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Improved hybrid watermarking Technique

Anshul Chopra[1], Sangeeta dhall[2], Shailender Gupta[3]

ECE Department, YMCA,University of Science and Technology,Faridabad (India)

ABSTRACT

Security raises to the safety of any manuscript from exterior attacks or intrusions. Due to prompt growth of internet, various challenges have come up such as copyright protection, illegal distribution of private images. One of the possible solutions to provide security to the owner's data is Digital watermarking. Watermarking refers to the process of hiding the secret message (text, audio, image, logo, signature) into the document for providing authentication. This paper is an effort to introduce an improved, hybrid frequency domain technique DWT-SVD along with its comparison with standalone version. Robustness analysis is done on the basis of various performance matrices such as Peak signal to noise ratio(PSNR), Mean Square Error(MSE),Mean absolute Error(MAE).

Keywords: Digital watermarking,DWT-SVD, Frequency domain, MAE, MSE, PSNR.

I.INTRODUCTION

Security of any text may be accomplished by the method of cryptography or steganography[1].A procedure in which the message is altered into another form,so that it can't be recite or recognize by the person refers to cryptography.Its goal line is to avertthe interceptor from acquisition of any information about the plain text from cipher text whereas steganography is the process of hiding the message in another media (Image, Video or Audio), so that nobody can notice the presence of secret message.Its main objective is to prevent media from giving knowledge of occurrence of secret data[2]. Digital watermarking differs from steganography in terms ofapplication areas and type of information to be stored in media which is being transferred from source to destination.

Watermarking system comprise of embedding and detection part. The embedding part receipts the original image and watermark image, perform the embedding process and provide the watermarked image at the output.This image is sent at the sender side where extraction process is applied on it, which results in getting the watermark image. It offers ownership security of data, tracking of data and provides protection.

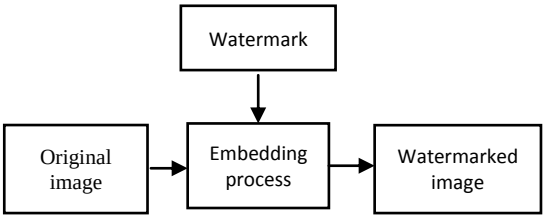


Fig 1: Embedding part

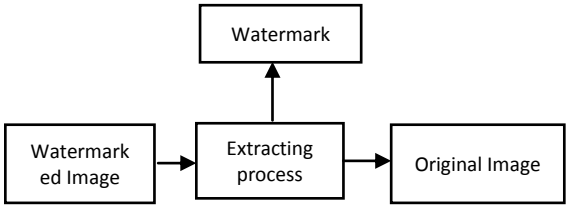


Fig 2: Detector part

This paper organized as follows section II provides classification of watermarking techniques, Section III describesPerformance metrics, Section IV gives Snapshots and Section V draws conclusion followed by references.

II.CLASSIFICATION OF WATERMARKING

Watermarking techniques can be classified on different basis, one such base is domain. On the basis of domain these are classified as Spatial domain and Frequency domain. Techniques that work in spatial domain suffers from signal compression and hostile attacks. Frequency domain techniques are much more robust against above said attacks than spatial domain techniques.

1. Spatial domain Techniques:

These techniques works on pixel value of media or cover image.The watermark is embedded after modifying the pixel value of cover image. LSB substitution is one of the simplest and most popular methods to embed the watermark in LSB bit of the pixel value in cover image i.e. in time domain [3]. These Techniques having various disadvantages such as attacks on watermarked image can devastate the watermark image, sensitive to filters [4].

2. Frequency Domain Techniques:

These techniques embed watermark by modifying the transform domain coefficient, There can be various types of transformations such as Discrete cosine transform (DCT),Discrete wavelet transform (DWT),FastFourier Transform (FFT),Fractional Fourier transform (FrFT), Hadamard transform ,Singular Value Decomposition (SVD),Stationary wavelet transform(SWT) etc.[5] .

1.1 Discrete wavelet transform (DWT)

Wavelet transform is an extensively used technique in image processing, watermarking etc. Wavelets are oscillations which are rapidly decaying like waves having mean value zero and it consist of finite duration. Transform used is Haar DWT consist of 2 operations Vertical and horizontal[6]. DWT decompose the image into three spectral directions i.e. Horizontal, VerticalandDiagonal.

The procedure for Haar –DWT is as follows:

Step 1: As shown in Fig.3, Pixels are scanned left to right in horizontal direction, performing addition with neighboring pixel and store result in left side. Difference operation result is stored in right.Low frequency part(L) is represented by pixels addition while high frequency part (H) by pixel difference.

Step 2: As shown in Fig. 4, Pixels are scanned left to right in vertical direction, performing addition with neighboring pixel and result store on left,difference operation result on right.At last the bands achieved are LL,LH,HL,HH.Magnitude of DWT coefficient is larger in LL band also known as approximation coefficient matrix and it provide information of image like smooth area whereas LH,HL,HH refers as Detailed coefficients matrix.

HH higher frequency part of image gives information about the sharp edges.

Advantage of DWT is that wavelets are localized in time and frequency around certain point, it is designed to get good frequency resolution for low frequency component and vice versa.

Different mother wavelets are present such as Haar, Daubechies etc.

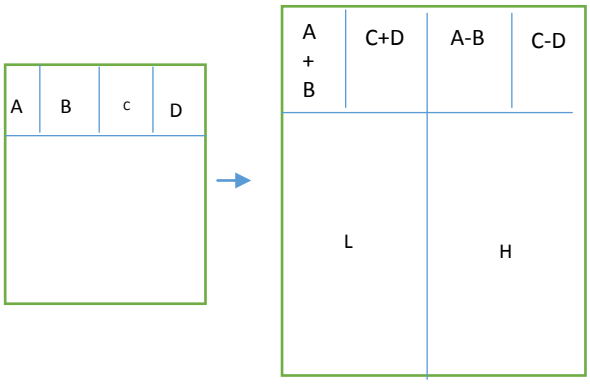


Fig 3: Horizontaloperation on first rows

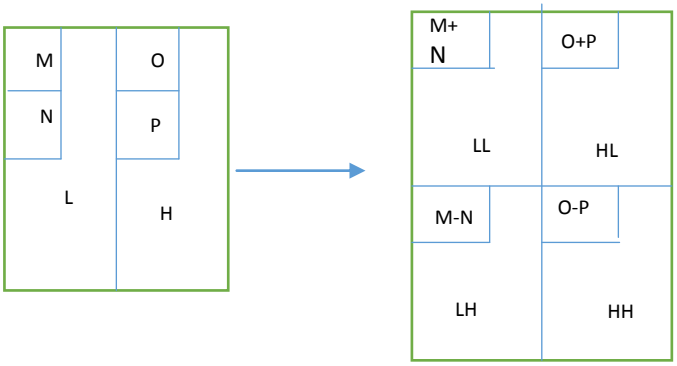


Fig 4: vertical operation

1.2 Singular value Decomposition (SVD)

In SVD a rectangular matrix of (m*n) image is used where m is no. of rows of image and n is no. of columns of image. Its mathematical equation is given by :

$$\mathbf{A = U_{n*n} * S_{m*n} * V^{T}_{m*m}(1)}$$

U : left singular vector

V: Right singular vector

S: Diagonal matrix which is singular

U ,V are orthogonal to each other given as

$$\mathbf{U * U^T = I_{n*n}(2)}$$

$$\mathbf{V * V^T = I_{m*m}(3)}$$

Output of SVD is more secure and robust in nature, it split the image in 3 components Horizontal (U), vertical (V), Diagonal (S). Its advantages are, it can be used in solving fast positive problems,provide rightful ownership, reduces the number of degree of freedom in complex system but is expensive .[7]

1.3 DWT-SVD watermarking Technique

Hybrid technique refers to combination of two or more techniques for better results,so DWT –SVD is an improved technique[8]. The cover image is divided into various sub-bands. Singular value decomposition is performedon LL sub-band which results in increased robustness in terms of PSNR as most of the energy is concentrated in low sub-band.

1.3.1 Algorithm of DWT-SVD Hybrid Watermarking:

1.3.1.1 Embedding algorithm:

Input: Cover image (I),watermark image(W)[9]

Output:watermarked image(wat)

Step 1: Take cover image.Convert RGB to grayscale.

Step 2:Using DWT, decompose cover image into four bands LL,LH,HL and HH.

Step 3: Apply SVD into the LL sub-band.

$$\mathbf{LL = U_{LL} * S_{LL} * V_{LL}^T(4)}$$

Step 4: Watermark image is taken into consideration and modified by multiplying with scaling factor alpha then addition is performed with the SVD LL sub-band obtained in step 3

$$\mathbf{S_{LLD} = S_{LL} + \alpha * W(5)}$$

Step 5: Since the watermark image is directly added to Singular value of LL sub-band it is necessary to reconstruct it by again applying SVD to S_{LLD}

$$\mathbf{S_{LLD} = U_{SSL} * S_{SSL} * V_{LL}^T(6)}$$

Step 6: Replace S_{SSL} with SLL in step 2

$$\mathbf{LL_{SVD} = U_{LL} * S_{ssL} * V_{LL}^T(7)}$$

Step 7: Compute the inverse DWT to obtained watermarked image.

1.3.2 Extracting algorithm

Input: watermarked image (wat)

Output: watermark image(W)

Step 1: Dwt is used to again decompose the watermarked image (wat)into four sub-bands at receiver side LL_W, LH_W, HL_W, HH_W

Step2 :Apply SVD to the sub-band of LL_W

$$\mathbf{LL_W = U_W * S_W * V_W^T(8)}$$

Step 3: Using singular vectors from step 4 in embedding algorithm construct $s *_{LLD}$ using step 2

$$\mathbf{S *_{LLD} = U_{SLL} * S_W * V_{SLL}^T(9)}$$

Step 4: watermark is extracted from the watermarked image and cover image as per step 4 in embedding algorithm used

$$W=\frac{S*_{LLD}-S_{LL}}{\alpha} \quad (10)$$

Step 5: The watermark image obtained from step 4 is matched with the watermark image send during the embedding, if the pixel get matched watermark image obtained is correct from cover image hence provide protection against any attack.[10]

III.PERFORMANCE METRICS:

To analyze the performance of the proposed scheme on the basis of robustness[11] various parameters are taken into consideration, which are described below:

3.1Robustness analysis:

This technique is used to measure the quality of the image.Different parameters are:

3.1.1Mean square error(MSE):

It used to calculate the error between the watermarked image with respect to original image.

MSE is given by:

$$\mathbf{MSE} = \frac{1}{M*N*3}\sum_{C=1}^{3}\sum_{Y=1}^{N}\sum_{X=1}^{M}[F^{c}(x,y) - F^{c\sim}(x,y)]^{2} \quad (11)$$

where $M \times N$ is the size of image (height and width respectively).

C = 1 to 3 denotes the red, green and blue colour plane respectively.

$Fc(x, y)$ = value of pixel at position (x, y) in c colour plane of cover image.

$Fc\sim(x, y)$ = value of pixel at position (x, y) in c colour plane of watermarked-image.

3.1.2Mean absolute error (MAE):

It calculates the average of absolute error between the watermarked and cover image .

MAE is given by:

$$\mathbf{MAE} = \frac{\sum_{i=1}^{n}|yi - xi|}{n}$$

Whereyi is final watermarked image

xi is cover image

n is size of image

3.1.3Peak signal to noise ratio(PSNR) :

It is most commonly used parameter for measuring the quality of image after embedding .High value of PSNR means more robustness, which refers to less pixel change between the watermark and cover image. It is defined in terms of MSE .The PSNR is givenas:

$$PSNR = 10log_{10}\frac{MAX^{2}}{MSE}$$

where MAX is the maximum value of pixel in the image. It is 255 for colour image of 8 bits.

IV.RESULT &SNAPSHOTS

Table 1: Technique snapshots for 64*64 cover image and 32*32 watermark image

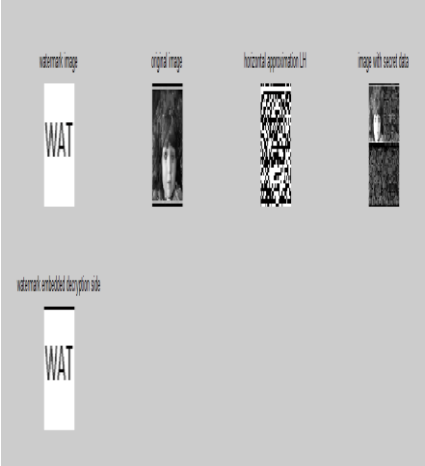
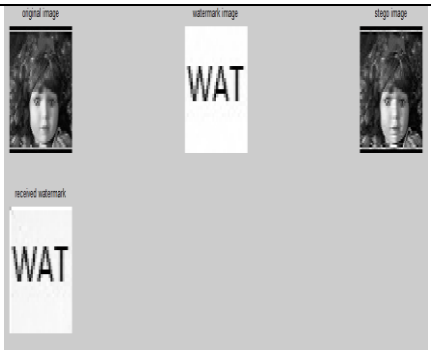
Techniques	Snapshot
DWT	
SVD	
DWT-SVD	

Table 2: Robustness parameters of different techniques

Techniques	MSE	MAE	PSNR
DWT	0.1103	0.2509	27.7057
SVD	0.5661	0.1103	30.6021
DWT-SVD	0.3198	0.5147	33.0817

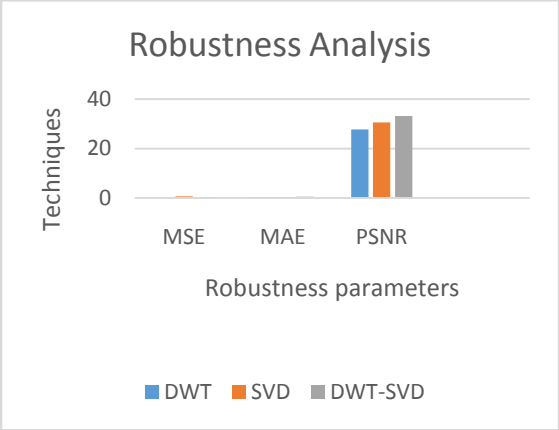


Fig5: Robustness Analysis graph

VI.CONCLUSION

Withstand alone techniques the result provide is better and it help in security of data but by using the hybrid method i.e. DWT-SVD techniques, the result are much more improved and hence robustness can be achieved so that cover image after embedding can be easily transferred from source to destination it leads to integrity of data ,copyright protection.

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