

Steganography: A Message Hiding Technique

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Abstract— Steganography is the art of hiding information and an effort to conceal the existence of the embedded information. It serves as a better way of securing message than cryptography which only conceals the content of the message not the existence of the message. It also shows the comparisons between steganography and cryptography. Original message is being hidden within a carrier such that the changes so occurred in the carrier are not observable. In this paper we will discuss how digital images can be used as a carrier to hide messages. In this paper also analyses the performance of some of the steganography tools, steganography software. Steganography is a useful tool that allows covert transmission of information over an over the communications channel. Combining secret image with the carrier image gives the hidden image. The hidden image is difficult to detect without retrieval. This paper will take an in-depth look at this technology by introducing the reader to various concepts of Steganography, a brief history of Steganography and a look at some of the Steganographic technique.

Key words: Steganography, Steganalysis, Digital watermarking, Stego key, Stego image and Cryptography

I. INTRODUCTION

Internet users frequently need to store, send, or receive private information. The most common way to do this is to transform the data into a different form. The resulting data can be understood only by those who know how to return it to its original form. This method of protecting information is known as encryption. A major drawback to encryption is that the existence of data is not hidden. Data that has been encrypted, although unreadable, still exists as data. If given enough time, someone could eventually unencrypt the data. A solution to this problem is steganography. The ancient art of hiding messages so that they are not detectable. No substitution or permutation was used. The hidden message is plain, but unsuspecting to the reader. Steganography's intent is to hide the existence of the message, while cryptography scrambles a message so that it cannot be understood. Before the invention of digital means, traditional methods were being used for sending or receiving messages. Before phones, before mail messages were sent on foot. For the messages where privacy was of prime concern, the ways of implementing security were following:

- 1) Choosing the messenger capable of delivering the message securely.
- 2) Write the message using such notations that actual meaning of the message was concealed.
- 3) Hide the message such that even its presence can't be predicted.

In steganography, the possible cover carriers are innocent looking carriers (images, audio, video, text, or some other digitally representative code) which will hold the hidden information. A message is the information hidden and may be plaintext, cipher text, images, or anything that can be embedded into a bit stream. Together the cover

carrier and the embedded message create a stego-carrier. Hiding information may require a stego key which is additional secret information, such as a password, required for embedding the information. For example, when a secret message is hidden within a cover image, the resulting product is a stego-image. A possible formula of the process may be represented as: cover medium + embedded message + stego key = stego-medium

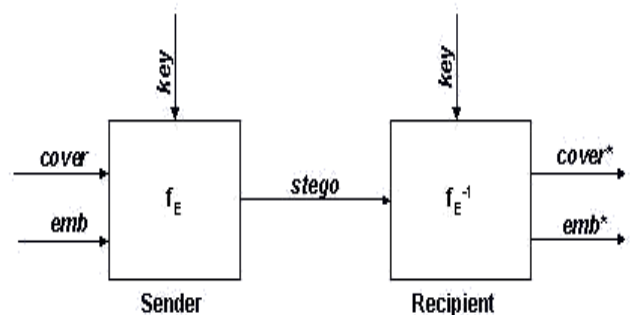


Fig. 1: Graphical Version of the Steganographic System

- f_E : steganographic function "embedding"
- f_E^{-1} : steganographic function "extracting"
- cover: cover data in which emb will be hidden
- emb: message to be hidden
- stego: cover data with the hidden message

The advantage of steganography is that it can be used to secretly transmit messages without the fact of the transmission being discovered. Often, using encryption might identify the sender or receiver as somebody with something to hide. For example, the picture of our cat could conceal the plans for our company's latest technical innovation.

II. HISTORY OF STEGANOGRAPHY

It is believed that steganography was first practiced during the Golden Age in Greece. An ancient Greek record describes the practice of melting wax off wax tablets used for writing messages and then inscribing a message in the underlying wood. The wax was then reapplied to the wood, giving the appearance of a new, unused tablet. The resulting tablets could be innocently transported without anyone suspecting the presence of a message beneath the wax.

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Later on Germans developed microdot technology which FBI Director J. Edgar Hoover referred to as "the enemy's masterpiece of espionage. Microdots are photographs the size of a printed period having the clarity of standard-sized typewritten pages. The first microdots were discovered masquerading as a period on a typed envelope carried by a German agent in 1941. The message was not

hidden, nor encrypted. It was just so small as to not draw attention to itself. Besides being so small, microdots permitted the transmission of large amounts of data including drawings and photographs.

Another common form of invisible writing is through the use of Invisible inks. Such inks were used with much success as recently as WW-II. An innocent letter may contain a very different message written between the lines. Early in WW-II steganographic technology consisted almost exclusively of invisible inks. Common sources for invisible inks are milk, vinegar, fruit juices and urine. All of these darken when heated.

III. USES OF STEGANOGRAPHY

- 1) Steganography can be a solution which makes it possible to send news and information without being censored and without the fear of the messages being intercepted and traced back to us.
- 2) It is also possible to simply use steganography to store information on a location. For example, several information sources like our private banking information, some military secrets, can be stored in a cover source. When we are required to unhide the secret information in our cover source, we can easily reveal our banking data and it will be impossible to prove the existence of the military secrets inside.
- 3) Steganography can also be used to implement watermarking. Although the concept of watermarking is not necessarily steganography, there are several steganographic techniques that are being used to store watermarks in data. The main difference is on intent, while the purpose of steganography is hiding information, watermarking is merely extending the cover source with extra information. Since people will not accept noticeable changes in images, audio or video files because of a watermark, steganographic methods can be used to hide this.



Fig. 2: Steganography Types

- 4) E-commerce allows for an interesting use of steganography. In current e-commerce transactions, most users are protected by a username and password, with no real method of verifying that the user is the actual card holder. Biometric finger print scanning, combined with unique session IDs embedded into the fingerprint images via steganography, allow for a very secure option to open e-commerce transaction verification.
- 5) Paired with existing communication methods, steganography can be used to carry out hidden exchanges. Governments are interested in two types of hidden communications: those that support

national security and those that do not. Digital steganography provides vast potential for both types. Businesses may have similar concerns regarding trade secrets or new product information.

- 6) The transportation of sensitive data is another key use of steganography. A potential problem with cryptography is that eavesdroppers know they have an encrypted message when they see one. Steganography allows to transport of sensitive data past eavesdroppers without them knowing any sensitive data has passed them. The idea of using steganography in data transportation can be applied to just about any data transportation method, from E-Mail to images on Internet websites.

IV. STEGANOGRAPHY AND CRYPTOGRAPHY

A. Comparison of Steganography and Cryptography:

Steganography and cryptography are closely related. Cryptography scrambles messages so it can't be understood. Steganography on the other hand, hide the message so there is no knowledge of the existence of the message.

- Cryptography is about protecting the content of messages (their meaning).
- Steganography is about concealing the existence of messages
- Watermarking is about establishing identity of information to prevent unauthorized use
 - They are imperceptible
 - They are inseparable from the works they are embedded in
 - They remain embedded in the work even during transformation

B. Combination of Steganography and Cryptography:

Those who seek the ultimate in private communication can combine encryption and steganography. Encrypted data is more difficult to differentiate from naturally occurring phenomena than plain text is in the carrier medium. There are several tools by which we can encrypt data before hiding it in the chosen medium.

In some situations, sending an encrypted message will across suspicion while an invisible message will not do so. Both methods can be combined to produce better protection of the message. In case, when the steganography fails and the message can be detected, it is still of no use as it is encrypted using cryptography techniques.

V. STEGANALYSIS

Steganalysis is "the process of detecting steganography by looking at variances between bit patterns and unusually large file sizes". It is the art of discovering and rendering useless covert messages. The goal of Steganalysis is to identify suspected information streams, determine whether or not they have hidden messages encoded into them, and, if possible, recover the hidden information. Unlike cryptanalysis, where it is evident that intercepted encrypted data contains a message.

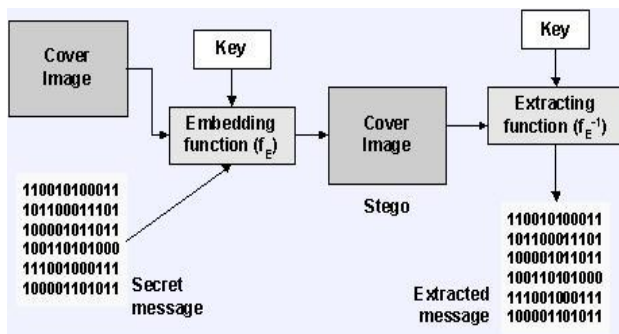


Fig. 3: A Graphical Version of the Steganographic System

Steganalysis generally starts with several suspect information streams but uncertainty whether any of these contain hidden message. The steganalyst starts by reducing the set of suspect information streams to a subset of most likely altered information streams. This is usually done with statistical analysis using advanced statistics techniques.

VI. STEGANALYSIS TECHNIQUES

Hiding information within an electronic medium cause alteration of the medium properties that can result in some form of degradation or unusual characteristics

A. Unusual Patterns:

Unusual patterns in a stego image are suspicious. For example, there are some disk analysis utilities that can filter hidden information in unused partitions in storage devices. Filters can also be used to identify TCP/IP packets that contain hidden or invalid information in the packet headers. TCP/IP packets used to transport information across the Internet have unused or reserved space in the packet headers

B. Visual Detection:

Analyzing repetitive patterns may reveal the identification of a steganography tool or hidden information. To inspect these patterns an approach is to compare the original cover image with the stego image and note visible differences. This is called a known-carrier attack.

By comparing numerous images it is possible that patterns emerge as signatures to a steganography tool. Another visual clue to the presence of hidden information is padding or cropping of an image. With some stego tools if an image does not fit into a fixed size it is cropped or padded with black spaces.

There may also be a difference in the file size between the stego-image and the cover image. Another indicator is a large increase or decrease in the number of unique colors, or colors in a palette which increase incrementally rather than randomly.

C. Tools to Detect Steganography:

The disabling or removal of hidden information in images is dependent on the image processing techniques. For example, with LSB methods of inserting data, simply compressing the image using lossy compression is enough to disable or remove the hidden message. There are several available steganographic detection tools such as Encase by Guidance Software Inc., ILook Investigator by Electronic Crimes Program, Washington DC, various MD5 hashing utilities, etc.

1) RSA Algorithm:

Encrypting using RSA, we encrypt our data that is hidden in an image. Hackers cannot identify hidden data in images easily and at most they can get encrypted data from images which will not reveal any confidential information.. Care should be taken during the selection of prime numbers, so that hacker will not able to reveal key to decrypt.

2) MD5 Algorithm:

MD5 algorithm provides data integrity. Message digest is sent along encrypted data which is hidden in image. At receiver side, receiver first get data from image, decrypt it and then find message digest using same algorithm and compare it with original message digest. If they are same, data isn't tempered. Hence data integrity is maintained.

VII. SOFTWARE OF STEGANOGRAPHY

A. EZStego (Stego Online, Stego Shareware, Romana Machado):

- Java based software program which supports only GIF and PICT formats;

B. Gif-It-Up v1.0 (Lee Nelson):

- A stego program for Windows 95 that hides data in GIF files

C. Hide and Seek (Colin Maroney):

- can hide any data into GIF images;

D. JPEG-JSTEG (Derek Upham):

- can hide data inside a JPEG file

E. MP3Stego (Fabien A.P. Petitcolas, Computer Laboratory, University of Cambridge):

- can hide data inside MP3 sound files;

F. Steganos (Demcom, Frankfurt, Germany) encrypts files and then hides them within BMP, DIB, VOC, WAV, ASCII and HTML files.

VIII. WORKING OF STEGANOGRAPHY

All of the approaches to steganography have one thing in common that they hide the secret message in the physical object which is sent. The following figure shows the steganography process of the cover image being passed into the embedding function with the message to encode resulting in a steganographic image containing the hidden message. A key is often used to protect the hidden message. This key is usually a password, so this key is also used to encrypt and decrypt the message before and after the embedding. Secrets can be hidden inside all sorts of cover information: text, images, audio, video and more. However, there are tools available to store secrets inside almost any type of cover source. The most important property of a cover source is the amount of data that can be stored inside it, without changing the noticeable properties of the cover.

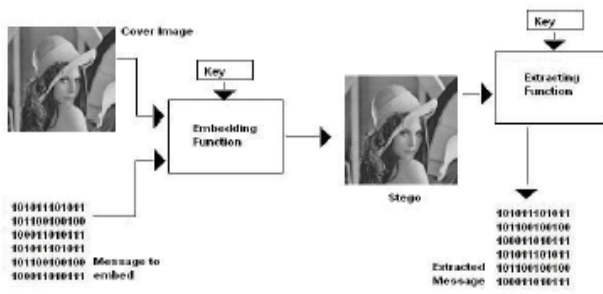


Fig. 4: Steganography Procedure

In this phase, here we are going to implement steganography technique on the following images.

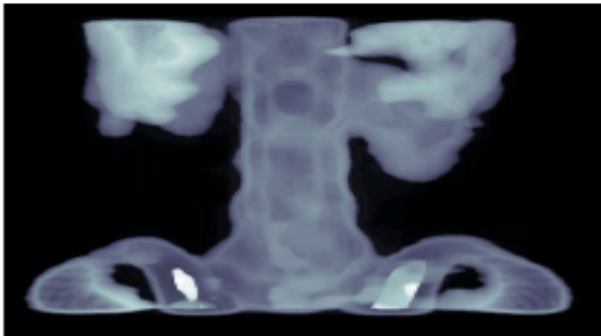


Fig. 5: Cover Image



Fig. 6: Secret Image

The figure 8.2 is our Cover Image and Figure 8.3 is our Secret Image. After applying this technique on it we get the following image. This will be known as Stego Image.



Fig. 7: Stego Image

After implementation of this technique if we take a look on the histogram of both the images cover image and stego image respectively we will find both are very different from each other. The following figures show the histogram of cover image and stego image.

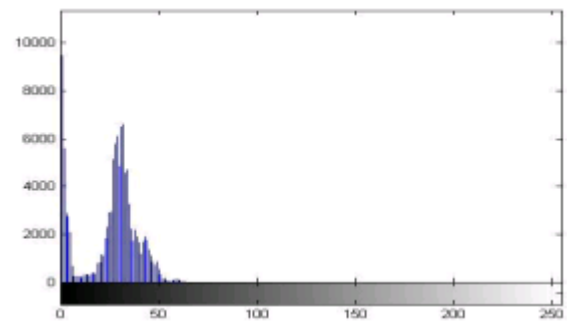


Fig. 8: Histogram of Cover Image

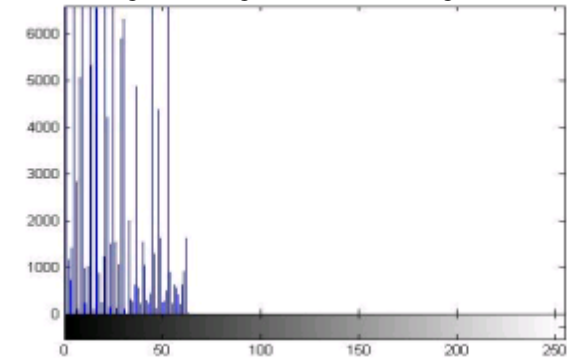


Fig. 9: Histogram of Stego Image

The above two Figure 8.5 shows the histogram of our Cover Image and Figure 8.6 shows the histogram of Stego Image. Both the images are different from each other.

IX. STEGANOGRAPHY SOFTWARE APPLICATION

A. Digital Watermarking;

Digital watermarking is the process of embedding information into a digital signal in a way that is difficult to remove. The signal may be audio, pictures or video, for example. If the signal is copied, then the information is also carried in the copy. A signal may carry several different watermarks at the same time.

1) Visible Watermarking:

In this, the information is visible in the picture or video. Typically, the information is text or a logo which identifies the owner of the media. When a television broadcaster adds its logo to the corner of transmitted video, this is also a visible watermark.

2) Invisible Watermarking:

In this, information is added as digital data to audio, picture or video, but it cannot be perceived as such (although it may be possible to detect that some amount of information is hidden). The watermark may be intended for widespread use and is thus made easy to retrieve or it may be a form of Steganography, where a party communicates a secret message embedded in the digital signal. In either case, as in visible watermarking, the objective is to attach ownership or other descriptive information to the signal in a way that is difficult to remove. It is also possible to use hidden embedded information as a means of covert communication between individuals.



Fig. 10: Invisible Watermarking

Digital Watermarking can be used for a wide range of applications such as: Copyright protection Source Tracking (Different recipients get differently watermarked content). The numbers of possible applications for digital watermarking technologies are increasing rapidly. For example, in the field of data security, watermarks may be used for certification, authentication, and conditional access. Certification is an important issue for official documents, such as identity cards or passports. Digital watermarks are created by converting copyright information into apparently random digital "noise" using an algorithm that is imperceptible to all but special watermark reading software. So while a JPEG file that is read by a Web browser may display a pretty picture, that same file will display the copyright when read by the watermark software.

X. CONCLUSION AND FUTURE SCOPE

Steganography transmits secrets through apparently innocuous covers in an effort to conceal the existence of a secret. Digital image steganography and its derivatives are growing in use and application.

In areas where cryptography and strong encryption are being outlawed, citizens are looking at steganography to circumvent such policies and pass messages covertly. As with the other great innovations of the digital age: the battle between cryptographers and cryptanalysis, security experts and hackers, record companies and pirates, steganography and Steganalysis will continually develop new techniques to counter each other.

In the near future, the most important use of steganographic techniques will probably be lying in the field of digital watermarking. Content providers are eager to protect their copyrighted works against illegal distribution and digital watermarks provide a way of tracking the owners of these materials. Steganography might also become limited under laws, since governments already claimed that criminals use these techniques to communicate.

The possible use of steganography technique is as following:

- Hiding data on the network in case of a breach.
- Peer-to-peer private communications.
- Posting secret communications on the Web to avoid transmission.
- Embedding corrective audio or image data in case corrosion occurs from a poor connection or transmission.

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