Impact Analysis for Securing Image Data Using Hybrid SLT and DCT

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***Abstract*—This paper propose a hybrid technique in securing image data that will be applied in telemedicine in future. Based on the web-based ENT diagnosis system using Virtual Hospital Server (VHS), patients are able to submit their physiological signals and multimedia data through the internet. In telemedicine system, image data need more secure to protect data patients in web. Cryptography and steganography are techniques that can be used to secure image data implementation. In this paper, steganography method is suggested to be applied using hybrid between Discrete Cosine Transform (DCT) and Slantlet Transform (SLT) technique. DCT is calculated on blocks of independent pixels, a coding error causes discontinuity between blocks resulting in annoying blocking artifact. While SLT applies on entire image and offers better energy compaction compare to DCT without any blocking artifact. Furthermore, SLT splits component into numerous frequency bands called sub bands or octave bands. It is known that SLT is a better than DWT based scheme and better time localization. Weakness of DCT is eliminated by SLT that employ an improved version of the usual Discrete Wavelet Transform (DWT). Some comparison of technique is included in this paper to show the capability of the hybrid SLT and DCT.**

***Index Terms*—Steganography, discrete cosine transform, slantlet transform.**

I. Introduction

In this highly digitalized world, the Internet serves as an important role for data transmission and sharing data. However, since it is worldwide and publicized medium, some confidential data might be stolen, copied, modified or destroy by an unintended observer.

Telemedicine is one of the application which using Internet to communicate each other. The telemedicine was developed based on multidisciplinary integration of information technology, network technology, medical instrumentations and clinics medicines. According to the paper of Chung Hsien Kuo that presented about an asynchronous web-based Ear-Nose-Throat (ENT) diagnosis system to carry out location independent diagnosis [1]. Based on ENT web diagnosis system, patient with distance location can submit their physiological signal and multimedia data to the virtual hospital server in internet.

The patients may ask for a diagnosis at a distance location instead of going to hospital directly. Using Virtual Hospital Server (VHS), physician may process the online diagnosis in the Internet. Attackers could be eliminated by securing methods to secure the data directly or indirectly. The securing methods that will be applied in this paper is Steganography.

In Steganography, secret message is the data that sender wishes to remain confidential and can be text, images, audio, video or any other data that can be represented by a stream of bits. The cover or host which the message is embedded and serves to hide the message called "Stego-Image" [2]. There are three characteristic to design Steganography: (a) Invisibility [2], where human eyes cannot distinguish between original and stego-image. Invisibility is also known as imperceptibility. (b) Capacity [2], where it manage to embedded more data, providing that the manage remains its quality. (c) Time Localization, where the use of Slantlet (henceforth, SLT) perform the of stego-image more effectively. In addition, good time localization properties make a good representation of image [3].

The outline of this paper presents five sections where section 1 is the introduction of the paper. Section 2 covers literature review on ENT telemedicine for the domain application, include the techniques of Steganography, Section 3 covers Steganography comparison. Meanwhile Section 4 propose the idea of hybrid Slantlet Transform (henceforth, SLT) and Discrete Cosine Transform (henceforth, DCT). Finally, Section 5 presents the conclusion of this paper.

II. Literature Study

This section consists of three subsection which explain the literature review on technique that has been applied in ENT Telemedicine, the used of DCT and SLT in different application respectively.

A. ENT Telemedicine

A web-based telemedicine system for remote ENT diagnoses to carry out location independent diagnoses has been developed by [4], [1]. The system start with a patient with chronic middle ear disease and perforated ear drum is tested. A nurse used an Electric Diagnosis Hub (Henceforth, EDH) and a Symptom Data Recording Software (Henceforth, SDRS) program to submit the EPR to the VHS. A physician review the EPR using web browser and then the symptom can be successfully found. Meanwhile, the patients site modules of EDH and SDRS will be combined together and then implemented using an advance RISC machine (ARM) based embedded system to reduce the wiring complexity and improving the reliability.

B. Application using DCT and SLT

Anjali A. Shejul and Prof. U. L. Kulkarni [2] used frequency domain approach such as DWT and DCT as the Steganography method to embed secret data in skin region

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of images for biometric system. Manikopoulos C. et al. [5] proposed a hybrid of DCT and Neural Network classifier using grayscale image for Steganography Detection System (SDS) and prove that SDS achieve perfect detection rate with no misclasiffication error. Sarkar A. et al. [6] use low frequency coefficient DCT to get security for establish Earth Mover's Distance (EMD) in computer vision application and the result was evaluated using Support Vector Machine (SVM).

Meanwhile Madhubanti Maitra and Amitava Chatterje [7] use Slantlet Transform based intelligent system for magnetic resonance brain image classification to develop for automated diagnosis. Slantlet Transform used by Cheng-Tao Hsieh et al. [8] with the field programmable gate array (FPGA) hardware realization for electrical power system disturbance detection to increase the capability of signal discrimination, hence improving the grasping the disturbance intrusion. Another researcher, Adnan Hadi M. Al-Helali at al. [9] describes results that SLT is a good way to enhance the edges and reduce the noise in multispectral image fusion.

This review show that none of the researcher have being implementing Steganography for securing the data. As a result, this study would like to take this opportunity to investigate the capability of DCT and SLT for ENT telemedicine. However, in this paper, comparison on DCT images and SLT images has been done in order to observe the capability of using SLT embed with DCT.

III. Steganography Comparison

This section presents a comparison of techniques that has been applied in [10], [11]. In [7], the data was tested using images size 128x128 and 256x256 gray scale images, while the format of images are *.tif, *.png, *.bmp and *.jpg.

Table I presents the comparison of DWT and SLT. DWT was chosen since it has excellent spatial localization, frequency spread, and multi-resolution characteristic. Due to excellent spatial frequency localization properties, the DWT is very suitable to identify areas in the host image. Meanwhile, SLT was chosen because SLT provide better time localization [3], [11] and signal compression as compared to DCT and Discrete Haar-Wavelet Transform [11].

Meanwhile in [11], the data was tested using images 512x512 gray scale level. The performance of the technique were evaluated by Peak Noise to Signal Ratio (PSNR) and simulated in MATLAB. Table I show the imperceptibility is better in case of SLT than DWT. For example in the last row, the SLT PSNR value in tulip.jpg is 60.2497, while the DWT PSNR is 27.7425.

TABLE I: Comparison of Proposed Algorithm based on SLT with DWT based Method, Using PSNR [10]

Image	DWT Method Secret bit = 154	SLT Method Secret bit = 154
Barbara.png	31.1244	54.0462
pool.bmp	27.6686	59.4805
lena256.bmp	28.8096	59.4296
Tulips.jpg	27.7425	60.2497

Table II shows the comparison of DWT and DCT method. Here, DCT was chosen because it have advantages such as: good in security, imperceptibility, visibility, robustness to cover attacks such as JPEG compression, low pass filtering, noising, and cutting [12]. DCT was chosen because of its good capacity of energy compression and decorrelation [13].

TABLE II: Comparison of DWT with DCT based Method, Using PSNR [14]

Image	DWT Method	DCT Method
Lena	31.733	32.287
Barbara	29.792	30.469
Baboon	31.185	31.895

For example, the image Lena in Table II shows that the PSNR of DCT method is 0.554 more than PSNR of DWT method. This also shows thah the DCT method is slightly better than the DWT method. Although, the results from Table I and Table II were taken from [10] and [14], respectively, it is predicted then SLT will provide significant result as compared to DWT nad DCT.

IV. Hybrid DCT and SLT

A. Discrete Cosine Transform (DCT)

DCT is a change of basis that take a real valued functions and transform them with respect to an orthonormal cosine basis. This works as follows [15] :

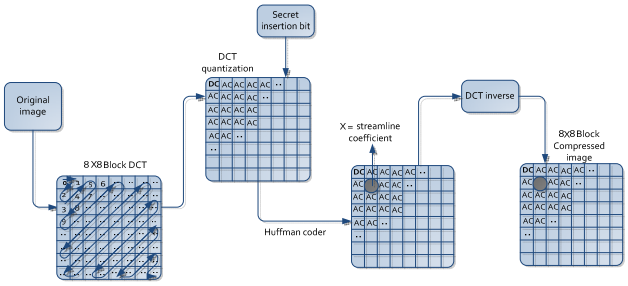

Fig. 1. Image compression process using DCT technique

The first step, original image split into 8x8 block using DCT block. After that, the image split using zigzag technique into 63 coefficients. Each coefficient can be quantized while insert the secret bit. After this, the image implement to chose the streamline coefficient by Huffman coding. Inversion image using DCT invers to make the image compression done, than the result is 8x8 compressed DCT block image.

DCT is very useful in image compression, and also is core of JPEG standard in lossy image compression. For an M × N digital image f (x, y), its two-dimensional discrete cosine transform is defined [16].

$$C(u,v) = a(u)a(v)\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} \mathrm{f(x,y)\ x\cos}\frac{(2x+1)u\pi}{2\mathrm{M}}\cos\frac{(2y+1)v\pi}{2\mathrm{N}}$$

u=0,1,2,…,M-1; v=0,1,2,…,N-1;

a(u) and a(v) are respectively defined.

$$\mathbf{a(u)} = \begin{cases} \frac{\sqrt{1}}{M}, u = 0 \\ \frac{\sqrt{2}}{M}, u = 0, 1, 2, \dots, M-1 \end{cases} \quad \mathbf{(1)}$$

$$\mathbf{a(v)} = \begin{cases} \frac{\sqrt{1}}{N}, v = 0 \\ \frac{\sqrt{2}}{N}, v = 0, 1, 2, \dots, N-1 \end{cases} \quad \mathbf{(2)}$$

Its two-dimensional Inverse Discrete Cosine Transform (IDCT) is given :

$$f(x) = \sum_{u=0}^{M-1} \sum_{v=0}^{N-1} \mathbf{a(u)a(v)C(u,v)} \; \mathbf{x} \cos\left[\frac{(2x+1)u\pi}{2M}\right] \cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad \mathbf{(3)}$$

x=0,1,2,3,...,M-1; y=0,1,2,3,...,N-1

B. *Slantlet Transform (SLT)*

SLT is an equivalent from DWT but provides better time-localization because the shorter support of component filter [17]. DWT usually implemented in form of an iterated bank with tree structure, but SLT draws its inspiration from an equivalent form of parallel structure with parallel branches [18].

Compressing scheme using SLT, the data is first applied to two-level filter structures $H_0(z)$, $H_1(z), H_2(z)$ and $H_3(z)$ as shown in Figure 2.

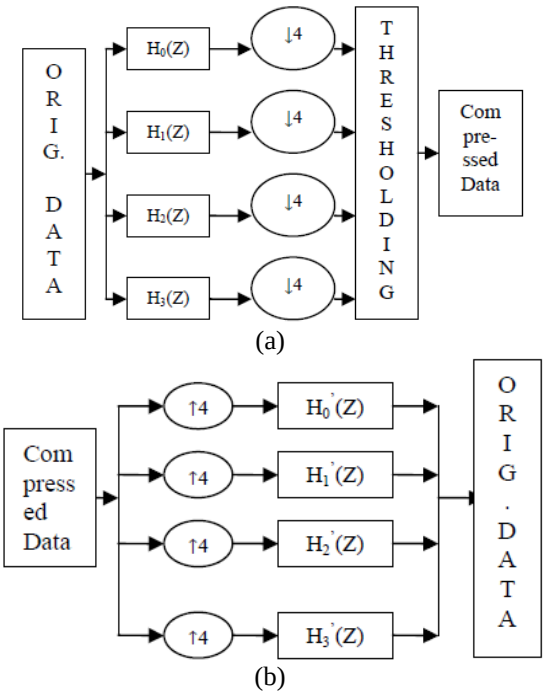

Fig. 2. (a)Two-level SLT based data compression and (b) two-level SLT based re-construction scheme [17]

The output are down sample by a factor of 4 which are the transform coefficients then thresholded using suitable parameter. The Inverse Slantlet Transform (ISLT) is perform to reconstruct the original data on these thresholded. The filter coefficient used in SLT filter bank is describes by [11].

Sushil Kumar and S.K. Muttoo [17], [10], [11] describes the advantages of Slantlet Transform (SLT) are better than DWT, Haar Wavelet and Contourlet Tranform in image quality, best payload, get better result for extracting and embedding the original image, increase embedding capacity, and get imperceptibility.

As mentioned in the previous section, DCT and SLT has shown its significant capability in securing images data. With intention to be implement in ENT telemedicine, this study would like to investigate the capability of combining DCT nad SLT for securing images data. The flow of combining this two technique is shown in Fig. 3 and Fig. 4.

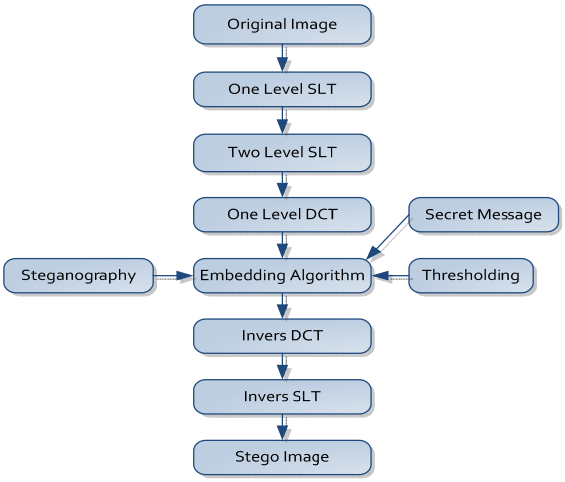

Fig. 3. Flowchart of embedding process.

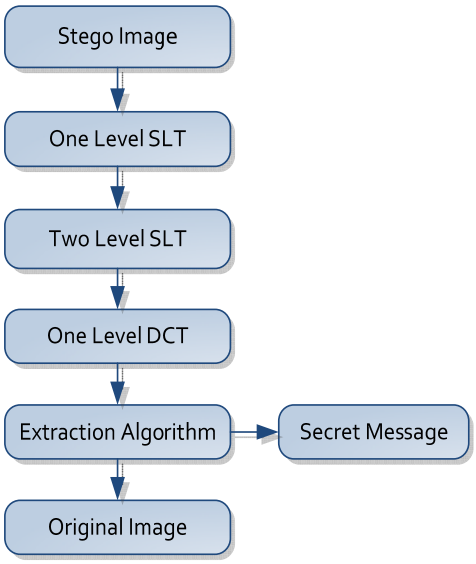

Fig. 4. Flowchart of extraction process.

Fig. 3 is the flow of embedding process which taken the 8x8 pixel original image. The image split into SLT sub-band in LL1, LH1, HL1, and HH1 and chose LL1 as sub-band embedding in 1D-SLT. The LL1 sub-band split again into four sub-band and selected LH2 in 2D-SLT. After this, the image will be devide into 63 coefficient. Using the low frequency coefficient DCT, secret bit enter in selected coefficient. Next step is inversion by DCT and finally invers by SLT. Meanwhile, Figure 4 is the flow of extracting process which taken the stego image to 1D-SLT using LL1 sub band then LH2 in 2D-SLT. Trained the image using ID-DCT though selected coefficient to read the secret message.

V. CONCLUSION

Impact analysis on SLT and DCT techniques have been presented in this paper. Due to the advantage of SLT and DCT provide in section 2, it is suggested to be implemented in ENT images, as our future work. The hybrid SLT and DCT techniques are predicted to show better results than

DWT and DCT.

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