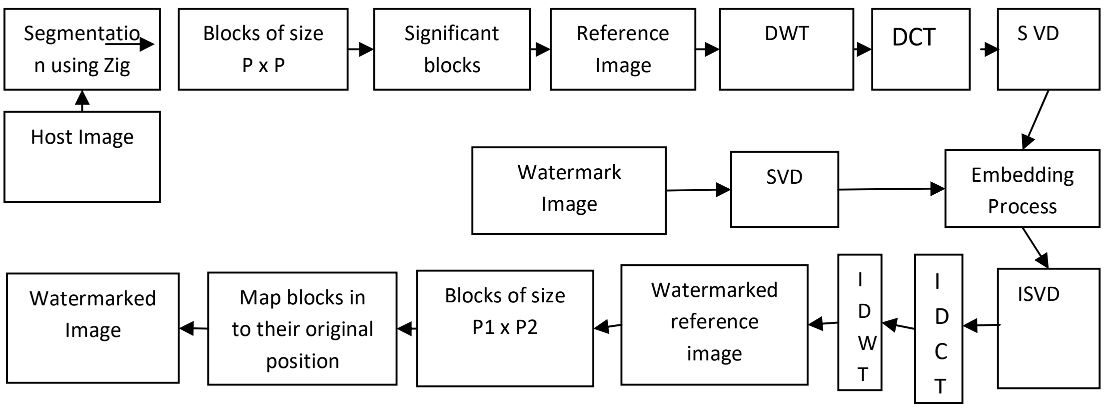

Figure 1: watermark embedding process

Step6: perform SVD on watermark image as shown in equation 2

$W_{SVD} = U_W * S_W * V_W^T$ (2)

Step7: Modify the single values of reference image with the singular values of watermark as shown in equation 3

$f_{SVD}^{*} = S_{DCT}^{SVD} + \beta * S_W$ (3)

Where, β gives the watermark depth.

Step8: Perform inverse SVD as shown in equation 4.

$f_{isvd}^{*} = U_{DCT}^{SVD} * f_{SVD}^{*} * V_{DCT}^{SVD^T}$ (4)

Step9: Perform inverse DCT and inverse DWT to construct the modified reference image, denoted byf_{ref}^{*}. Again f_{ref}^{*} is segmented into blocks of size $p_1 \times p_1$and mapped onto their original positions for constructing the watermarked image.
We save the positions of the significant blocks and reference image for the extraction process.

B. *Watermark Extraction*

The objective of the watermark extraction is to obtain the estimate of watermark. For watermark extraction, original reference and watermark images, left and right singular vectors must be available at the receiver end.
Step1: Using the positions of significant blocks, make the reference image from the watermarked image, denoted by F_{ref}^{W}.
Step2: Perform DWT and DCT on watermarked image, F_{ref}^{W}.Which is denoted by f_{ref}^{W}.
Step3: Perform SVD transform on f_{ref}^{W} as shown in equation 5

$$f_{ref}^{W} = U_{ref}^{W} * S_{ref}^{W} * V_{ref}^{W^T} \quad (5)$$

Step4: Extract the singular values of the watermark as shown in equation 6

$$S^{ext} = \frac{S_{ref}^{W} - S_{DCT}^{SVD}}{\beta} \quad (6)$$

Step5: Obtain theextracted watermark as shown in equation 6

$$W^{ext} = U_w * S^{ext} * V_W^T \quad (7)$$

3. RESULT ANALYSIS

A. ***Imperceptibility Performance.***

Imperceptibility means that the perceived quality of the image should not be distorted by the presence of watermark. The peak signal to noise ratio (PSNR) is as shown in equation 8 and 9 and typically used to measure the degradation between original image and watermarked image.

$$\text{RMSE} = \sqrt{\frac{[f(i,j) - F(i,j)]2}{N2}} \quad (8)$$

$$\text{PSNR} = 20\log\frac{255}{RMSE}\ \text{dB} \quad (9)$$

RMSE is the root mean square error and the comparison between the host image and watermarked image. f (i, j) and F(i, j) represent host and watermarked images respectively. Size of the host image is N × N.

B. Robustness Performance.

Robustness of a watermarking algorithm is as shown in equation 10 that the embedded data should survive any signal processing operation on the host signal goes through and preserve its fidelity. The similarity between the original watermark and extracted watermark from the attacked watermarked image was measured by using correlation factorρ, which is computed using the following equation:

$$\rho(w, \widetilde{w}) = \frac{\sum_{i\,1}^{N} w_i \widetilde{w}_i}{\sqrt{\sum_{i=1}^{N} w_i^2}\sqrt{\sum_{i=1}^{N} \widetilde{w_i^2}}} \quad (10)$$

Where N is number of pixels in watermark, w and $\widetilde{w}$ is the original extracted watermarks respectively. The correlation factorρ, may take values between -1 and 1.

The algorithm discussed in the above section has been implemented in MAT lab for the gray scale Mandrill image of size 512 × 512. For watermark, copyright gray scale image of size 128 × 128 was used. The original image Mandrill was watermarked with copyright image. In our experiment, the size of blocks taken to 8 × 8. We investigate the robustness of algorithm by considering the Average filtering, Median filtering, Compression, Cropping, Gaussian noise, Histogram equalization, Resize, Rotate, Pixilation, Sharpening, Wrapping and Motion blur attacks. After these attacks on watermarked image, we have compared the extracted watermarks with the original one. In table 1,we compare the normalized cross correlation (NCC) results with existing ref [20]. This comparison shows that the proposed algorithm well robust against all the attacks. We also compare our results with the existing paper [21]. Here also the proposed algorithm gives the good Robustness against all the attacks. The comparison has shown in table 2.

(a) Watermarked Image	(b) Extracted watermark	(a) Watermarked Image	(b) Extracted watermark
Figure 2 (a) Average filtering		**Figure 2 (b) Median filtering**	

Different types of attacks.

1) Average Filtering and Median Filtering: The most common manipulation in digital image is filtering. The extracted watermarks, after applying 13 × 13 average and median filtering are shown in figure 2 (a) & (b). It can be observed after applying these filters, images are very much degraded and lot of data is lost but the extracted logo watermark is still recognizable.

2) *Gaussian Filter (75%) and Compression (80:1):* To verify the robustness of watermarking scheme, another measure is noise addition. In real life, the degradation and distortion of the image come from noise addition. In our experiment, we have added 75% additive Gaussian noise in the watermarked image. The attacked watermarked image and extracted watermark are shown in figure 3(a).In real life applications, storage and transmission of digital data, a lossy coding operation is often performed on the data to reduce the memory and increase efficiency. Hence we have also tested our algorithm for the JPEG compression (80:1). The attacked watermarked image and the extracted watermark are shown in figure 3(c) and (d) respectively.

(a) Watermarked Image	(b) Extracted watermark	(a) Watermarked Image	(b) Extracted watermark
Figure 3 (a) Gaussian filtering		**Figure 3 (b) Compression**	

3). Cropping (25% reaming) and rotation (50^0): Image cropping is very frequently used in real life. Cropping in image is done by either hiding or deleting rows or columns. This is a lossy operation. For this attack, 75% of the watermarked image is cropped and the watermark is extracted. The attacked watermarked image and the extracted watermark are shown in figure-4 (a) and (b) respectively. We have also tested our algorithm for rotation. The attacked watermarked image and extracted watermark are shown in figure-4 (c) and (d) respectively.

(a) Watermarked Image	(b) Extracted watermark	(c) Watermarked Image	(d) Extracted watermark
Figure 4 (a) Cropping		**Figure a (b) Rotation**	

4) Histogram and Pixilated (3): The watermarked image is exposed for histogram equalization attack. The attacked watermarked image and the extracted watermark are shown in figure-5 (a) and (b) respectively. Pixilation (mosaic) is another disturbing operation on watermarked image to eliminate or destroying the watermark. The corresponding attacked watermarked image and the extracted watermark are shown in figure-5(c) and (d) respectively.

		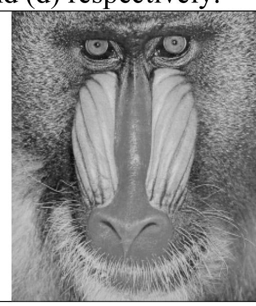	
(a) Watermarked Image	(b) Extracted watermark	(c) Watermarked Image	(d) Extracted watermark
Figure 5 (a) Histogram Equalization		**Figure a (b) Pixilation (3)**	

Table 1: Comparison of NCC values with ref-20

Attacks	Existing Method (ref 20)		Proposed method	
	Boat	**Mandrill**	**Boat**	**Mandrill**
Average Filtering (13 x 13)	0.1198	-0.2473	1.0000	1.0000
Median Filtering (13 x 13)	-0.0852	-0.1556	1.0000	1.0000
Additive Gaussian noise (75%)	0.6749	0.6956	0.9500	0.9489
JPEG compression (80:1)	0.9751	0.9471	0.9999	0.9981
Rotation (50^0)	0.8810	0.8641	0.9992	0.9969
Cropping (25% area remaining)	0.2570	0.4715	1.0000	1.0000
Resizing (512 -> 128 -> 512)	0.8846	0.8964	1.0000	1.0000
Histogram Equalization	0.0871	-0.2375	0.9995	0.9938
Sharpening (by factor 80)	0.7299	0.7573	0.9979	0.9870
Wrapping	0.9182	0.8846	0.9999	0.9984
Pixilation 2	-0.1854	-0.3363	1.0000	1.0000
Motion blur	0.7240	0.7013	1.0000	0.9999
Contrast Adjustment (-50)	-0.7939	-0.7839	1.0000	0.9995

Table 2: Comparison of NCC values with ref-21

Attacks	DWT-DCT-SVD	Proposed DWT-DCT-SVD
PSNR	78.23	80.51
NCC	0.9404	0.9999
Gaussian Noise	0.8874	0.9502
Low Pass Filter	0.5541	1.0000
salt & Pepper	0.8682	0.9917
Contrast Enhancement	0.1256	0.9997
JPEG-60	0.9395	0.9998
JPEG-80	------	0.9999
JPEG-100	-----	0.9999
Cutting	0.0401	0.9999
Rotation-45^0	0.0275	0.9994
Rotation-30^0	-----	0.9996
Rotation-60^0	------	0.9997
Rotation-90^0	------	0.9998

5) Sharpening (100) and Contrast (50): Simultaneously sharpening attack, the sharpness of the watermarked host image is increased by a factor 80. The information is almost lost but we are still able to extract the water mark. For contrast adjustment, the contrast of the watermarked host image is increased by 50%.

6) Resize, Motion blur and Wrapping:

The other prime image processing attack was resizing. The resizing was performed from 512-> 128 -> 512. Motion blur was another type of image processing attack. Another distortion attack on image was wrapping. With this attack on watermarked image, we successfully extracted the watermark from this attacked image.

Table 3: Comparison of NCC values with ref-22

Attacks	SVD and Edge detection	Proposed DWT-DCT-SVD
Low Pass Filter	0.4890	1.0000
salt & Pepper	0.8657	0.9917
JPEG-60	1.0000	0.9998
JPEG-80	1.0000	0.9999
cropping	0.8941	0.9999
Rotation-10^0	0.7422	0.9998
Rotation-20^0	0.6874	0.9996
Rotation-40^0	0.5889	0.9995
Rotation-60^0	0.6031	0.9997
resize	0.8155	1.0000

4. CONCLUSIONS

In this paper we proposed a self-reference image watermarking by using the technique DWT-DCT-SVD. The watermark is usually meaningful gray scale image instead of a noise type Gaussian sequence. The proposed method is highly robust and can survive the watermark in any of attacks. The quality of the watermarked image is good in terms of perceptibility. The PSNR value for a boat image was 43.88 db. In our observations, no one can extract watermark without knowing the value of embedding depth. We compare work our work with ref papers 21 and 22 respectively. In comparison with these papers our results are superior. When compare with ref paper 22 the JPEG attack is good against our work. The future work will be carried out by embedding the watermarks in remaining other three bands.

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