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Secured Data Transmission Using Wavelet Based Steganography and Cryptography by Using AES Algorithm

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Abstract

Steganography and cryptography methods are used together with wavelets to increase the security of data while transmitting through networks. In discrete wavelet transform, “analysis filter bank “can be used for analyzing image signal by passing through it.. This filter bank consists of a low pass and a high pass filter at each decomposition stage. The digital watermarking plays an important role in embedding information into a digital image signal, for verification and identity of its owners. In this paper the embedded information is applied as text. Before embedding the text in image, text is encrypted using Advanced Encryption Standard (AES) algorithm. The text can be a sentence or a key with alphabetic words having the length of 8 characters. Using Least Significant Bit (LSB) method, the encrypted text is embedded into the “LL sub-band wavelet decomposed image”. The inverse wavelet transform is applied and the resultant image is transmitted to the receiver. Now at the receiver‟s end, the image transformed using wavelet and encrypted text is extracted by using LSB method. The paper also shows how the AES algorithm is used in decryption of result.

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Keywords: Steganography, cryptography, watermarking, discrete-wavelet, Encryption, Decryption

1. Introduction

Data security is paramount concern for all the net users irrespective of the network. The present day hackers are a threat to the data and the threat hangs like a Damocles sword. The transmission of data through any channel of

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communication needs strong encryption techniques for the purpose of data security. The recent trends and development in information technology highlights the need for safe, secure and protected transmission of data. The conventional encryption methods failed to give the desired result of protecting the data. Simple way is to come up with unique id and passwords, and a combination of alphabets & numerical .AES has emerged as a frontrunner and efficient algorithm because of inherent inbuilt in advantage of better security with less implementation complexity. After extensive research in image coding, for image compression application, DWT [13] works as a standard tool, for their data reduction capability. The complete image is compressed and transformed into a single data object by wavelet compression system, rather than block by block as in a DCT-based compression system. When the entire image is achieved there will be a uniform distribution of compression error across that image. An image resolution enhancement in the wavelet domain is a subject of interest for further research and recently many new algorithms have been proposed. Of these the Discrete Wavelet Transforms (DWT) is the most-suited application. DWT decomposes an image into different sub-band images. Which can be named as low-low (LL), low-high (LH), high-low (HL), and high-high (HH).Here the sub-bands have the same size as the input image. Xuan et al.‟s method is based on the integer wavelet transform to improve the embedding capacity [1].

1.1. Present Associated Work

Now days, data hiding techniques are needed to conceal a number of applications. For such as digital images, audio, and video. Today it includes distinguishing and imperceptible marks that contain a hidden copyright notice or serial number to help and prevent from unauthorized copying [2, 3,4]. Cryptography is a technique for storing and transmitting data in a specified form. It is closely related to scrambling plaintext i.e. ordinary text into *cipher text* (i.e. a process called encryption), then back again for getting plain text named as decryption. Cryptography can also be categorized as symmetric key cryptography and asymmetric key cryptography [14,16].The symmetric key cryptography is also defined as private-key cryptography, where the secret key may be held by the person concerned or a copy of the private key cryptography may share the massage by sender and receiver. Asymmetric key cryptography also called public key system is a two-key system, in which one key encrypts the information and the other one decrypts it. The encrypted message has a private key which is never shared while only the sender knows it. If the system encrypted the message with the proposed receiver‟s public key and then again with the sender‟s secret key or private key, then the receiving system may decrypt the message by first manipulating its secret key and then by the sender‟s public key. Using this method the sender and the receiver may be able to confirm one another and also maintain the secrecy of the given message. Nowadays, steganography is basically considered a sub-discipline of digital data communication security domain [57]. Steganography is a technique used to hide information in some covered media. The term “Steganography” is derived by combining two Greek words i.e “steganos “ and “ Graphy” , where “Steganos” means „covered‟ or „secret‟ and “Graphy “ means „writing‟ or „covered data‟. In Steganography the existence of information will not be noticed by viewers as it is embedded inside some medium. This medium is referred to as „covered object‟ or „data‟.

The main function of Steganography is to convey the information secretly by concealing in media such as image, audio and video and also implementing watermarking. To hide the secret information, the message is embedded in cover text by using some embedding algorithm, so that the “stego text “or “cipher text” is formed. The text is subsequently delivered to the receiver through transmission channel. The same stego text is processed by the extraction algorithm using “secret key “or the “stego key”. The image Steganography following the concept of “what you see is what you get” ,allows the two parties to communicate secretly by allowing copyright protection and using digital watermark. Least significant bit incorporation is a general approach for embedding information in a cover image. In the proposed research the LSB technique is used in the concept of 24 bit image or 8-bit image. The 24-bit image is embedded with three bits of information one in each pixel. One in each Least Significant bit position of the three 8-bit values, either increases or decreases, while the value of changing the Least Significant Bit does not change the appearance of the image. So the stigma image remains same as the cover image. Least Significant Bit (LSB)-substitution make replaces the least significant bit with a secret bit stream. While LSB matching is either added or subtracted randomly from the pixel value of the cover data , the embedding bit does not match. The revised LSB matching was proposed to improve by applying lowering the number as a modification [8]. To improve the image quality, the optimal LSB

substitution [9], the approximately optimal LSB substitutions based on genetic algorithm [10], and the modulus LSB substitution [11] proposed. The past , research study interpolation methods were used to improve image quality and embedding capacity. The present study attempts to we define a semi-reversible data hiding ,which was introduced by Jung and Yoo to analyze the proposed method [12].

In the 8-bit ,one bit of information could be hidden. Now any one can hide a message in three pixels of an image. The original three pixels are (11101010 11101000 11001011) (01100110 11001010 11101000) (11001001 00100101 11101001)

A steganographic system can hide the letter “A” which has a position 65 into ASCII character set and has a binary representation “1000001”by altering the channel bits of pixels.

(11101011 11101000 11001010)
(01100110 11001010 11101000)
(11001000 00100100 11101001)

In this case, only four bits are changed to insert the character “A” successfully. So changes that are made to the LSBs are very small invisible to the human eye. That‟s why the message is effectively hidden.

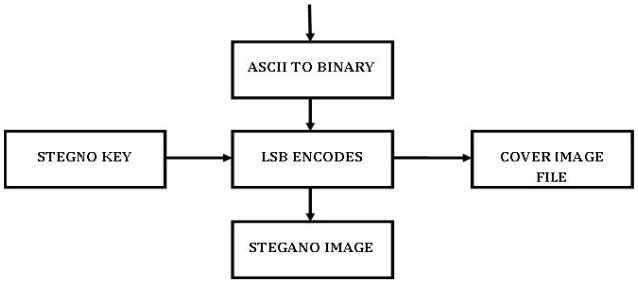


Figure 1: LSB Insertion mechanism

2. PROPOSED METHODOLOGY

In this paper, a new method is used to send the data in a more secured manner. The given text which is to be transmitted is encrypted with one of the symmetric key techniques: AES with the given key. In this process by using the key, the given text is encrypted. Then this resultant text is decrypted with the same key. (Here, the key is of length 56-bit.) Then, that cipher text is embedded into the LL subband of the wavelet transformed image. The method to embed the data is the Least Significant Method. This method is described in Algorithm-1. Note that, as we are modifying the LSB (±1 or no change to the given pixel value) since our human eye cannot find the difference between the original image and the watermarked image. Once the cipher text is embedded into the LL subband, inverse wavelet transform is applied. Then this resultant image is sent to the receiver.

2.1. Algorithm-1: Least Significant Method

Begin Step-1: Read the value of the pixel. Step-2: Convert it to its equivalent binary form. Step-3: Modify the least significant bit accordingly.

End. At the receiver‟s end, the receiver does the forward wavelet transform of the received image. Now, from the LL subband, the text is extracted. The extracted text which has encrypted form is decrypted using the one key. The wavelet-based steganography has a new concept irrespect of application of wavelets[15]. Here the information is stored in terms of wavelet coefficients of an image. But in the LSB technique there is a change in the bits of actual

pixels.

2.2. Algorithm: HAAR WAVELET

The HAAR transformation returns many coefficients that are 0, or closed to 0. After taking a haar transform of some image, the idea is to hide bits in the coefficients that are below some threshold value, the same being the haar inverse of the modified data. Theoretically it is observed that there should not be much modification of the image because we are hiding the bits insignificant coefficients.

Implementation:

ENCODE:

1. Take the wavelet transform of an image.
2. Find the coefficients below a threshold value.
3. Replace these bits with bits of data to be hidden.
4. Take inverse transform.
5. Store it as a regular image, in any standard format.

DECODE:

1. Take the wavelet transform of an image.
2. Find the coefficients below a threshold value.
3. Extract the bits of data from these coefficients.
4. Combine the extracted data bits into an actual message Output the message or data.

2.3. AES DATA

Advanced Encryption Standard (AES) is a symmetric encryption algorithm in which we can use only one key for both encryption and decryption that can be used by sender and receiver. In AES we can use 128,192 or 259 bits long with each of them contains 2128,2192 and 2256 combinations. The secrecy maintained by the key is secured **and** authentication is maintained the key itself. In this both the keys must be kept secret. But without knowing private key or at least other information impossible to decode the cipher text. With the help of public key and algorithm it must be insufficient to find the private key. We need secrecy and authentication, only one key is enough that is private key for encryption. In cryptographic solutions DES and AES will provide the security but from cryptography point of view they differ one is symmetric and another one is asymmetric. AES key is harder to break than DES, and both need more dealing out to distribute keys between sender and receiver. The AES algorithm formulated in the figure below.

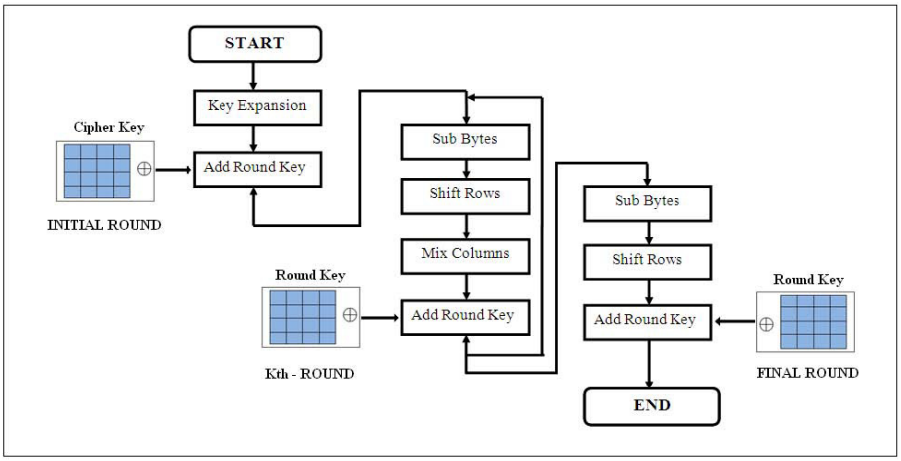


Figure 2: AES algorithm

2.4. Conversion from Plain Text to Cipher Text

AES is a block cipher. It operates on plain text with a block of bits and returns cipher text with the same size. In this algorithm we have performed 10/12/14 rounds. It contains the byte substation, shift rows, mix columns and then add round key. The sub-stution of each byte uses one table with a 16x16 bytes and it contained a permutation of all specified values. Each byte of state is replaced by the byte indexed with row and column. In shift rows is used circular byte. Shift in each, the 1st row is unchanged and the 2nd row is 1 byte circular shift to the left and the 3rd row is 2 bytes circular shift to the left likewise it may process and decrypt inverts using circular shift to right. In the mix columns, each column is processed and separated and each byte is replaced by a value dependent on all bytes in the column. And add round key is a XOR state with 128-bits of key processed by column and inverse for decryption.AES decryption is not identical to encryption since the steps done in reverse order but is defined as equivalent inverse cipher with steps as for encryption by using inverse of each step with a different key.

3. Implementation

3.1. Selecting an Image file

First, select any image file, behind which the user wants to hide data. The image which is selected should have fixed height and width. Now save the image file as in jpeg extension and the image appears as an original image file.

3.2. Image Steganography

For Sender Side

In this, The sender will select the original image in jpeg extension format. Now the sender read the file using „imread" function. And convert the image file from rgb to gray using a function „rgb2gray". After this read the text and convert that text into a binary format. Then the key is read and the text is converts into encrypted format .When the wavelet transformation function i.e. sumdiff() is used .The image can divide into the sub bands as LL , LH, HL , HH. The binary cipher has to be put into LL Sub band by using embeddingfunc(). We can apply the inverse wavelet transformation function and convert the image into its original size. And the image is sent to the receiver.

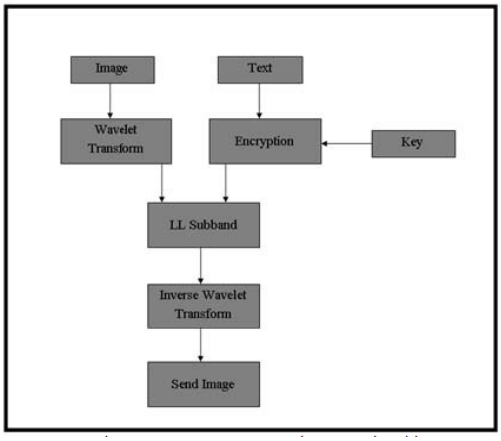


Figure 3: Image Stenography at Sender Side

Creating Stego Image file

For creating stegno Image file, combine stego text file and stego image file using digital watermarking. This forms the stego image text file at transmitter side in which hidden text is present.

3.3. For Receiver Side

When the receiver reads the text file using „fread‟ it gets converted into an image. For this receiver apply the wavelet transformation function i.e., sumdiff( ) and divide the image into four sub bands as LL, LH, HL, HH. Now choose the required LL sub band from the image. Using extractionfun2 ( ) to extract the code from image and convert it into hexadecimal format and then store it into a variable „extra1‟.Now decrypt the encrypted code by using „des1keydecrfunc ( )‟.

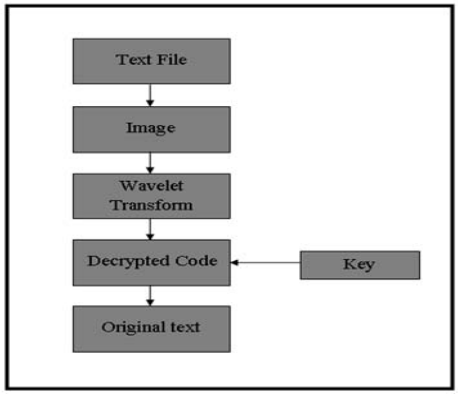


Figure 4: Image Stenography at Receiver Side

3.4. Image Recovery

The image file is read by the function „imgread‟ and the text file is opened using fopen function and is stored into a variable „fid‟. Using the function fread it is stored into a variable „a‟. Now convert the text file into the image file using matrix representation. Here to perform some addition and subtractions on the matrix it is placed into the proper sub band i.e., LL, LH, HL, HH. The image can be recovered by the text using „extractionfun‟.

3.5. Main Architectural Diagram for proposed Work:

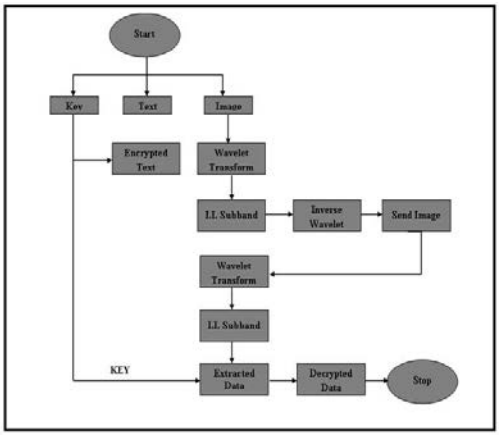
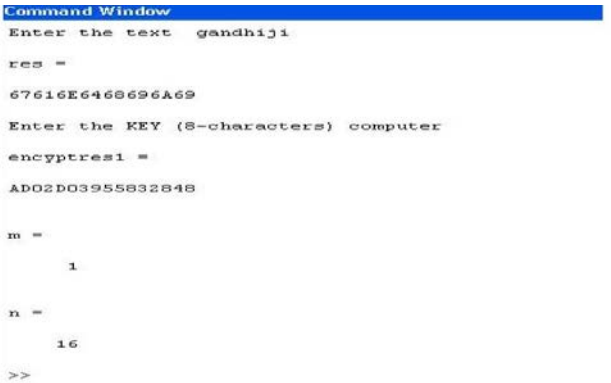


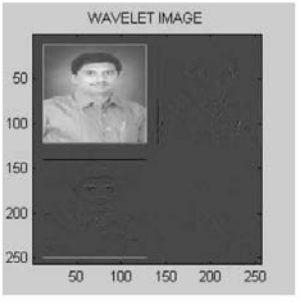
Figure 5: Proposed Work Diagram

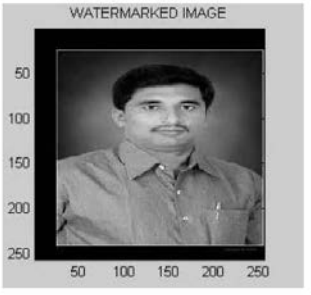
In this proposed architecture, the embedded information is applied as text. Before embedding the text in image, text is encrypted using Advanced Encryption Standard (AES) algorithm. The text can be a sentence or a key with alphabetic words having the length of 8 characters. Using Least Significant Bit (LSB) method, the encrypted text is embedded into the “LL sub-band wavelet decomposed image”. The inverse wavelet transform is applied and the resultant image is transmitted to the receiver. Now at the receiver‟s end, the image transformed using wavelet and encrypted text is extracted by using LSB method.

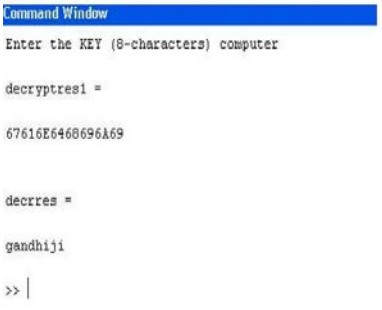
4. Results and Discussion

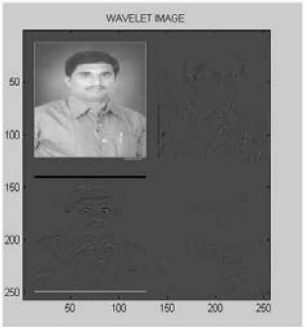
By taking an example the text „**gandhiji**" is taken as input. For this text, the corresponding hexa representation is „**67616E6460696A69'**. Key-„**computer'** which is the lenth of 8 characters is taken to alter the message „Gandhiji". The result after the encryption using the Key is „**AD02D03955032040**". Now this result is decrypted using the Key result in „**67616E6460696A69**". And this data is the one which is going to be embedded into the image. At the other end, the given image is transformed using the Haar forward wavelet transform to get the LL, LH, HL and HH subbands. The data resulting from the above method is embedded into the LL subband. After that, the image gets transformed back to the original form using Haar inverse wavelet transform. After receiving the image from the sender, the image once again gets transformed using Haar forward wavelet to extract the hidden data and that data is decrypted using the steps given in following Figures. Finally, the original message is received as „gandhiji".

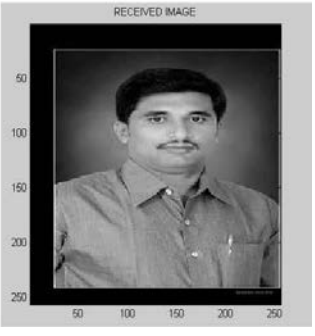












5. Conclusion

The cryptographic algorithm alone is not a very secure way to be used for the data transmission. So a new method which combines cryptography and steganography is provided to give much better option for data transmission. In this project a method to combine steganography (Least Significant Method) and cryptography (AES) is considered, so as to provide a more secure way for data transmission through any unsecured or public networks. To further increase the security of the data,the encrypted text is not embedded in the image itself. Instead,it is embedded in the LL-subband of the wavelet transformed image

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