Audio in Image Steganography based on Wavelet Transform

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ABSTRACT
Security of data is very important in data communication. Everyday a lot of information is transferred form one user to another on internet and so the possibility of data theft also increases. Steganography provides a solution for the security of information during data transmission. Steganography is the science which makes the valuable information invisible to prevent it from unauthorized user. In this paper an audio message has been embedded in an image using the LSB (Least Significant Bit) technique and the wavelet transform. To hide a speech in an image is challenging as size of speech is larger than size of image. Number of bits in 1kb of speech is almost equal to an image. This paper describes how maximum speech can be embed in an image.

Keywords
Audio Steganography, Image steganography, LSB technique, and wavelet transform.

1. INTRODUCTION
With the development in use of internet, data communication has become easy. In comparison with the analog data communication, digital communication provides us many benefits such as high speed, better quality, compression etc. But digital data communication has some disadvantages also, like the fear of data theft during the transmission. Security of information is one of the important requirements in the field of information transmission, whether it is the transmission of images on internet or transmission of data in military applications which needs to be more secure. Steganography provides security to the information to be transmitted. Steganography is the science of hiding secret message in a cover message. Cover message can be audio, image, text, video. Steganography can be compared with the cryptography; another technique for information security. Cryptography deals with the encryption of secret message before the transmission but the encrypted message itself gives the information of presence of valuable message where the steganography makes the secret message invisible to the unauthorized users.

Steganography is the Greek word came from 'stegnos' and 'graphie' means protected writing. This technology is very old started in 440BC.

Steganography is evaluated on three parameters:

1. Perceptual transparency, 2. Robustness and 3. Hiding capacity. This paper describes how the hiding capacity can be increased.

In section 2 there is a preview on the classification of steganography and details of image and audio steganography as they are used in this paper. Section 3 discusses the proposed algorithm comprising audio compression, embedding and extraction algorithms and the results and their analysis will be discussed in section 4.

2. STEGANOGRAPHY
2.1 Classification of Steganography
Steganography can be classified in four types-

2.1.1 Text steganography
Text steganography deals with the hiding of text message in a cover text [7].

2.1.2 Image steganography
Image steganography deals with the hiding of secret image in another cover image [7].

2.1.3 Audio steganography
In audio steganography a secret audio is made hidden in audio cover message [7].

2.1.4 Video steganography
Video steganography hides the secret message in video [7].

2.2 Image Steganography
In image steganography weakness of human visual perception system is considered as the strong point of the steganographic system. Image steganography is classified in two domains- Spatial Domain and Transform Domain.

In spatial domain techniques the secret message is embedded in the intensity of the pixels directly, while for transform – also known as frequency domain, images are first transformed and then the message is embedded in the image.

2.3 Audio Steganography
In audio steganography the weakness of Human Auditory System is considered as the strong point. There are several techniques for the audio steganography. They are-

2.3.1 LSB Coding
In LSB (Least Significant Bit) coding the LSB plane of the cover is altered by the secret information.

2.3.2 Parity Coding
Parity coding method breaks a signal down into separate regions of samples and encodes each bit from the secret message in a sample region's parity bit [6].

2.3.3 Phase Coding
Phase coding technique encodes the message bits as phase shifts in the phase spectrum of a digital signal [6].

2.3.4 Echo Hiding
In this method the information is embedded by introducing an echo into the discrete signal [6]

2.3.5 Spread Spectrum

Spread spectrum method spreads he message over the sound file's frequency spectrum, using a code that is independent of the actual signal [6]

How image and audio steganography are used in this paper is discussed in further sections.

3. PROPOSED SCHEME

There are several techniques of steganography that hides- 1) text in image, 2) text in audio, 3) image in audio, 4) image in video, 5) audio in video. This paper proposes a technique to hide a speech in an image. There are some challenges as the size of speech is larger than an image. In this paper wavelet transform technique and LSB method of hiding data are used together to obtain a new methodology for hiding an audio in an image. LSB technique is one of the most popular techniques in the steganography field for data hiding. This technique hides the secret message in the 8th bit plane of the cover data. Wavelet transform is used here for the compression of speech. Wavelet compression is explained later [2]. The methodology is divided in two parts.

- Embedding audio
- Extracting audio

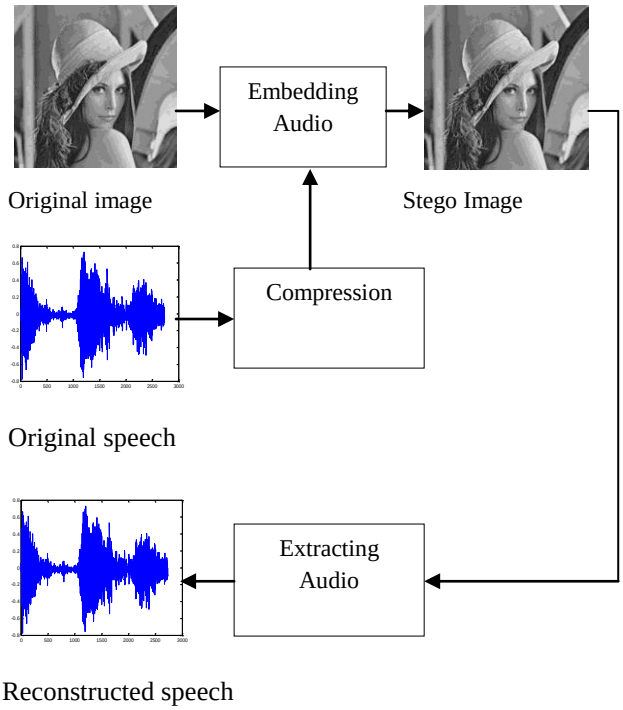

Fig.1 Methodology

3.1 Audio Compression

Compression of an audio signal allows us to hide more amounts of data in an image. In this algorithm compression is done using wavelet transform. Wavelet transform is a transform which provides the time and frequency information of a signal simultaneously Wavelet transform is a useful tool as it provides a lot of application and compression is one of them. Wavelet transform is being used here because it provides various options for selecting the best wavelet for the compression. Wavelet transform includes the decomposition of a signal in approximation and detail parts. Approximation part consist most of the information of the signal. And this concept is used for the compression of speech signal. For the compression the detail part of the speech signal is set to zero and the approximation part is taken into consideration as the approximation part of the signal contains the maximum part of the original signal. The decomposition of speech signal can be done to multiple levels, thus compression can be done to multiple levels but the content of information needs to be taken care of. After compression the compressed speech signal is passed through the embedding process discussed in the next section.

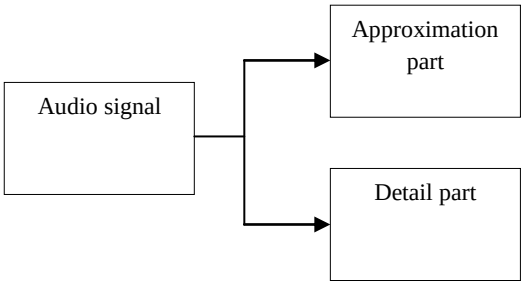

Fig.2 Wavelet decomposition of audio signal

3.2 Embedding Algorithm

Embedding algorithm hides the compressed speech in an image by using LSB (Least Significant Bit) technique. In LSB technique 8th plane of the image is considered where the embedding is done, because by changing the bits of LSB plane the cover image will not be so much affected but by embedding the bits in the MSB (Most Significant Bit) the quality of image will be distorted completely. This method is successful because it brings minor changes in the quality of cover. Fig.3 shows that how MSB plays an important role for the quality of image.

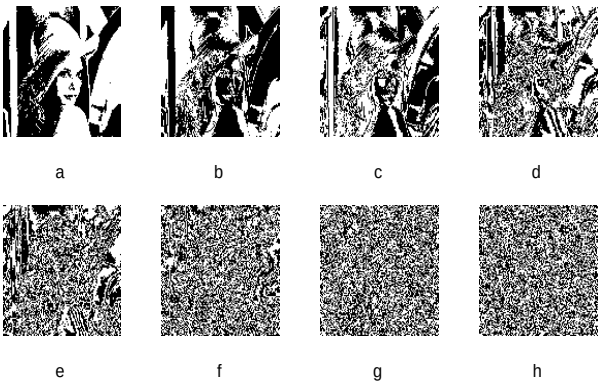

Fig.3 8 Planes of an Image

The process of embedding involved the conversion of pixels of cover image and secret audio into binary sequence and then embedding the binary sequence of audio in 8th plane of the cover image. Before embedding the audio is made to compress to half its size.

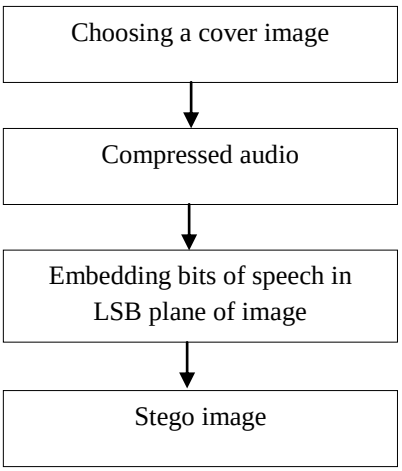

Fig.4 Algorithm of Embedding audio

3.3 Extraction Algorithm

The extraction process is reverse of embedding procedure. For this process stego image is considered and the algorithm was applied on it. Here from the stego image 8^{th} bit plane will be extracted and then binary sequence of LSB plane will be converted into pixel values. The result will be the embedded compressed audio.

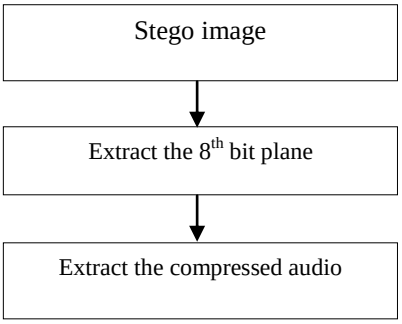

Fig.5 Algorithm of Extracting audio

3.4 Reconstruction of Original Signal

The resultant audio after the extraction process is the compressed one. After that the main work is to obtain the original audio from that compressed audio. For that inverse wavelet transform will be used.

4. Results and analysis

The above algorithm has been implemented in MATLAB R2009b. Results were calculated by embedding seven speeches in Lena image. Below there is the original image and the stego image.

Table 1. PSNR of image after embedding speech

Speech	Size	PSNR of Image
Speech 1	2.29kb	59.6548
Speech 2	3.01kb	58.4587
Speech 3	4.24kb	56.9259
Speech 4	5.38kb	55.8573
Speech 5	7.96kb	54.2085
Speech 6	8.33kb	53.9835
Speech 7	9.90kb	53.2833

The speeches which were embedded in the image were compressed first and for that some calculations were done to select the best wavelet. Calculations were based on the compaction ratio of wavelets. Results showed that the Daub 18 has the highest compaction ratio, which means the approximation part in this wavelet contains more amounts of original data as compared to others. We have done the compaction ratio test up to two levels for Haar, Daubechies, and Coif wavelets.

Fig.6 Original Image

Fig.7 Stego Image

The PSNR of the image after the embedding of speech in image is given in table 1.

Results showed that as the size of speech is increased the PSNR decreases. The relation between PSNR and size of image is given graphically below-

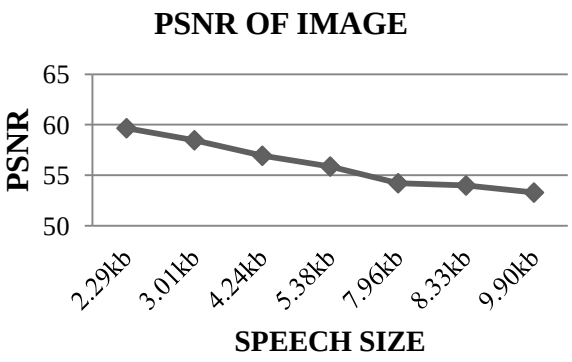

Fig.8 Graph between speech and PSNR of image when particular speech was embedded

5. FUTURE WORK

Future work will be to increase the size of speech to be hided in image in such a way that the MSE of the speech should decrease and the PSNR of image should increase.

6. CONCLUSION

This paper discusses that a large amount of audio can be hided in an image after compression. We used wavelet transform for the compression which compressed the audio to half of its original size; it can be further compressed by using wavelet compression technique. The difference between original image and stego image was not detectable and the audio after reconstruction was similar to the original audio.

7. REFERENCES

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