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Data Security through Steganography and Cryptography in VOIP

Shilpa Sunil Wankhade
Department of Information Technology
Terna Engineering College Nerul, Navi Mumbai,India
Email: shlpwankhade@yahoo.co.in

Prof. Ramesh V. Shahabade
Department of Computer Engineering
Terna Engineering College Nerul, Navi Mumbai,India
Email: rameshshahabade@ternaengg.ac.in

***Abstract* – Current practice of data hiding technique exists, uses image, audio, video, or protocol headers as medium for hiding our information. The real-time text hiding is to hide the secret text into a cover speech in realtime communication systems such as voice over Internet Protocol. VOIP the new and promising communication medium that can be used as a host for steganography. Steganography is an effective way of hiding secret data, by this means of protecting the data from unauthorized or unwanted viewing. An information-smuggling technique called Steganography- the communication of secret messages inside a perfectly innocent carrier.Using cryptography technique will encrypt and decrypt message to provide better security. Cryptography protects the message from being read by unauthorized parties, steganography lets the sender conceal the fact that he has even sent a message. By hiding one secret text into the cover speech using steganography we can get a stegospeech, which sounds meaningful and indistinguishable from the original cover speech. Therefore, even if the Hackers catch the audio packets on Network, they would not notice that there is some secret text hidden inside it. In this work, to develop a Voice Chat Tool, this can also enable us to send secret data hidden inside the voice packets at the same time. We have used LSB method of steganography also we provide encryption to the message to be sent to provide better security. There is no restrictionon the length of message as more the communicators talk larger the file is sent.**

***Keywords* – Real Time Communication, VOIP, Information Hiding, Steganography, LSB, Cover Speech, Protocol Headers, Stego Speech.**

I. INTRODUCTION

Steganography derives from the Greek word steganos, meaning covered or secret, and graphy(writing or drawing). On the simplest level, steganography is hidden writing, whether it consists of invisible ink on paper or copyright information hidden in an audio file. Using the steganography, we can embed a secret message inside a piece of unsuspicious information and send it without anyone knowing of the existence of the secret message. Steganography and cryptography are closely related. Cryptography scrambles messages so they cannot be understood.It is a common approach to protect the audio contents by an encryption algorithm, such as the Data Encryption Standard (DES) or the Advanced Encryption Standard (AES)[3]. However, there may be some potential problems for these approaches. Steganography on the other hand, will hide the message so there is no knowledge of the existence of the message in the first place. At present time Voice over Internet Protocol(VOIP) is one of the most popular services in the internet. VoIP is a general term for a family of transmission technologies for delivery of voice communications over IP networks such as the Internet or other packet-switched networks. Voice-over-IP (VoIP) as a new field for applied steganography. The term "VoIP" describes the digitalization, compression and transmission of analogue audio signals (in the majority of cases speech) from a sender to a receiver using IP packets. The receiver applies the reverse process and gets the reconstructed audio signal. After that he can act as the sender. A detailed review of Steganography methods that may be applied during signalling phase of the call can be found in. A new approach in Network Data hiding is to hide the Secret Text and series of characters in actual voice packet while keeping the application of the system intact. Any malicious user who would try to intercept this data would find this data as important as original VOIP data. Steganography is a art and science of writing hidden messages in such a way that no one, apart from sender and intended receiver suspects the existence of messages, a form of security.Nowadays, the UDP streaming files are used as a cover medium for hiding data and the RTP protocol uses this medium for successful transmission of hidden messages. But these techniques failed to satisfy the conditions such that the UDP would change its features and affect the transmission. Due to this fact, the attackers can guess the hidden information and break the confidentiality. Hence a solution is to be proposed to send original data in voice packets file and send the streaming content over UDP protocol without changing its characteristics. VOIP steganography covers a wide range of information hiding techniques, including popular techniques based on IP or TCP or UDP and other protocols. The main idea is to use free, redundant or unused fields of these protocols. In this work the VOIP call will be limited to two hosts using point-to-point connection with static IP addresses. This is As a result different from the real life VOIP applications which use client server calls, the system will be based on LAN network which provides an environment with almost zero noise.

The rest of the paper is organized as follows: section II deals with literature survey. In section III some methods of audio steganography are summarized. Section IV deals with proposed system.In section V experimental results are discussed. Finally section VI deals with conclusion and future scope.

II. LITERATURE SURVEY

Many of current audio and network steganography algorithms are theoretically applicable to VoIP streams but inpractice only some of them are feasible or applicable to VoIP taking in mind available equipment and technology.

Kratzer etal. [16], suggested that messages to be encrypted prior to embedding to improve security. Later they proposed a scheme that introduces the cryptographies for embedded messages. However, the encryption operation must be carried out offline before the embedding operation, because the adopted cryptographies are often time-consuming and incur delays that may degrade the speech quality. Gopalan and Wenndt [19] presented a method of embedding covert data in a cover audio signal by inserting low power tones. Chungyi and Quincy [20], proposed a scheme for transmitting secret speeches based on information hiding in VoIP systems. Their hiding process consists of two steps: First compressing the secret speeches and then filling their binary bits directly into the LSBs of cover speech using G.711. Thomas Vogel and Christian Kraetze[18],summarize the design principles from the general approach and introduce extended experimental test results of a Voice-over-IP(VoIP) framework including a steganographic channel. Chungyi Wang [3], propose a scheme for speech hiding in a real-time communication system such as voice over Internet Protocol (VoIP). A novel design of real-time speech hiding for G.711 codec, which is widely supported by almost every VoIP device. HuiTian[4], presents an adaptive steganography scheme for Voice over IP (VoIP). Differing from existing steganography techniques for VoIP, this scheme enhances the embedding transparency by taking into account the similarity between Least Significant Bits (LSBs) and embedded messages. Moreover, we introduce the notion of Partial Similarity Value (PSV).Ahmed[1], The functional and cost advantages if Internet telephony are evident. The hacker scene is constantly looking for new weak spots and developing ingenious methods of attack to gain access to confidential and penetrate further into network. One of the most security issues faced by VOIP is end-to-end user identity, responder identity and how to authenticate it. To guarantee the privacy and integrity of the response information is important. In this research some security issues about VOIP, the role of steganography in VOIP communication, and a proposed mechanism to secure VOIP based on steganography and one time password. ZhiweiYu [21], illustrates a stegocommunication threat to business owner Charless. If Charless purchases a VOIP service for business related communications by an employee Alice, then he faces the risk that Alice may undetectably communicate a business secret to an outside party Bob. In this insider-threat scenario, Charles can mitigate his security risk by installing a stegodetector.Yong Feng Huang[6], his paper describes a novel high-capacity steganography algorithm for embedding data in the inactive frames of low bit rate audio streams encoded by G.723.1 source codec, which is used extensively in Voice over Internet Protocol (VoIP). Study reveals that, contrary to existing thought, the inactive frames of VoIP streams are more suitable for data embedding than the active frames of the streams; that is, steganography in the inactive audio frames attains a larger data embedding capacity than that in the active audio frames under the same imperceptibility.Mengyu, Q., A.H. Sung, and L. Qingzhong[12], In this paper, they propose a scheme for steganalysis of MP3Stego based on feature mining and pattern recognition techniques. We first extract the moment statistical features of GGD shape parameters of the MDCT sub-band coefficients, as well as the moment statistical features, neighbouring joint densities, and Markov transition features of the second order derivatives of the MDCT coefficients on MPEG-1 Audio Layer 3. Support vector machines (SVM) are applied to these features for detection. Experimental results show that our method can successfully discriminate the steganograms created by using MP3stego from their MP3 covers, even with fairly low embedding ratio.

III. METHODS OF AUDIO STEGANOGRAPHY

There are many steganographic techniques for hiding secret data or messages in audio. Major and common techniques include [9], [10],[11].

A. LSB coding

Least significant bit (LSB) coding is the simplest way to embed information in a digital audio file. By substituting the least significant bit of each sampling point with a binary message, LSB coding allows for a large amount of data to be encoded. The following diagram illustrates how the message 'HEY' is encoded in a 16-bit CD quality sample using the LSB method:

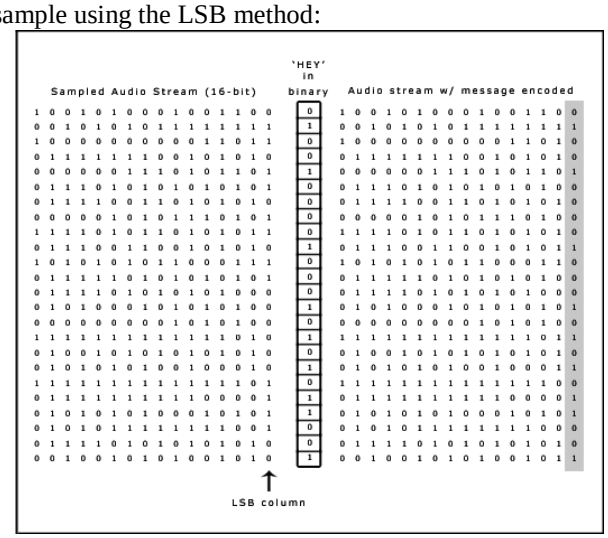

Fig.1. 'HEY' is encoded in a 16-bit CD quality sample

In LSB coding, the ideal data transmission rate is 1 kbps per 1 kHz. In some implementations of LSB coding,

however, the two least significant bits of a sample are replaced with two message bits. This increases the amount of data that can be encoded but also increases the amount of resulting noise in the audio file as well. Thus, one should consider the signal content before deciding on the LSB operation to use. For example, a sound file that was recorded in a bustling subway station would mask low-bit encoding noise.

B. Phase coding

The phase coding technique works by replacing the phase of an initial audio segment with a reference phase that represents the secret information. The remaining segments phase is adjusted in order to preserve the relative phase between segments. In terms of signal to noise ratio, Phase coding is one of the most effective coding methods. When there is a drastic change in the phase relation between each frequency component, noticeable phase dispersion will occur.. Phase coding relies on the fact that the phase components of sound are not as perceptible to the human ear as noise is. Rather than introducing perturbations, the technique encodes the message bits as phase shifts in the phase spectrum of a digital signal, achieving an inaudible encoding in terms of signal-to-perceived noise ratio.

C. Spread spectrum

Spread spectrum (SS) method attempts to spread secret information across the audio signal's frequency spectrum as much as possible. This is analogous to a system using an implementation of the LSB coding that randomly spreads the message bits over the entire sound file. However, unlike LSB coding, the SS method spreads the secret message over the sound file's frequency spectrum, using a code that is independent of the actual signal. As a result, the final signal occupies a bandwidth in excess of what is actually required for transmission. Two versions of SS can be used in audio steganography: the direct-sequence and frequency-hopping schemes. In direct-sequence SS, the secret message is spread out by a constant called the chip rate and then modulated with a pseudorandom signal. It is then interleaved with the cover-signal. In frequency-hopping SS, the audio file's frequency spectrum is altered so that it hops rapidly between frequencies.

D. Echo hiding

In echo hiding, information is embedded in a sound file by introducing an echo into the discrete signal. Like the spread spectrum method, it too provides advantages in that it allows for a high data transmission rate and provides superior robustness when compared to the noise inducing methods. To hide the data successfully, three parameters of the echo are varied: amplitude, decay rate, and offset (delay time) from the original signal. All three parameters are set below the human hearing threshold so the echo is not easily resolved. In addition, offset is varied to represent the binary message to be encoded. One offset value represents a binary one, and a second offset value represents a binary zero.

E. Parity Coding

Instead of breaking a signal down into individual samples, the 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. If the parity bit of a selected region does not match the secret bit to be encoded, the process flips the LSB of one of the samples in the region. Thus, the sender has more of a choice in encoding the secret bit, and the signal can be changed in a more unobtrusive fashion.

IV. PROPOSED SYSTEM

General architecture of the proposed VoIP steganography prototype is shown in Figure 1 below.

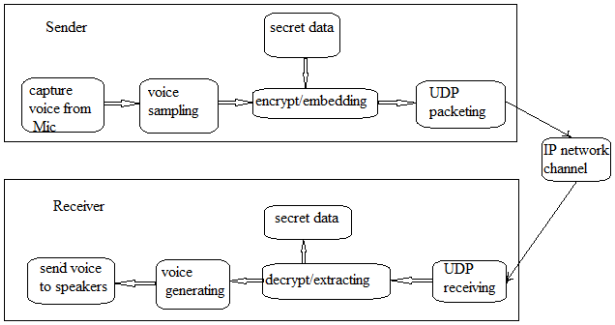

Fig.2. Architecture of the proposed VOIP steganography prototype

The first step is to implement VoIP call by using either client server based or point-to-point based architecture. The VoIP call will be point-to-point based and consists of three steps: initializing call, performing the conversation, and ending the call. The initialization of VoIP calls start when one endpoint (the sender) sends an INVITE message to the other endpoint(the receiver) using receiver's IP address. If the receiver accepts the invitation, an OK message will be sent back to the sender. By receiving the OK message, the initialize step is done and both the parties will start the next (conversation).

A. Embedding Process

As the conversation session starts, voice signals are captured from microphone and sampled into PCM codes. The secret data will now be encrypted and then embedded using LSB technique. The stego voice signal will be packetized into UDP packets and sent to the receiver.

- *Algorithm for embedding process*

Step 1: Get secret data and convert it to an array of bits A1.
Step 2: Get a portion of voice data and save it into an array of bytes A2.
Step 3: Insert starting bytes (0, 255, 0, 255, 0) into voice data array.
Step 4: Insert 1 bit of secret data array into LSB of voice data array byte.
Step 5: Increment indexes of A1 and A2.
Step 6: repeat Step 4 and 5 until end of A1.

Step 7: Insert ending bytes (255, 0, 255, 0, 255) into voice data array

B. Extracting Process

Received UDP packets from the sender are extracted by the use of extracting function. The hidden data are then extracted from the audio bits and converted back to its original form and displayed on the GUI of the receiver.

- *Algorithm for extracting process*

Step 1: Get the received voice signal and save it into an array of bytes A2.
Step 2: Search the received voice data for the starting bytes (0, 255, 0, 255, 0).
Step 3: Extract the LSB of one byte of voice data array and save it into an array of bits A1.
Step 4: Increment indexes of A1 and A2.
Step 5: Repeat Step 4 and 5 until finding the ending bytes (255, 0, 255, 0, 255).
Step 6: Recombine array A1 into array of characters.
Step 7: Display the result (the array of characters) on the GUI.

V. Experimental Results

Results of VOIP call are presented below.

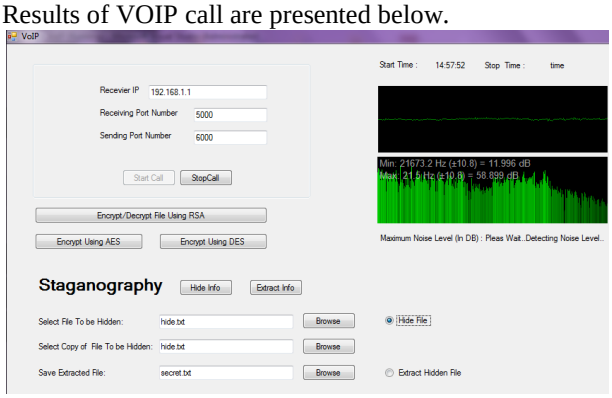

Fig.3. VOIP call steganography GUI-1

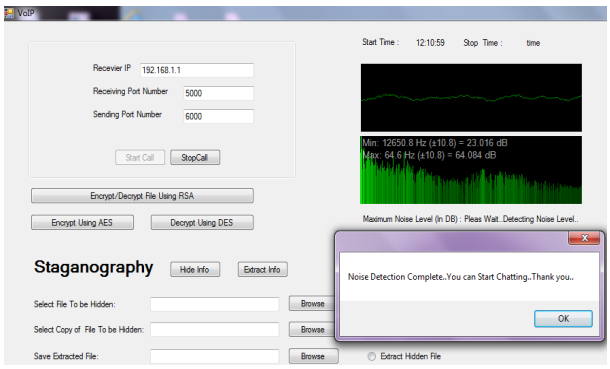

Fig.4. VOIP call steganography GUI-2

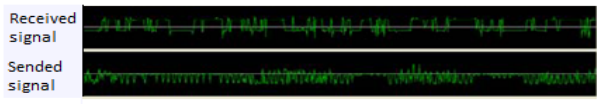

Fig.5. Screenshot of VOIP call steganography results

Different secret data with different lengths are tested as shown in table below.

1. Results of hiding different sizes of secret data

Table 1: LSB

Measure	100 Bytes	1 KB	4 KB	8 KB
Time to extract data(sec)	3	238	1380	2908

2. Capacity-The notion of capacity in data hiding indicates the total number of bits hidden and successfully recovered by the Stego system. In proposedsystem, capacity is high.
3. No effect on voice quality- the ability of the embedded data to remain intact. The proposed system is secure and robust against noise.
4. Real-time packet delivery- the concept of Steganography in real time communication VoIP lets the sender conceal the fact that he has ever sent a message; in this application there is no restriction on the length of message as more the communicators talk larger the file is sent.

VI. Conclusion and Future Scope

Steganography is an effective method of hiding data which has been used throughout history. The application 'Steganography in VoIP' is very important for the people who wish to ensure security to data they are transmitting. This software provides the communication of secret messages inside a perfectly innocent carrier i.e. voice packets. The concept of Steganography in real time communication VoIP lets the sender conceal the fact that he has ever sent a message. In this application there is no restriction on the length of message because more the communicators talk larger the file is sent. LSB technique of VoIP steganography is tested and evaluated. Proposed system is robust against noise and is high capacitive.

Future Scope: The scope of project is very vast. We will try to build the project dynamic and flexible so it can be adopted in any situations. Making the software accessible worldwide so that each and every individual can interact with our application whenever he or she is in need of it.

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