Hybrid Watermarking with Reduction of Noises for Color Image

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***Abstract*-The method to protect digital data in communication such as text, images, audio and video from content modification, is called digital watermarking. Here we have proposed a new watermarking scheme based on DCT-DWT-SVD. The performance results also shown here. The techniques are used here are non-blind techniques. First technique uses SVD of DC coefficients using 2D-DWT and another considers SVD of all DCT values of 2D-DWT of main image. To check the robustness PSNR and Normalized cross-correlation are used**

Keywords: Watermark; DWT; DCT; SVD; PSNR; NCC.

I.INTRODUCTION

With development communication methods like web communication and multimedia technology, the transmission of digital data has been increased so there are risks of security attacks. With the good communication, secured communication is also required now. For this secure communication the technique is called digital watermark technique has been adapted. This is the process to embedding the data into digital media like image, audio and video.Watermarking can be divided into two (i) spatial or transform domain [11]. (ii) According to visibility (visible or invisible).The quality of watermarking attacks[3].middle band

attacks[3].Middle band coefficient of DCT based watermarking scheme is given for image authentication. DWT is applied then after DCT of LL is computed. Then mid band coefficient is selected and SVD is applied on it. It is very robust against JPEG compression[4].R. Mehul has suggested that to get robustness for vast range of attacks watermark insertion can be performed in both low and high value coefficients[5]. Authors proposed color image watermarking using second level DWT decomposition and block base DCT. First they divide color image into three channels Red, Green and Blue and then apply DWT to selected color and select HL or LH band for further decomposition. They selected low and high frequency band so robustness and imperceptibility result is very good[6]. A hybrid block based technique is proposed by V. Santhi. In that First singular value is selected for watermark embedding in all different band after first level decomposition[7]. A hybrid technique based on SVD and DCT is proposed. More transparency is obtained using only Singular values of a recognized pattern and LPSNR is Adopted to achieve high robustness[8]. Author proposed can be evaluated using robustness, behavior and capacity. any watermarking scheme is robust if it performs better in various attacks[15, 16]. Behavior of watermarking scheme can be determined after inserting the watermark. If image is getting distorted after insertion of watermark then the scheme is not good in behavior (transparency) [13, 14].Capacity is the measurement of the data to be inserted in the cover image. If the capacity is more, then large data can be hide.

II RELATEDWORK

Authors proposed watermarking algorithm based on DWT-DCT and SVD. They apply one level DWT decomposition of cover image and select LL band for watermarking[1]. In this paper DC coefficient based watermarking scheme for color image is suggested. They apply wavelet decomposition one level to color image. Then divide the selected band into 4X4 subblocks and DCT is applied. First DCT value is selected from all subblocks. Then SVD is performed on that. The method is tested against various attacks and result is good for LL band in compare to other band[2].Robust watermarking scheme is proposed by Navas. In that they combine advantage of three techniques(DCT-DWT-SVD).scheme is very robust for different kind of image processing

watermarking scheme based on DCT-DWT-SVD. They apply second level decomposition of cover image. DCT is apply to second level HL coefficient and divide it into four quadrant using zigzag sequence. SVD is applied to each Quadrant and modified with SVD of watermark. Algorithm gives good PSNR and also robust to various attacks. Quadrant B1 gives good results compare to other three[9]. Author proposed watermarking scheme based on DWT and SVD using all four frequency bands. Singular values of watermark is inserted into all four frequency bands singular values after first level DWT. Experimental results shows that LL gives highest magnitude of wavelet coefficient as well as of singular values[10].

Most of watermarking scheme mentioned above is used gray scale image as cover image and binary or gray scale watermark. In proposed scheme colour image is used as cover image and as watermark image. There for capacity is increased. To achieve robustness against different attacks watermark is embedded in lower band and to get good transparency modification is done in singular values. DCT gives best result against compression there fore to

overcome problems of compression attacks in existing techniques in second technique we apply DCT to both cover image as well as watermark.

III. PROPOSED ALGORITHM I

Proposed algorithm combines merits of three different techniques DCT, DWT and SVD. First the original color image is selected and apply one level DWT to it. The LL band is select for second level decomposition and HH band is selected To achieve imperceptibility. It is divided into 4X4 subblocks. DCT is applied to each subblocks and first DC coefficient of each block is selected and formed it in matrix. To this matrix SVD is applied and singular values are modified with singular values of watermark. Inverse SVD, IDCT and IDWT is performed to get watermarked image.
The procedure for embedding and extracting the watermark is given below.

A Watermark embed process

The embedding process is divided into following steps and is briefly described as given below:

1. The original image OI of size NxN and color channel are selected. DWT is applied to decompose into four N/2xN/2 sub-bands LL,HL,LH and HH.
2. Apply DWT to LL sub-band to decompose it into four N/4xN/4 LL_LL,LL_HL, LL_LH,LL_HH.
3. Divide LL_HH band into 4x4 square blocks apply DCT to it and select first DCT value of each block to get DCT coefficient matrix B
4. Apply SVD to B,B=U1*S1*$V1^T$, and obtain U1, S1 and V1.
5. Let OW of size N/16xN/16 to represent watermark. Apply SVD to it, OW= W_U*W_S*W_V' and obtain W_U, W_ S and W_V.
6. Modify S1 with watermark such that S=S1+a*WS and Obtain B* using B*=U*S*V^T.
7. Apply IDCT to B*to produce LL_HH*.
8. Apply IDWT to LL_LL, LL_HL, LL_LH and LL_HH* to get matrix LL*.
9. Apply IDWT to LL*,HL ,LH and HH, set it to selected color channel to get watermarked image WI.

B. Watermark Extraction Process

The extraction process is divided into following steps and is briefly described as given below:

1. Color channel is selected and DWT is applied to WI to get LL*,HL,LH and HH.
2. DWT is applied to WI to get LL_LL,LL_HL,LL_LH and LL_HH*.
3. Divide LL_HH band into 4X4 square blocks.
4. The DCT is applied to each block of sub band LL_HH*,select first DCT values and get matrix A.
5. SVD is applied to matrix A, A=WU*WS*WV^T and obtain WU,WS,WV
6. Obtain SW=(S-WS) /a.
7. Obtain EW=W_U*SW*W_V^T

IV. PROPOSED ALGORITHM II

In this algorithm first level decomposition of wavelet is applied to cover image then LL band is selected for second level decomposition and its HH band is selected. Now DCT is applied to this band and get DCT coefficient matrix. SVD is performed on this DCT coefficient matrix. Watermark image is decomposed at first level and HH band is selected. DCT is applied to this HH band and we get DCT coefficients of watermark then SVD is applied to it. Singular values of cover image DCT coefficients is modified with singular values of watermark. Perform inverse transform and we get watermark image.

A. Watermark embedding process

The embedding process is divided into following steps and is briefly described as given below:

1. Let OI be the Original color image of size NxN.
2. From R,G,B(1,2,3) select any one color component. Suppose for Red color select(:,:,1) from original image.
3. DWT is applied to decompose it into four N/2xN/2 sub-bands LL, HL, LH and HH.
4. Apply DWT to LL band to decompose it into four N/4 x N/4 sub-bands LL_LL,LL_HL, LL_LH and LL_HH.
5. Apply DCT to LL_HH and get DCT coefficient matrix B.
6. Apply SVD to matrix B, B=U*S* $V1^T$, and obtain U, S and V.
7. Let watermark of size N/2xN/2 to represent watermark. Apply DWT to decompose it into four N/4xN/4 sub-bands WLL, WHL, WLH and WHH
8. The WHH band is selected and apply DCT to it and get DCT coefficient matrix D
9. Apply SVD to matrix D, D=U1*S1* $V1^T$, and obtain U1, S1 andV1
10. Modify S with watermark such that S2=S+ a*S1.
11. Obtain B* using B*=U*S2* $V1^T$.
12. Apply IDCT to B*to produce LL_HH*.
13. Apply inverse DWT to LL_LL,LL_HL,LL_LH and LL_HH* to get LL*.
14. Apply inverse DWT to LL*,HL, LH and HH to get watermarked image color name_ WI for selected color component.
15. Set value of that component to Original color image.
16. Get color watermarked image WI.

B. *Watermark Extraction Process*

The extraction process is divided into following steps and is briefly described as given below:

1. watermarked image color component is selected.
2. Apply DWT to WI to get LL*,HL,LH and HH.
3. Apply DWT to WI to get LL_LL,LL_HL,LL_LH and LL_HH*.
4. Select LL_HH* band and apply DCT to subband HH* and get matrix A.
5. Apply SVD to A, A=WU*WS*WVT and obtain WU,WS,WV.
6. Obtain Sr =(S-WS)/a.
7. Obtain Wr=U1*Sr* $V1^{T}$.
8. Apply inverse DCT to Wr and get W.
9. Apply inverse DWT to LL,HL,LH and W and get extracted watermark.

V. EVALUATION PARAMETERS

The PSNR and NCC are used as evaluation parameter.

Peak Signal to Noise Ratio (PSNR), is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Let A is the original image &B is the watermarked image of size m x n then MSE(Mean Square Error) & PSNR will be

$$\text{MSE} = \frac{1}{MN}((|A - B|)_{i=0\ j=0}^{M-1\ N-1}) \quad (1)$$

$$PSNR = 10.\log 10(MAX^2 A/MSE) \quad (2)$$

Normalized cross correlation is calculated to evaluate the robustness of algorithm NCC is defined as follows where OW is original watermark and EW is Extracted watermark.

$$NC = (OW * EW)_{i=0\ j=0}^{M-1\ N-1} / (OW * OW)_{i=0\ j=0}^{M-1\ N-1} \quad (3)$$

EXPERIMENT RESULTS

The efficiency of proposed algorithm for different images are considered for numerical simulation. It is tested using the tool MATLAB 2013. Here results are given using 512 x 512 color image “PEPPER”, as cover image and 32 x 32 color fruits as watermark in algorithm one and 256 x256 color PEPPER in both algorithm.

Fig.1 image database.

Fig.2 Original color image.

Fig.3 Original watermark image

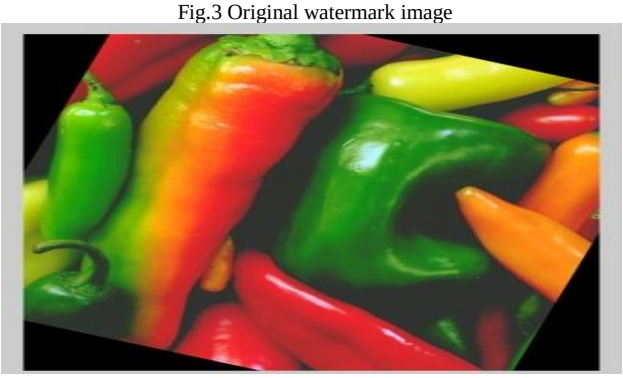

Fig.4 Attacked image.

Fig.5 Extracted image.

CONCLUSION

The extraction of watermark does not depend on the original cover image.

1. In the proposed algorithm the features of DWT-DCT-SVD techniques are combined.
2. Embedding of watermark is done only in DC components of all frequency bands to increase the robustness.
3. Algorithm is tested against many attacks and found to be robust. So that the new system can be used in applications such as copyright protection and ownership verification
4. Watermark embedded in low frequency components are resistant to salt and pepper noise, Gaussian noise, Gaussian blur, cropping, color contrast and compression attacks. Similarly watermarks embedded in high frequency components are resistant to image sharpening, histogram equalization, rotation and resize.
5. It is found that the proposed algorithm is not robust to rotation attack in RGB color space and our future work is to design the new system robust to rotation attack.

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