A Proposed Watermarking Technique in Transform Domain

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ABSTRACT
Security of images is a major concern area as digital images are available all over world wide web. Many watermarking techniques have been developed to protect images from illegal manipulations. In this paper , we propose a watermarking technique for gray scale images in transform domain using DCT and DWT. The proposed technique was compared with other techniques and it has shown higher robustness against attacks.
KEYWORDS
Watermarking, DCT, DWT

1. INTRODUCTION

Watermarking is the process of adding some secret information like owner's logo, control information in multimedia data which may be images, videos, audios. A digital image watermark is a signal permanently embedded into a digital image that can be detected or extracted later by means of some operations for authentication purposes. The hidden watermark should be inseparable from the host image, robust enough to resist any manipulations while preserving the image quality. Thus through watermarking, intellectual properties remains accessible while being permanently marked.

For images ,watermarking techniques in different domains have been proposed which could be spatial or transform domain .

Spatial domain watermarking techniques for grayscale images in which each pixel of host image is compared with each pixel of watermark and its position is saved as key . At watermark extraction key is used to regenerate the watermark[1].

The image is divided into blocks DCT is applied in each block twice.Then, SVD on the each new block to get matrices U, S and V for each block and the first value of each matrix S is collected together to form a new matrix. Apply SVD on the new matrix again to get the S matrix. .The pixel value of watermark is embedded into the new S matrix [2].

A DWT-DCT- SVD technique in which first a DWT is applied on image then LL band is divided into blocks , DCT applied on each block,apply SVD on each block.Extract maximum singular values . Apply SVD on watermark. Modify the singular values of image by using singular values of watermark. Apply inverce DCT then inverse DWT on each block to get the watermarked image[3]

A DWT allows an image to be broken up into into different subbands Watermark is embedded by adding PN Sequence into horizontal and vertical subbands of the image[4].

A new watermarking scheme was proposed for JPEG images using modified DCT. The advantage is that it minimizes blocking artifacts which are common JPEG images, thus improving the visual quality [5].

Watermarking Techniques in different domains are also compared[6]

In section 2 a watermarking technique that uses both DCT and DWT is described, Section 3 gives the experimental results, Section 4 conclusion and future scope is given.

2. PROPOSED TECHNIQUE

2.1 WATERMARK EMBEDDING ALGORITHM

The algorithm is divided into 5 steps which are described as follows:

Step 1: Acquiring the images : cover image, watermark.

Step 2: Preprocessing of images / Application of transform.

Step 3: Watermark Preparation.

Step 4: Watermark Embedding.

Step 5: Getting the resultant watermarked image.

Now, a complete description of each step is described below:

Step 1: Acquiring the images: cover image, watermark:

Select a grayscale bitmap image of size 512*512 as the cover image. Select another grayscale bitmap image of size 64*64 as watermark.

Step 2: Preprocessing of images/ Application of Transform:

Apply DWT   transform to   cover object image   to decompose the image into   four wavelet transform   (LL) as well as horizontal (HL), vertical (LH) and diagonal (HH) detail components.   Then again apply the DWT transform to HL band to get LL_2, HL_2, LH_2, HH_2 bands. Divide the HL2   band into blocks of

size 8*8.   Apply DCT to each block in the HL2 subband.

Step 3: Watermark Preparation:

Change the gray scale watermark into a vector of zeros and ones. Generate two highly uncorrelated pseudo random sequences PN_Aand PN_B the sequences PN_A and PN_B are generated such that there values lie between (-11 to +11).

Step 4: Watermark Embedding

Number of elements in each of the two pseudorandom sequences must be equal to the number of mid-band elements of the DCT-transformed DWT sub-bands. Then we embed the two pseudorandom sequences, PN_A and PN_B, with a gain factor k, in the DCT transformed 8*8 blocks of the HL_2 sub-bands of the cover   image.

If the watermark bit is zero then

X' = X + k* PN_zero (for mid-band coefficients only)

else watermark bit is one

X' = X + k* PN_one (for mid-band coefficients only)

Step 5: Getting the resultant watermarked image:

Apply inverse DCT to each block after its mid–band coefficients have been modified. To embed the watermark bits.Apply inverse DWT (IDWT) on the DWT transformed image, including the modified sub- band to produce the watermarked host image.

2.2 WATERMARK EXTRACTION ALGORITHM

The   watermark   extraction   process   is divided into 4 steps:

Step 1: Acquiring the image: Watermarked Image

Step 2: Preprocessing of images/ Application of Transform

Step 3: Watermark Extraction

Step 4: Reconstruct the watermark

Now, each step is explained below:

Step 1: Acquiring the image: Watermarked Image:

The watermarked image obtained is of same size as original image (512*512)

from watermark embedding algorithm.

Step 2: Preprocessing of images/Application of Transform

Apply DWT transform to the watermarked image to decompose it into LL,HL,LH,HH sub bands. Again apply DWT to the HL band to decompose it into LL2 ,HL2,LH2, HH2 sub-bands. Divide the HL2 band into blocks of size 8*8 . Apply DCT to each block.

Step 3: Watermark Extraction

Generate same two uncorrelated sequences PN_A, PN_B that were generated   during watermark embedding algorithm.Calculate the correlation between the mid band coefficients and two pseudo   random sequences. The correlation function should be such that it can help   us   in   finding   value   between Pseudorandom sequence and DWT, DCT transformed mid band coefficients.

X' =X+ k* PN_sequence (could be PN_A , PN_B). Number of elements in each of the two pseudorandom sequences must be equal   the number of   mid-band elements of the DCT-transformed DWT sub-bands.

So the correlation could be as:

The   correlation   between   the   mid   band coefficients and PN sequence zero is given

Correlation_A =

(Mid Band Coefficients / PN_A) –k

Correlation_B =

(Mid Band Coefficients / PN_B) –k

Step 4: Reconstruct the watermark

If the Correlation_A   was higher than the Correlation_B then the extracted watermark bit is considered 0, otherwise the extracted watermark bit is considered 1.Reconstruct the watermark using the extracted watermark bits.

2.3 PARAMETERS USED

The   above   mentioned   embedding   and extraction algorithm is executed in MATLAB its performance can be evaluated using following parameters as PSNR,NCC. The peak signal to noise ratio (PSNR) is used   to evaluate the image quality by calculating the mean square error (MSE) between the images to compare.

$$\text{MSE} = \frac{1}{N} \sum (X_p - Y_p)^2$$

Where p is the unity of the N pixels in the image. X and Y are the grayscale of the images to compare.

(A) PSNR

With above information   calculate PSNR by equation   where X max   is max   luminance (i.e. for 8-bit image, X max = 255).

$$\text{PSNR} = 10 \log_{10} \frac{(X\ max)^2}{\text{MSE}}$$

Its unit is db. And the bigger the PSNR value is, the better the watermark conceals.

(B) NC

$$NC = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} W(i,j)\ W'(i,j)}{\sqrt{\sum \sum [W(i,j)]^2}\ \sqrt{\sum \sum [W'(i,j)]^2}}$$

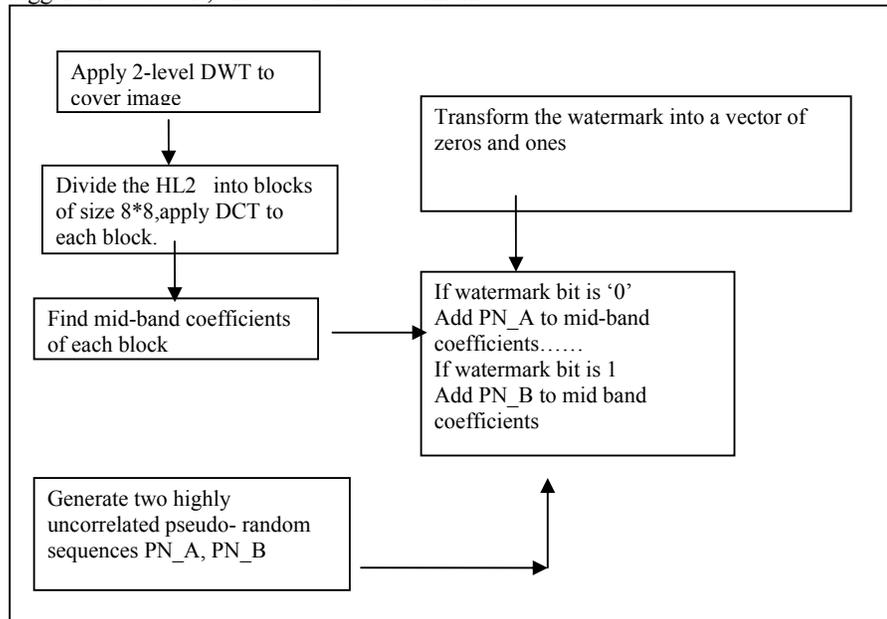The value of NC is between 0 and 1. And the bigger the value is, the better the watermark robustness is [3-4].

```
┌─────────────────────────────────────────────────────────────────────────┐
│  ┌──────────────────────┐                                                 │
│  │ Apply 2-level DWT to │                                                 │
│  │ cover image          │        ┌────────────────────────────────────┐  │
│  └──────────┬───────────┘        │ Transform the watermark into a     │  │
│             │                    │ vector of zeros and ones           │  │
│             ▼                    └──────────────────┬─────────────────┘  │
│  ┌──────────────────────┐                           │                    │
│  │ Divide the HL2 into  │                           │                    │
│  │ blocks of size 8*8,  │                           ▼                    │
│  │ apply DCT to each    │        ┌────────────────────────────────────┐  │
│  │ block.               │        │ If watermark bit is '0'            │  │
│  └──────────┬───────────┘        │ Add PN_A to mid-band               │  │
│             │                    │ coefficients……                     │  │
│             ▼                    │ If watermark bit is 1              │  │
│  ┌──────────────────────┐        │ Add PN_B to mid band               │  │
│  │ Find mid-band        │───────▶│ coefficients                       │  │
│  │ coefficients of each │        └────────────────────────────────────┘  │
│  │ block                │                           ▲                    │
│  └──────────────────────┘                           │                    │
│  ┌──────────────────────┐                           │                    │
│  │ Generate two highly  │                           │                    │
│  │ uncorrelated pseudo- │───────────────────────────┘                    │
│  │ random sequences     │                                                │
│  │ PN_A, PN_B           │                                                │
│  └──────────────────────┘                                                │
└─────────────────────────────────────────────────────────────────────────┘
```

Fig 1 Watermark Embedding

```
┌─────────────────────────────────────────────────────────────────────────┐
│  ┌──────────────────────────────┐                                        │
│  │ Apply 2-level DWT to         │                                        │
│  │ watermarked image            │                                        │
│  └──────────────┬───────────────┘                                        │
│                 │                                                         │
│                 ▼                                                         │
│  ┌──────────────────────────────┐                                        │
│  │ Divide the HL2 into blocks   │                                        │
│  │ of size 8*8, apply DCT to    │                                        │
│  │ each block.                  │                                        │
│  └──────────────┬───────────────┘                                        │
│                 │                     ┌──────────────────────────────┐   │
│                 │                     │ Calculate correlation        │   │
│                 ▼                     │ between mid-band coefficients │   │
│  ┌──────────────────────────────┐     │ and PN_sequence,             │   │
│  │ Find mid-band coefficients   │────▶│                              │   │
│  │ of each block                │     │ If Correlation_0> Correlation_1│ │
│  └──────────────────────────────┘     │ Extracted watermark bit is '0'│  │
│                                       │ Else                         │   │
│                                       │ Extracted watermark bit is '1'│  │
│  ┌──────────────────────────────┐     └──────────────────────────────┘   │
│  │ Generate two highly          │                   ▲                    │
│  │ uncorrelated pseudo-random   │───────────────────┘                    │
│  │ sequences PN_zero, PN_one    │                                        │
│  └──────────────────────────────┘                                        │
└─────────────────────────────────────────────────────────────────────────┘
```
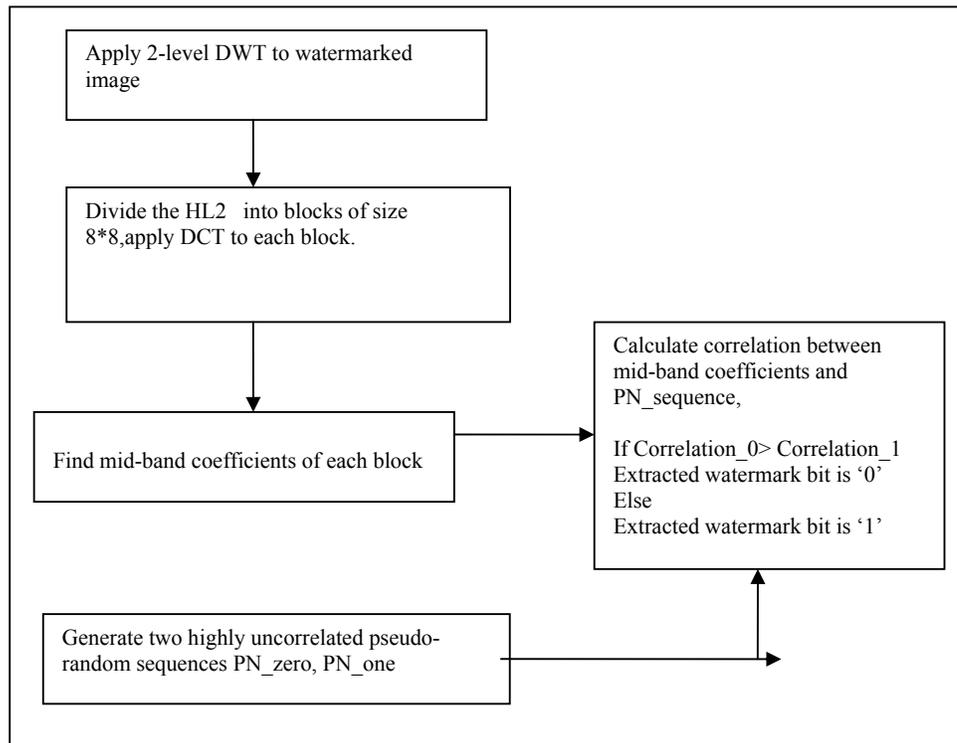
Fig 2 Watermark Extraction

3. EXPERIMENTAL RESULTS

The proposed technique was implemented in MATLAB for various test images , The results for LENA image are given below.

The proposed watermark embedding algorithm was applied on a 512*512 size of Lena image,and a watermark of size 64*64

Fig 3 Original Image   Fig 4 Original Watermark

Now the watermarked image and extracted watermark are shown below

Fig 5 Watermarked Image   Fig 6 Extracted Watermark

Next attacks like adding noise, effect of sharpening, blurring, cropping were performed on test images for proposed technique.

The proposed technique is compared with other techniques DCT- SVD[2],DWT-DCT-SVD[3],Watermark Wavelet[4]. All these techniques and proposed technique were implemented in MATLAB. Then these techniques were applied on 30 test images and results were compared for PSNR values of these test images when diffent techniques were applied on them. A graph is plotted which is shown below.
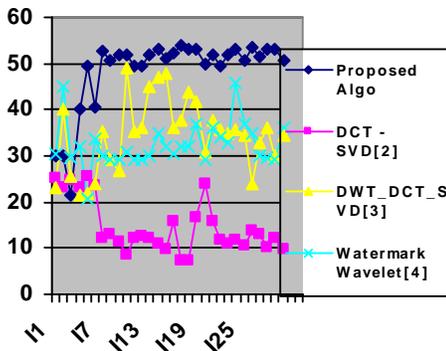
Fig 7 PSNR values for different   techniques

Now the techniques are compared when salt and pepper noise of density (0.5) is added to images .The graph is shown below
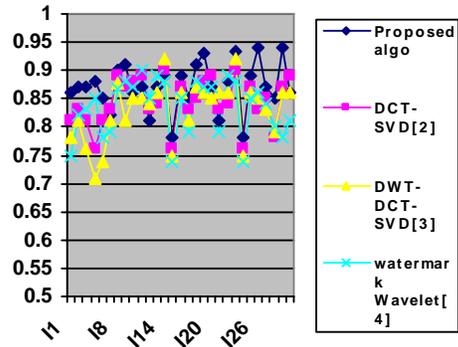
Fig 8 NC values for salt and pepper noise (0.5)

Now the techniques are compared when Gaussian noise with mean(0) and variance (0.4) is added to images .The graph is shown below
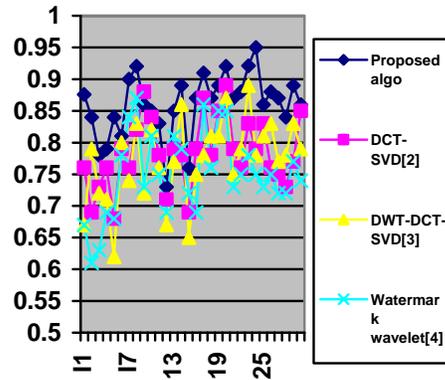

Fig 9 NC values for guassian noise mean(0) and variance (0.4)

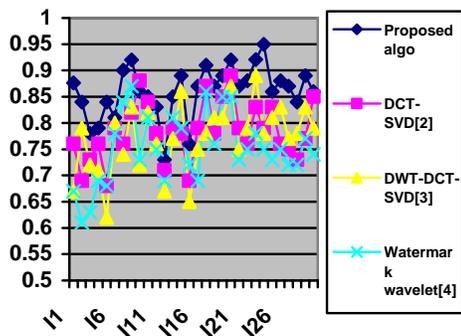Next images were sharpened at (alpha=0.7) and the graph is shown below.

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Fig 10 NC values for sharpening at (alpha=0.7)

Next images were blurred at Len(30) and theta(45) and the result for various techniques is shown below
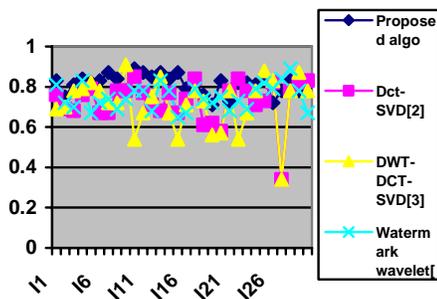
Fig 11 NC values for blur at Len(30) and theta(45)

From the above graphs it can be seen that proposed technique gave better results for various test images compared to other techniques against noise, sharpening, blurring.

4. CONCLUSION

In this paper a new watermarking technique for grayscale images using DCT and DWT has been proposed. The technique was implemented in MATLAB and the proposed. Technique was compared with other techniques. Simulation results show that proposed technique is better than other techniques in terms of its robustness against attacks. The same technique can be used for different sub-bands like LH_2 and implemented for the technique was m and results could be compared. Further security could be achieved by use of keys, to embed watermark and during watermark extraction use keys.