A Secured Delivery Scheme for Images

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Abstract. Computer and Network security of late has become a major issue with the advent of Internet. Presently, many software tools are available to implement data security. In this paper, we have proposed a new technique to hide an image file entirely with in another image file keeping two considerations in mind which are Size and Degree of Security. At the source, the image which is to be hidden (target image) is encoded at the end of another image (cover image). Double layer security of the hidden image can be achieved (over the untrusted network) by; firstly, the starting point of encoding the image data is depended on the size of the images and it is stored within the encoded image at the end of its header information as a cipher text.; secondly, the target image is hidden behind the cover image by following our encrypted image hiding technique.

Keywords: Network, image, security, encryption, hiding.

1 Introduction

Data hiding can be defined as the process by which a message signals or image is imperceptibly embedded into a host or cover to get a composite signal. Steganography is the art and science of writing hidden messages in such a way that no one apart from the sender and intended recipient even realizes there is a hidden message. Generally, in steganography, the actual information is not maintained in its original format and thereby it is converted into an alternative equivalent multimedia file like image, video or audio which in turn is being hidden within another object. This apparent message (known as stego-object in usual terms) is sent through the network to the recipient, where the actual message is seperated from it.

In this paper, we have considered some important features of data hiding. Our first consideration is that of embedding information into image, which could survive attacks on the network. Next, a hybrid digital embedding technique is proposed for hiding an image into another image in such a way that the quality of the recovered image improves significantly. Also to make the proposed scheme to run free of size constraints, we have introduced the concept of Padding before doing the actual hiding.

Another important feature, conceived in the encryption process of the images is Multilayered Security. Here, firstly the size difference of the two considered images (target and cover image) is hidden in an encrypted format with in the cover image. After that the entire target image is hidden at the end of the cover image by following our encryption technique which is described in the section-III.C. Thus if the ultimate object to be transferred gets snooped from the information channel, then also from it no way the information can be retrieved.

Lastly, in most of the algorithms designed based on the principle of Steganography, requires the sending original cover image along with the encoded cover image to the receiver. This approach makes the designed algorithm weaker as it conveys some idea of data hiding to the eavesdropper. But our method covers this lack as here only the encoded image will be sent to the receiver.

To the best of our knowledge, this work is specifically focused on protection of any information which is in the form of image. The design of this technique is based on extensive analytical as well as experimental modeling of the data-hiding process.

2 Related Works

The majority of today's steganographic systems uses images as cover media because people often transmit digital pictures over email and other Internet communication. Several methods exist to employ the concept of Steganography as well as plenty algorithms have been proposed in this regard. To gather knowledge regarding our approach, we have concentrated on some techniques and methods which are described below.

The next interesting application of steganography is developed by Miroslav Dobsicek [1], where the content is encrypted with one key and can be decrypted with several other keys, the relative entropy between encrypt and one specific decrypt key corresponds to the amount of information.

Min Wu and Bede Liu, June, 2003, proposed [2] a new method to embed data in binary images, including scanned text, figures, and signatures. The method manipulates "flippable" pixels to enforce specific block based relationship in order to embed a significant amount of data without causing noticeable artifacts. They have applied Shuffling before embedding to equalize the uneven embedding capacity from region to region. The hidden data can then be extracted without using the original image, and can also be accurately extracted after high quality printing and scanning with the help of a few registration marks.

F. Bartolini, A. Tefas, M. Barni and I. Pitas discussed the problem of authenticating video surveillance image. After an introduction used to stimulate the need for a watermark-based authentication of VS (Video Surveillance) sequences, a brief survey of the main watermark-based authentication techniques has been presented and the requirements that an authentication algorithm should satisfy for VS applications are discussed. A novel heuristic approach which is suitable for VS visual data authentication has been proposed [3].

Mark A. Masry, 2005, proposed a novel blind watermarking algorithm designed for map and chart images. The algorithm segments the image into homogeneous regions and adds multiple watermark signals to the locations of the pixels on the boundary of several regions. The presence of these signals in the watermarked image is determined using a correlation based detector. The watermarks can be detected in the presence of synchronization errors such as those incurred by cropping the image, or shifting by several columns or rows, and in the presence of noise. The algorithm is designed to efficiently process typical map images [4].

Rehab H. Alwan, Fadhil J. Kadhim, and Ahmad T. Al- Taani, 2005, have explained a method with three main steps [5]. First, the edge of the image is detected using Sobel mask filters. Second, the least significant bit LSB of each pixel is used. Finally, a gray level connectivity is applied using a fuzzy approach and the ASCII code is used for information hiding. The prior bit of the LSB represents the edged image after gray level connectivity, and the remaining six bits represent the original image with very little difference in contrast. The given method embeds three images in one image and includes, as a special case of data embedding, information hiding, identifying and authenticating text embedded within the digital images.

Yusuk Lim, Changsheng Xu and David Dagan Feng, 2001, described the web-based authentication system consists of two parts: one is a watermark embedding system and the other is authentication system. In case of watermark embedding system, it is installed in the server as application software that any authorized user, who has access to server, can generate watermarked image. The distribution can use any kind of network transmission such as FTP, email etc. Once image is distributed to externally, client can access to authentication web page to get verification of image [6].

In 2007, Nameer N. EL-Emam proposed an algorithmic approach to obtain data security using LSB insertion steganographic method. In this approach, high security layers have been proposed through three layers to make it difficult to break through the encryption of the input data and confuse steganalysis too [7].

Unfortunately, modifying the cover image changes its statistical properties, so eavesdroppers can detect the distortions in the resulting stego-image's statistical properties. In fact, the embedding of high-entropy data (often due to encryption) changes the histogram of colour frequencies in a predictable way. So, in order to obtain more security in our prescribed method, we have embedded an entire image behind another image by modifying discrete zone of pixels. By selecting discrete zone, we have tried to avoid any remarkable change in the cover image.

3 Our Work

Before going into the details of the algorithm proposed here for invisible watermark of the information behind the cover object, it is better to mention about the selection of the images and information which are to be steganographed. Here in this paper, the algorithm is basically implemented over normal bitmap image file, but it should be clarified that the same scheme can be extended to operate over other file formats also. The image file which is to be hidden is here referred as TargetImage and the image behind which it is to be hidden is termed as CoverImage. The selection of neither the TargetImage nor the CoverImage is constrained by any size limit.

After selecting the pictures, we have to pad the CoverImage with required white spaces, i.e., addition of extra white pixels if the size of it is less than the TargetImage. The padding will be done in such a way that after padding the size of the CoverImage will be equal to the size of the TargetImage in addition with 57. In the CoverImage, apart from the header information (54 bytes) three extra bytes are taken to store the size difference of the padded CoverImage and the TargetImage in an encoded format. In next attempt, the entire TargetImage will be hidden in the CoverImage starting from byte position whose value will be equal to size by following our data hiding technique.

It is better to be confessed that the method for encryption can be personalized, i.e., can be selected according to the user needs. But, the authors specifically suggests this specialized scheme, proposed in this paper, as because here the information are no longer being merged or masked with another and instead of that keeping the TargetImage as a key the information in the carrier, i.e., the CoverImage is altered to obtain resultant image which is taken as FinalImage. Thus no essence of the actual information is retrained in the FinalImage, whereas in usual methods of the mostly done bitwise merging; the information belongs in encrypted way directly merged into final object obtained.

3.1 SDSI_MAIN (TargetImage, CoverImage)

This is the main function in our algorithm. This function will be used in the sender side and will call other modules of our algorithm like Padding and Encryption. Arguments: This function will take TargetImage and CoverImage as argument and finally it will output the encoded stego-image.

1. Obtain the size of the TargetImage and store it as TargetImageSize.
2. Now choose the CoverImage and obtain its size and store it in CoverImageSize.
3. Now check the TargetImageSize and the CoverImageSize. If the TargetImageSize is greater than the CoverImageSize then call the PAD module with argument CoverImage and newSize where newSize is equal to the sum of TargetImageSize and 57.
4. Next obtain the difference of CoverImageSize and TargetImageSize and store it in Size.
5. Now call the SDSI_ENC module to hide the TargetImage behind the CoverImage with arguments CoverImage, TargetImage and size and thereby obtain the finalImage.
6. Send only the finalImage over the network to reach the intended destination.

3.2 PAD (PICTURE, SIZE)

This function is used in the algorithm to pad an image to obtain an image of the desired size from the input image.

Arguments: This function will take the image, which has to be padded along with the desired image size which is to be obtained after padding.

1. Obtain the width, length of the pixel matrix of the PICTURE (say R_P and C_P).
2. Fill pixels with white color until R_P* C_P*DPI >= SIZE.
   Here DPI stands for Depth per Index.
3. Return the PICTURE.

3.3 SDSI_ENC (PICTURE_1, PICTURE_2, SIZE)

This function is used in the algorithm to encrypt an image with the help of either same image (self encryption) or another image to obtain an encrypted image of the desired size.

Arguments: This function will take the cover image (PICTURE_1) in which another image will be hidden; the target image (PICTURE_2), which will be hidden, and finally it will output the stego-image as final image.

1. Read the bytes from starting of the PICTURE_1.
2. Repeat step 1 if numbers of bytes read is not equal to 54 (header size for a BMP image).
3. Obtain the octal format of SIZE and count the number of digits present in that format and store it in a variable say key.
4. Read the next byte of PICTURE_1 and replace it with key.
5. Next read key number of bytes of PICTURE_1 and replace each of them with the digits present in the octal format of SIZE staring from Left.
6. Read the first byte of the PICTURE_2.
7. If the value of the read byte is 0 then replace the current byte of the PICTURE_1 with 255 and read the next byte of PICTURE_1 and PICTURE_2. Otherwise go to the next step.
8. If the value of the read byte is 255 then replace the current byte of the PICTURE_1 with 0 and read the next byte of PICTURE_1 and PICTURE_2. Otherwise go to the next step.
9. If the value of the read pixel is greater than 0 and less than 255 then do the following operations. byte” = byte’ + SPN where byte’ is the corresponding byte of the PICTURE_1 and SPN is the sum of prime numbers starting from 0 to SIZE.
10. Now if the calculated byte” is greater than 255 then calculate: byte”’ = byte” – 255 and replace the current byte of PICTURE_1 with byte”’. Read the next byte of PICTURE_1.
11. Read the next byte of PICTURE_2 and go to step 4.
12. Now if the condition of the step 10 is false then replace the current byte of PICTURE_1 with byte” and read the next byte of PICTURE_1 and go to step 11.

13. Repeat the above steps from 7 to 12 until the end of any image is reached.
14. Return PICTURE_1 as final image.

3.4 SDSI_ENC (PICTURE_I, PICTURE_2, SIZE)

This function is used in the algorithm to decrypt an image with the help the original image to obtain a hidden image. This module will be executed in the receiver's side.

Arguments: This function will take only the source image (PICTURE_1) which has to be decrypted as this algorithm only requires the final stego-image to obtain the image behind it.

1. Read the bytes from starting of the PICTURE_1.
2. Repeat step 1 if numbers of bytes read is not equal to 54 (header size for a BMP image).
3. Read the next byte of PICTURE_1 and store it in a variable say key'.
4. Next read key' number of bytes of PICTURE_1 and store each of them in an array of bytes.
5. Obtain the entire array from the above step. Now perform the following operation :
   SIZE' = $\sum$ array[i] * 8^i where i varies from 0 to (key' – 1). This step is performed to locate the starting position of the hidden image within PICTURE_1.
6. Go to the byte number SIZE' of PICTURE_1.
7. Open a new image file say PICTURE_2.
8. If the value of the read byte from PICTURE_1 is 0 then store 255 in the PICTURE_2.
9. If the value of Pixel' is 255 then store 0 in the PICTURE_2.
10. Now if the value of read byte is greater than 0 and less than 255 then calculate: byte1 = byte - SPN and store byte1 in the PICTURE_2. Here SPN determines Sum of Prime Numbers in between 0 and SIZE'.
11. Now if the calculated byte1 is greater than 255 then calculate: byte11 = byte1 + 255 and store it in PICTURE_2.
12. If the condition of the above step is false then simply store byte1 in PICTURE_2.
13. Read the next byte of PICTURE_1 and go to step 8.
14. Return PICTURE_2.

4 Result and Discussion

The stated Algorithm has got five distinct divisions, a. main function which calls next three sections; b. Arrange: to calculate desired row and column of pictures; c. Pad: to pad the images as per row-column given by previous sections; d. Encryption; e. Decryption.

4.1 Complexity analysis of the stated algorithm

For Padding (Section III.B): To pad an image row wise, then we $O(n^2)$ is incurred. Again to pad an image column wise, complexity of $O(n^2)$ has incurred. So, overall time complexity becomes $O(2*n^2)$.

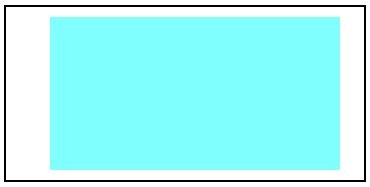
For Encryption and Decryption (Section III.C and Section III.D): For each row wise and column wise scan is being done. So, each one requires time of $O(rowsize*columnsize) \equiv O(n^2)$.

In this algorithm, operation is being done byte wise. So, no need of remembering whole pixel matrix is required. Thus amount of space required to run this algorithm comes under O(log n) and thereby it becomes an inplace algorithm.

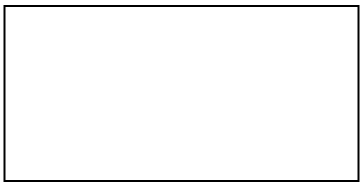
4.2 Test Results

To test the algorithm, we have chosen one cover image having size 350000 Bytes and one target image having size 97300 Bytes and they are shown in Figure 1. Now clearly size of the cover image is greater than the size of the target image. So, calling of the PAD module of our algorithm is not required. Next, we have calculated the size parameter of our algorithm and here it is 253700 Bytes. So, according to the algorithm the value of key is 6 and the octal representation of the parameter size is 757404. That means 55th no. byte will be modified with key and stating from 56th no. byte to (key+55) no. byte will be modified by the digits present in the octal format of size starting from left.

In next, we have to move to the byte position size of the cover image and then we have to modify the successive bytes depending on the target image.



Cover Image [351000 Bytes]



Target Image [97300 Bytes]

Fig. 1. Cover Image and Target Image

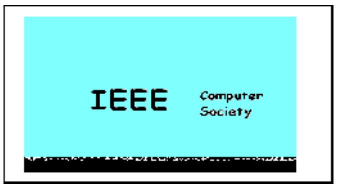


Fig. 2. Final Image

Fig. 3. Retrieved Target Image [97300 Bytes]

The resultant output Image shown in Fig. 2 after the execution of Encryption algorithm; in our case it is SDSI_ENC Algorithm. Only Final Image will be sent to the receiver.

The resultant output Image shown in Fig. 3 after the execution of Decryption algorithm; in our case it is SDSI_DEC Algorithm.

5 Conclusion

In this paper the major emphasis is given on the size and computational complexity, which incurs at the time of doing any operation in Steganographic approach. Most of the steganographic algorithms deal with two images at the receiver side in order to retrieve the original message. But this attempt led the intruders a way to guess the source of hidden communication.

In this paper, the authors implemented the basic algorithm through bitmap pictures, but there is no such constraint over selection of file format, i.e., the same procedure can be realized through any of available multimedia file formats. It is thereby expected that any kind of future endeavor in this field will definitely route it a path to design a secure system using the proposed algorithm for both Internet and Mobile Communication Technology.

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