University of
Science and Technology of Hanoi

Digital Signal Processing
Final Project Report

Audio Steganography

Group Meow - BI10 | ICT

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1 Introduction

1.1 Overview

Since the official birth of the Internet on January 1, 1983, security of information has become important more than ever. Cryptography, the method to encrypt and decrypt data in order to keep the information secret, was proposed as a technique to secure the secrecy of communication. But sometimes, in situations where the existence of the data also needs to be hidden, they came up with another technique called "Steganography".

The main concept of steganography is that it tries to hide, instead of encrypt the data. And Audio Steganography, which means applying steganography using audios, is the main topic that we are going to study in this project.

1.2 Group members

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2 Definition

- Audio Steganography means applying steganography using audios.
- It is the art of covertly transmitting hidden information by embedding messages into an audio signal.
- The host audio before steganography and the stego audio after steganography should have the same characteristics.
- Audio Steganography is one of the most effective way to secure the information privacy because:
  - Audio provides more features which can be used to hide information.
  - All 3 characteristics: Amplitude, Frequency and Phase can be manipulated.

  - An audio signal is perceived differently as a human. The difference in perception can allow us to hide more information within it and we can exploit the human auditory system to do so.

- Despite the fact that Audio Steganography is very effective, it is one of the most difficult domain to implement steganography.
- The three major performance standards of steganography technique, as known as "The magic triangle for data hiding", are:
  - Hiding capacity (data rate)
  - Inaudibility of distortion (Perceptual Transparency)
  - Robustness
- The workflow of Audio Steganography:

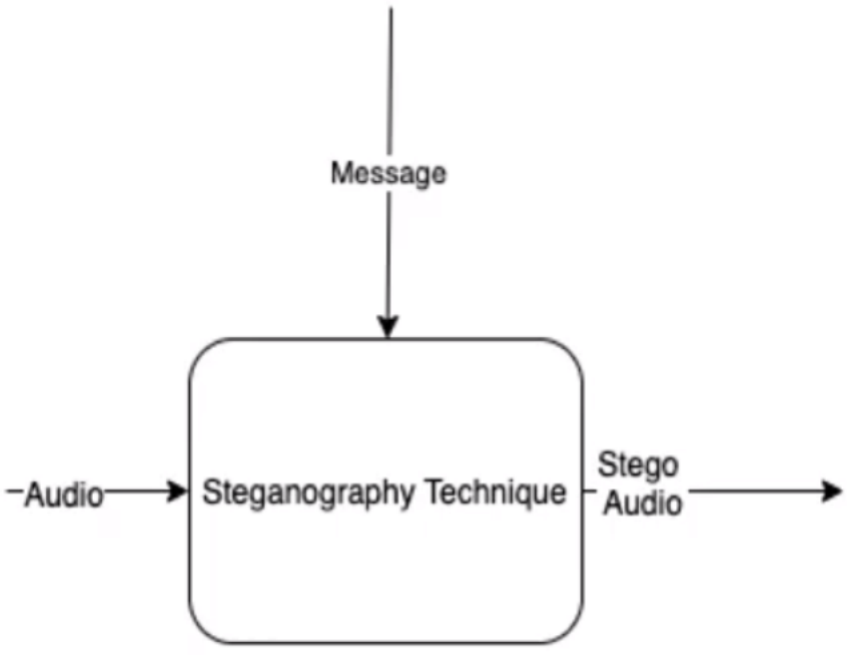

Figure 1: A basic workflow of Audio Steganography

3 Applications

Audio Steganography can be used anytime you want to hide data. With these new techniques, a hidden message is indistinguishable from noise.

- In the business world, Audio Steganography can be used to hide a secret chemical formula or plans for a new invention.
- Audio Steganography can also be used to send out trade secrets without anyone at the company being any the wiser.
- Most of the newer applications use Audio Steganography for DVDs like a watermark, to protect a copyright on information since the industry builds DVD recorders to detect and disallow copying of protected DVDs.

4 Techniques

There are numerous techniques of Audio Steganography were developed, such as:

- Least Significant Bit
- Phase Coding
- Echo Hiding
- Parity Coding
- Hide in silence Intervals
- Spread Spectrum
- Discrete Wavelet Transform
- Tone insertion

Because of the limitation of time, our system focuses on the Least Significant Bit and Phase Coding.

4.1 Least Significant Bit

4.1.1 Process

- Step 1: Convert the audio signal into a binary format
- Step 2: Divide the audio signal into smaller chunks
- Step 3: Convert the secret message into binary
- Step 4: Replace each last bit of the chunks by bits from the message

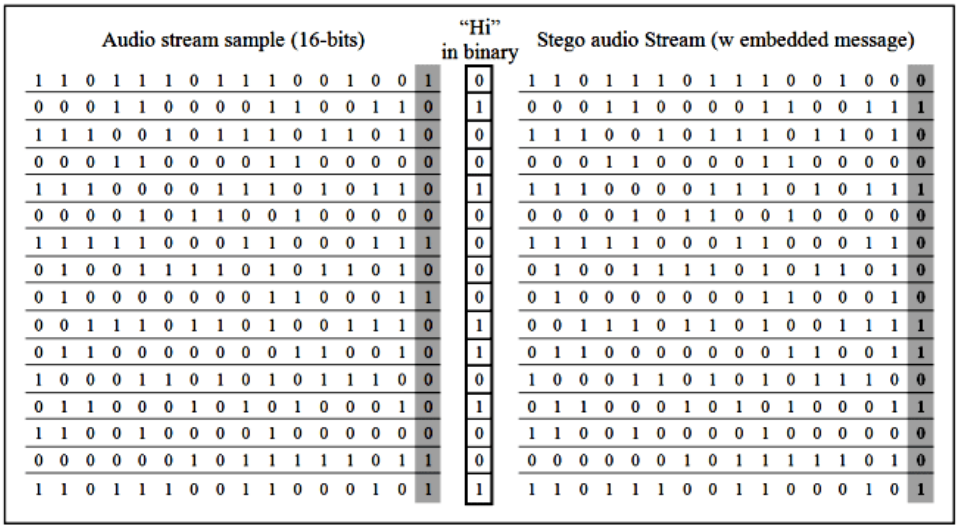

Figure 2: A visual description about how LSB is applied to embed a text "Hi" into a 16-bit audio stream sample

4.1.2 Advantages

Generally, LSB is the most popular and most frequently used method for audio steganography. It is:

- Easy to understand
- Simple to implement
- Does the job most of the time

4.1.3 Disadvantages

Besides the benefits, there are still some drawbacks, such as:

- Very low transfer capacity because only 1 bit can be hidden in a chunk of data.
- If there is a lot of information in the audio, changes can sometimes be perceived.

4.2 Phase Coding

Another technique though not as popular, but provides way better performance, is phase coding. The main concept of Phase Coding is to exploit human auditory system's insensitivity to relative phase of different spectral component.

4.2.1 Process

- Step 1: Divide the audio into smaller segments:
  - The header information such as bit rate, name, address, etc. is first extracted from the audio.
  - Then divide the rest into chunks whose sizes are equal to the size of the secret message.
- Step 2: Apply DFT (Discrete Fourier Transform) to each segment to create a matrix of the phases.
- Step 3: Convert the secret message to binary and insert it into the phase vector of *only the first signal segment* as follow:
  - If secret message bit = 0: increase the phase by $\pi/2$
  - Else, secret message bit = 1: decrease the phase by $\pi/2$
- Step 4: Create a new phase matrix using the new phase of the first segment and the original phase matrix
- Step 5: Apply the Inverse DFT using the new phase matrix
- Step 6: Combine the sound segments with the original header to create the new sound signal.

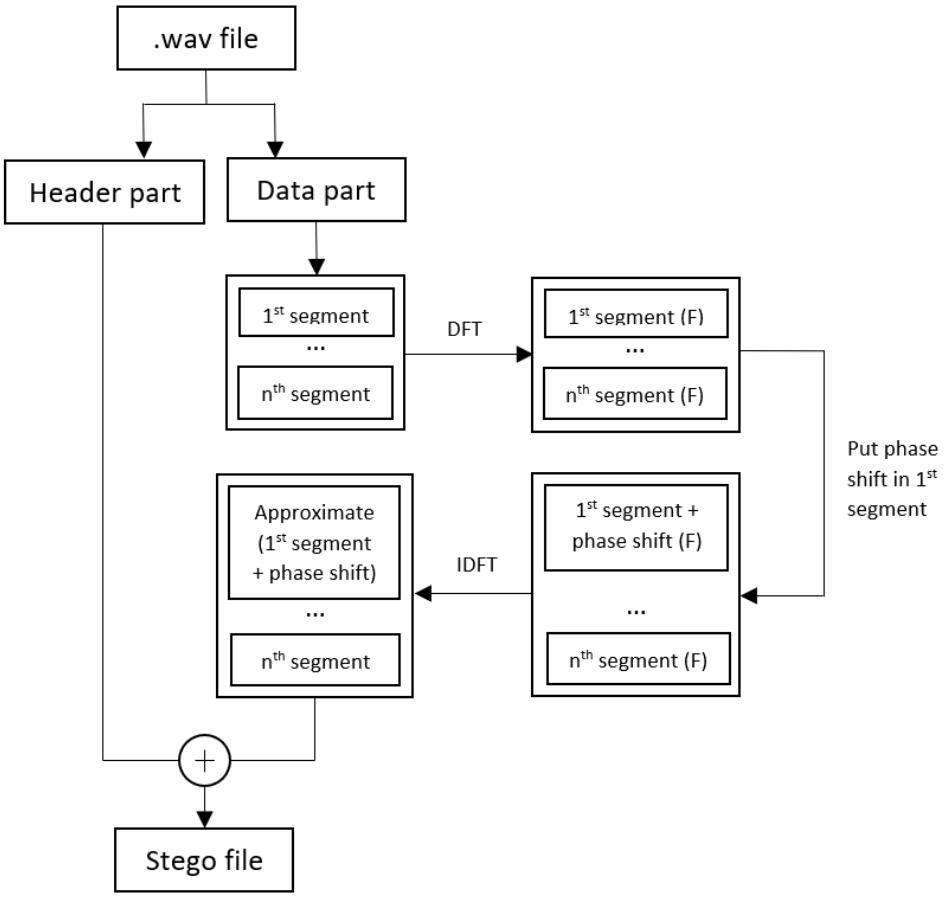

Figure 3: A visual description of the workflow of Phase Coding technique

4.2.2 Advantages

Compared to other techniques, particularly LSB, phase coding has some outstanding points:

- It is the most resistant to signal distortion
- It provides far better transfer capacity
- The difference in the audio is not perceivable to human

4.2.3 Disadvantages

Everything has its weaknesses. For phase coding:

- Since the secret message is located at the first block instead of distributed over the audio, it can easily be removed using cropping attack.
- It has low payload because only the first segment is used for secret message embedding.

5 Conclusion

For the topic "Audio Steganography", we have studied about:

- What it is
- Why we need it
- How to implement it

We also developed a simple system to apply Audio Steganography, which is capable of:

- Provide a friendly Graphical User Interface
- Allow the user to select an audio file and enter some text to encode it
- Display the name and the address of the files
- Allow the user to select an encoded audio file to decode it
- Select an algorithm between LSB and Phase Coding to encode and decode

Improvements can be made in the future:

- Allow the system to encode and decode not only .wav files, but also .mp3 files.
- Implement more algorithms.
- The LSB algorithm can be upgraded to "Modified LSB" algorithm, which provides better performance.
- The system now can only process audio files with not too high data rates, will be optimized to apply with higher data rates.

References

[1] Audio Steganography
https://www.youtube.com/watch?v=BdEkQ-J76kY

[2] Steganography and its application in security
http://www.ijmer.com/papers/Vol2_Issue6/EN2646344638.pdf

[3] Audio Steganography Used for Secure Data Transmission
https://link.springer.com/chapter/10.1007/978-81-322-0740-5_83

[4] Audio-Stego
https://github.com/shalom06/Audio-Stego

[5] Review on Steganography for hiding data
https://www.ijcsmc.com/docs/papers/April2014/V3I4201468.pdf

[6] Retail Manager
https://github.com/realmacaw/real-mart