

ADAPTIVE CONTOURLET TRANSFORM AND WAVELET TRANSFORM BASED IMAGE STEGANOGRAPHY USING SINGULAR VALUE DECOMPOSITION ON ECG SIGNAL

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Abstract- Steganography is the art and science of hiding the existence of information. In computer-based steganography, several forms of digital media may be used as “cover” for hidden information. Photos, documents, web pages and even MP3 music files may all serve as innocuous looking hosts for secret messages. In this paper, we generate a ECG signal of patient and hide this ECG signal in the image of patient i.e. patient photo is used as a cover for hiding the ECG signal. Steganography is done using the Contourlet transform. To hide the data in image Singular Value Decomposition (SVD) is used. The contourlet transform provides higher correlation coefficient. The results are comparing with the wavelet transform. The proposed system provides a better PSNR value than the wavelet transform.

Keywords: Steganography, Wavelet Transform, Contourlet Transform, SVD, ECG.

I. INTRODUCTION

Image steganography is the prominent research field in information hiding area from several years. Cryptography is “secret writing” whereas steganography is “covered writing” that hides the presence of message itself. Data hiding can be achieved using various file formats such as image, text, audio, video etc. However, image is the most popular carrier for data hiding as it possesses high degree of redundancy. Image used for data embedding is known as cover image and the image with embedded data is stego image. The data to be embedded is known as payload. Steganography identifies the redundant bits in cover image. In this, cover image is modified without changing its integrity. Steganography is used in secure communications, owner identification, authentication and data embedding. When implementing a steganograph system, several properties must be observed, which are:

Imperceptibility: an embedded steganograph is truly imperceptible if a user cannot distinguish original from the steganographed version.

Robustness: It should not be possible to remove or alter the steganograph without compromising the quality of the host data.

Payload: the amount of information that can be stored in a steganograph.

Security: according to Kirckhoff’s assumption, the choice of key governs the security of the encryption techniques. This assumption is also valid for steganograph techniques.

Steganographic methods can be broadly classified based on the embedding domain, digital steganography techniques are classified into (i) spatial domain (ii) frequency domain. In spatial domain method, the secret message is directly embedded into the host image by changing its pixel value. Transform domain tries to encode message bits in the transform domain coefficients of the image. Transformed are more robust compared to spatial domain ones. Transform

domain techniques includes Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT) etc. DWT is broadly used for digital Steganography.

The Contourlet transform [1] was proposed by M. N. Do and M. Vetterli. The contourlet transform provides a multi scale and multi-directional representation of an image. In [4], the authors introduced a new image decomposition scheme called CT which is more effective in representing smooth contours in different directions of an image than DWT. The study in [8] proposed a blind steganography algorithm in the translation invariant circular semantic contourlet transform (TICSCT) domain. Experimentation shows that this domain has higher capacity than wavelet and special domain and robustness and imperceptibility are improved.

Researchers developed a new filter bank based on non subsample contourlet and wavelet hybrid transform (NSCWHT) and study its application in [9]. They proposed a new image steganography based on developed NSCWHT. The work in [10] investigated the role of CT versus DWT in providing robust image steganography. Two measures are utilized in the comparison between wavelet based and contourlet based methods, peak signal to noise ratio (PSNR) and normalized cross correlation (NCC). A blind steganography algorithm is proposed in [6] in which extraction algorithm was designed as per maximum likelihood estimation. This paper carried on the static analysis to the high frequency subband coefficient of wavelet and contourlet transform. The extraction does not need original image neither does it need the original steganograph information.

There are many researchers in each of the steganography techniques and a brief description of some of these research are presented. The contourlet transform is a directional transform that has been introduced recently. In [8], it is shown that in spite of the redundancy of the contourlet transform, by using this transform in an image coding system, one can obtain better visual results.

II. FREQUENCY DOMAIN TECHNIQUES

In contrast to the special domain, frequency domain technique can embed more bits of steganograph and more robust to attacks, thus they are more attractive than special domain techniques.

A. Wavelet transform:

DWT for digital image is a mathematical formula which converts an image from special domain to frequency domain. The basic idea DWT of an image is described by decomposing a given image into four subbands (LL, HL, LH, and HH). LL

is the lower resolution approximation image as well as horizontal HL, vertical LH and diagonal HH detail components. To obtain the next wavelet level for example the LL is further decomposed into another four subbands (LL, HL, LH, and HH). This decomposition can be repeated several times. Fig. shows the example of two levels wavelet decomposition subband.

LL	LH	LH
HL	HH	
HL		HH

Fig. 1: Two levels wavelet decomposition subbands.

B. Contourlet Transform:

The Contourlet Transform (CT), proposed by Do and Vetterli [1][11], consists of a double iterated filter bank. First the Laplacian Pyramid (LP) is used to detect the discontinuities of the image and then a Directional Filter Bank (DFB) to link point discontinuities into linear structures. The general idea behind this image analysis scheme is the use of a wavelet-like transform to detect the edges of an image and then the utilization of a local directional transform for contour segment detection. Contourlet decomposition is shown in Fig. 2.

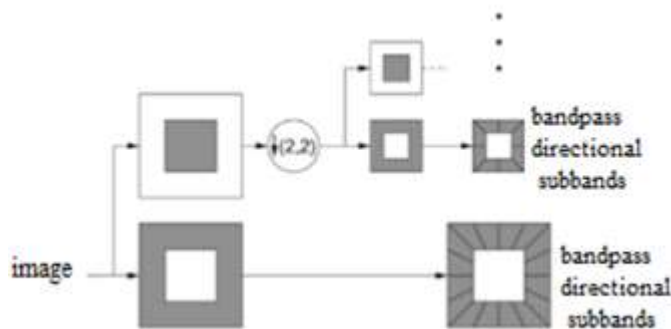


Fig. 2. Contourlet decomposition, laplacian pyramid followed by directional filter bank.

The Directional Filter Bank implementation utilizes an *l*-level binary tree decomposition and leads to *2l* directional subbands with wedge-shaped frequency partitioning. The Directional Filter Bank was designed to capture the high frequency content of an image, which represents its directionality.

C. SVD:

Singular value decomposition (SVD) can be looked at from three mutually compatible points of view. SVD is a method for identifying and ordering the dimensions along which data points exhibit the most variation. SVD can be seen as a method for data reduction.

SVD is based on a theorem from linear algebra which says that a rectangular matrix *A* can be broken down into the product of three matrices - an orthogonal matrix *U*, a diagonal matrix *S*, and the transpose of an orthogonal matrix *V*. The theorem is usually presented something like this:

$$Amn = Umn * Smm * V^T nm$$

where $U^T U = I$, $V^T V = I$; the columns of *U* are orthonormal eigenvectors of AA^T , the columns of *V* are orthonormal eigenvectors of $A^T A$, and *S* is a diagonal matrix containing the square roots of eigenvalues from *U* or *V* in descending order.

III. PROPOSED SYSTEM

Embedding Algorithm Based on CT and SVD:

- Step1: Generate the ECG signal.
- Step2: Read patient image and decompose it by applying CT to get subbands. Choose one of subbands to embed steganograph image on it.
- Step3: Read the ECG signal and convert it into gray scale image.
- Step4: Apply SVD on patient image and ECG signal image.
- Step5: To hide a ECG signal image into patient image, embedding formula with alfa factor is used.

$$Tds(i,1) = Cs(i,1) + (Ls(i,1) * \alpha)$$

Extracting Algorithm Based on CT and SVD:

- Step1: Decompose steganographed image which is obtained from embedding algorithm by applying ICT.
- Step2: Read the steganograph image and apply SVD on it.

$$Es(i,i) = (Ws(i,1) - Cs(i,1)) / \alpha$$

Step 3: Stego image quality is evaluated using the following parameters:

- 1) Root mean square error (RMSE): RMSE is one the ways to quantify the difference between cover image *C*(i, j) and stego image *S*(i, j). It is given by,

$$RMSE = \sqrt{\frac{1}{MN} \sum_{i=1}^N \sum_{j=1}^M (C_{ij} - S_{ij})^2}$$

where $N \times M$ =image size, C_{ij} = cover image, S_{ij} =stego image.

- 2. Peak signal to noise ratio (PSNR): PSNR is most commonly preferred metric to verify the perceptual quality of stego image. Here, the signal is original cover image and the noise is the error introduced due to embedding. It is given by,

$$PSNR = 20 \log_{10} \frac{255}{RMSE} dB$$

Step 4: Compare it with the wavelet transform.

IV. SIMULATION RESULTS

To evaluate performance of this method number of simulations were carried out. The original image is 512x512 gray scale images. For the contourlet transform, in the LP stage uses the “9-7” filters. Choose “9-7” biorthogonal filters because they have been shown to provide the best results for images, partly because they are linear phase and are close to being orthogonal.

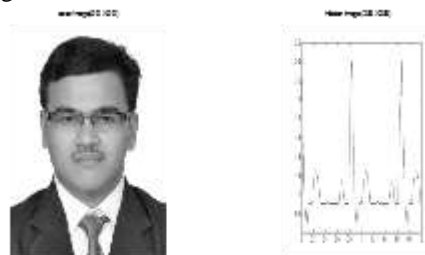


Fig. 3: Original image and Cover image

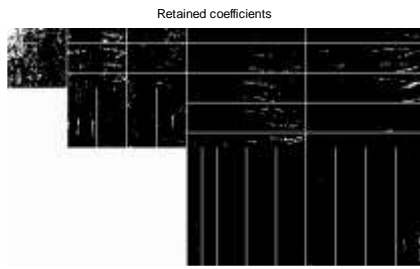


Fig. 4: Position of the retained coefficients

The original image is 512x512 gray scale image. The watermark image used is the logo of size 256x256 shown in Fig.3. The image is transformed by contourlet transform to obtain a decomposition level in Fig.4.



Fig.5: Steganography for the original image

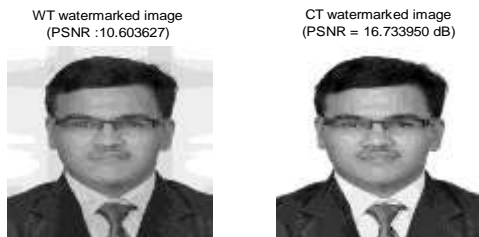


Fig.6: Nonlinear approximation analysis using wavelet and Contourlet (a). image1

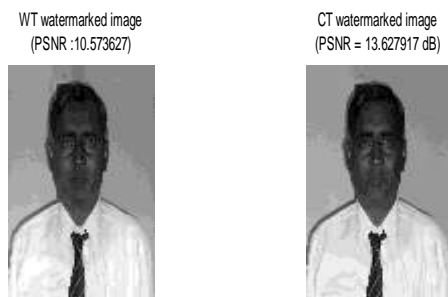


Fig.7: Nonlinear approximation analysis using wavelet and Contourlet (b). image2

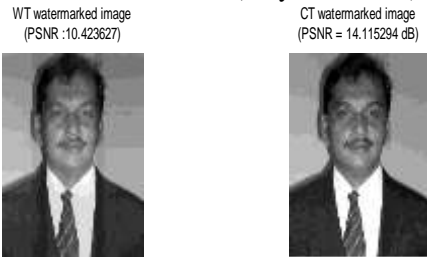


Fig.8: Nonlinear approximation analysis using wavelet and Contourlet (c). image3

Table 1 gives the Peak Signal to Noise Ratio of the proposed method tested with various host images.

Image	Without SVD		With SVD	
	WT PSNR (dB)	CT PSNR (dB)	WT PSNR (dB)	CT PSNR (dB)
Image.1	7.36	9.35	10.60	16.73
Image.2	10.06	27.28	10.57	13.62
Image.3	11.22	17.49	10.42	14.11

V. CONCLUSION

This paper presents WT and CT techniques of image steganography and comparing that techniques based on quality of stego image. Embedding encrypted steganograph to high frequency subbands allows high performance steganograph extraction. By increasing the levels of decomposition for the steganographed image, the resistance against the attacks & the quality of extracted steganograph can be improved. Contourlet transform provides multiscale and multiresolution expansion for images with smooth contours and rich in directional details. The contourlet transform uses the directional filter bank and provide shift invariant directional multi resolution. The contourlet transform and SVD achieve a better enhancement result.

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