Data Concealing Using Speech Steganography

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Abstract - *Steganography is the technique of hiding secret message in a cover medium in such a way that only the sender and the intended recipient knows the existence of communication. Speech steganography is concerned with hiding information in a cover (host) speech signal in an imperceptible way. Here present a novel speech steganography method using discrete wavelet transform and sparse decomposition. The proposed speech steganography method exploits the sparse representation to embed secret messages into the cover signal.*

Key Words: **data hiding, discrete wavelet transform, sparse representation, steganography, stego signal.**

1. INTRODUCTION

Digital communication has become an essential part nowadays. So the communication made must be secret. Techniques such as cryptography are being used on a large scale for transmitting information secretly. Steganography is a new approach of providing secure data transmission. The term steganography is derived from two Greek words, "stegno" means "secret" and "graphy" means "writing". So steganography literally means secret writing hide the secret message in a cover medium so that it cannot be seen [1].

Speech Steganography hides the secret message in speech signal called cover audio. Once the secret message is embedded in the cover audio, the resulting message is called stego message and stego message is transmitted to the receiver side. The secret message to be transmitted is embedded inside a cover file. Cover file could be images, videos or audio. Using a suitable embedding algorithm secret message is embedded into the carrier object. The resultant file is called stego file and this stego file is transmitted to the receiver side. At the receiver side stego file is decoded to extract the secret message.

Here proposed a novel wavelet domain speech steganography method, called the DWT-SD method, by exploring the sparse representation of wavelet coefficients. The proposed DWT-SD method hides the secret data in speech frames whose energy is higher than a specified threshold to avoid audible distortions due to data hiding. The low frequency wavelet sub-band is sparsely represented over the dictionary estimated from the high frequency wavelet sub-band. The secret messages are embedded into elements of the sparse representation. The secret bits are embedded and they could be decoded at the receiver side.

2. PROPOSED METHOD

Here it refers to the proposed algorithm as the DWT-SD speech steganography method, where the DWT and the SD stand for the discrete wavelet transform and the sparse decomposition concepts, respectively. The goal of this work is to present a speech steganography method which is less detectable, so more secure than existing popular methods. The novelty of this work comes from the employment of sparse representation (SR) of wavelet coefficients for secret data embedding. Sparse representation makes it possible to embed the secret data into the speech signal which leads to a more secure speech steganography method.

First divide the speech cover signal into non-overlapping frames. The frames whose energies are higher than a specific threshold, those are selected and used further for data embedding. The discrete wavelets transform (DWT) decomposes the cover signal frames into the low and high frequency components. The high frequency components of all frames of the speech signal are used to estimate a proper dictionary to represent the low frequency component sparsely over it. After finding a dictionary, the low frequency wavelet sub-band is represented sparsely over the estimated dictionary. A secret bit is encoded. The secret bits are embedded and they could be decoded at the receiver side. Once the secrete data is embedded, the low frequency wavelet sub-band of the stego signal is reconstructed from its sparse representation coefficient matrix. Stego signal is produced by reversing the framing process. Here inverse discrete wavelet transform is taken.

3. ALGORITHM

The algorithm of the proposed method contains two parts as mentioned below. First part gives the steps to embed the secret message into the speech signal & the next part gives the steps to detect the secret message.

A. Encoding

1) Read the speech signal.
2) framing and energy calculation
3) wavelet transform
4) sparse representation over dictionary learning
5) secret data embedding
6)Inverse of sparse decomposition and inverse wavelet transform
7) generate stego signal

B. Decoding

1) Read the stego signal.
2) framing and energy calculation
3) wavelet transform
4) dictionary restoration
5)sparse decomposition
6) secret data extraction

4. RESULT

Secret data is embedded into signal i.e. called as cover audio signal. The cover audio signal is shown in fig.1. After embedding the secret message, the signal called as stegno signal. The stego signal is made as it looks like cover audio signal. The cover and stego audio signal are look same. Stego signal should not be suspicious that it has secret message. The stego audio signal is shown in fig. 2.

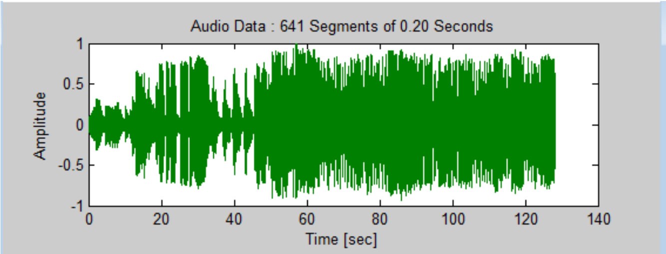

Fig. 1. Cover audio signal

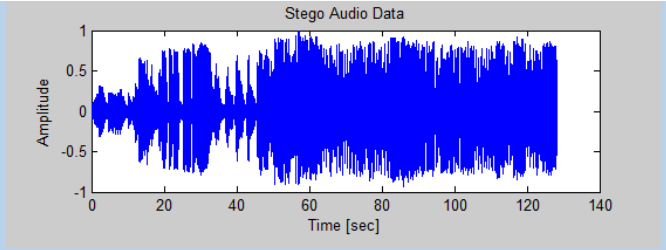

Fig. 2. Stego Audio signal

From the above spectra, one can get a clear idea of the two signals. If we compare them, we observe very small changes & these are so small that they cannot be detected, when one hears the modified carrier signal.

Evaluation parameter

In this paper, we use two objective performance measures. We use the DWT-SD to embed different payload values in cover signal. The embedding is done for different frame length values.

1. SNR values:

Signal-to-noise ratio (abbreviated SNR) is a measure that compares the level of a desired signal to the level of background noise. It is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise. While SNR is commonly quoted for electrical signals, it can be applied to any form of signal.

$$SNR_{db} = 10log_{10}(\frac{P_{signal}}{P_{noise}})$$

Table no.1 shows SNR values for different frame length at different embedding rate. The SNR value is good at low frame size and less message size.

As message length and frame length increases, the SNR value slightly decreases.

Message length (in byte)	Frame Length	
	0.20 sec	0.30 sec
144 byte	0.5045	0.2152
408 byte	0.4680	0.0258
824 byte	0.0190	0.0103

Table no. 1. Comparing the SNR Values of the stego signals obtained by the proposed DWT-SD method for different message size and frame length.

Further figure display the SNR values of the stego signal obtained proposed method, as a function of the frame length at different message size.

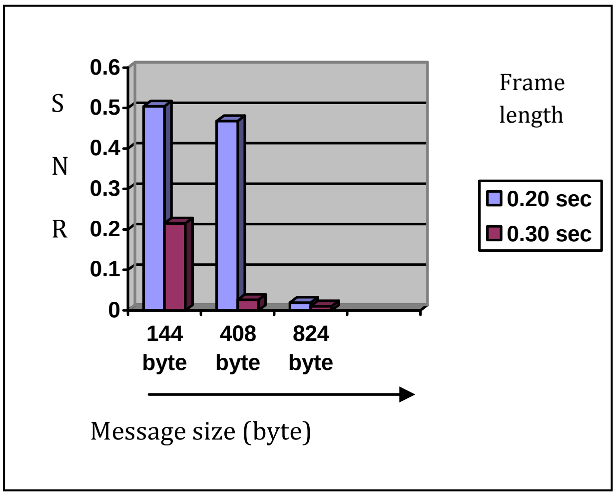

Fig.3. SNR Value for different message size.

2. PESQ:

Perceptual Evaluation of Speech Quality is a family of standards comprising a test methodology for automated assessment of the speech quality as experienced by a user of a telephony system. PESQ is a full-reference algorithm and analyzes the speech signal sample-by-sample after a temporal alignment of corresponding excerpts of reference and test signal.

Table no.2 shows PESQ values for different frame length at different message length. The PESQ value is good at low frame size and less message size. As message length and frame length increases, the PESQ value slightly decreases.

Message length (in byte)	Frame Length	
	0.20 sec	0.30 sec
144 byte	4.4968	4.4998
408 byte	4.4962	4.4796
824 byte	4.4836	4.4899

Table no. 2. Comparing the PESQ Values of the stego signals obtained by the proposed DWT-SD method for different message size and frame length.

Further figure display the PESQ values of the stego signal obtained proposed method, as a function of the frame length at different message size.

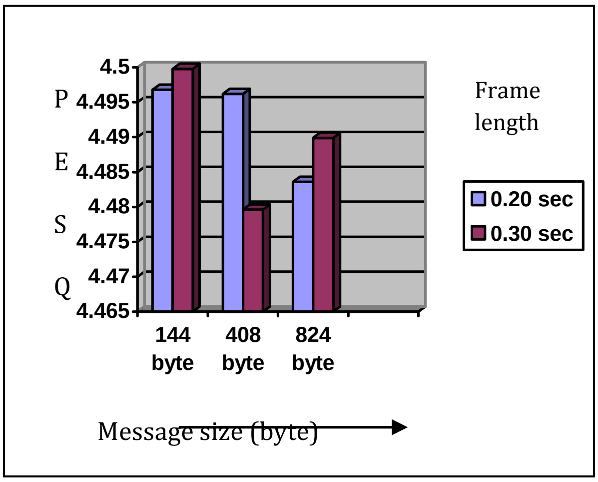

Fig.4. PESQ Value for different message size.

5. CONCLUSION

Thus, we have proposed a new technique of speech steganography by hiding a secrete message inside a speech file. The figures also show the closeness of the spectra of original carrier signal & the carrier signal after embedding the secret message inside it.

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