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Integer Wavelet Transform Based Steganographic Method Using Opa Algorithm

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Abstract - *This paper deals with secret communication in open environment like internet. Steganography attempts to hide the secret information and make communication undetectable. Steganography is used to conceal the secret information so that no one can sense the information.Steganographic method has many challenges such as high hiding capacity and imperceptibility. In existing paper have some problems like less robust and low hiding capacity. so in this paper I use integer wavelet transform(IWT) for increasing hiding capacity and Optimum pixel adjustment algorithm(OPA) for enhancing the image quality use MATLAB to implement my paper, because which has many inbuilt functions and easy to use.*

Keywords- *Steganography, Integer wavelet transform, Optimum pixel adjustment algorithm*.

I. Introduction

Steganography is the art and science of writing hidden messages in such a way that no one, apart from the sender and intended recipient, suspects the existence of the message, a form of security through obscurity. The word Steganography is of Greek origin and means "concealed writing" from the Greek words steganos meaning "covered or protected", and graphic meaning "writing". The first recorded use of the term was in 1499.The advantage of Steganography, over cryptography alone, is that message do not attract attention to themselves. Plainly visible encrypted messages no matter how unbreakable will arouse suspicion, and may in themselves be incriminating in countries where encryption is illegal. Therefore, whereas cryptography protects the contents of a message, Steganography can be said to protect both messages and communicating parties. It includes the concealment of information within computer files .In digital Steganography, electronic communications may include steganographic coding inside of a transport layer, such as a document file, image file, program or protocol. Media files are ideal for steganographic transmission because of their large size. The Least Significant Bit (LSB) substitution is an example of spatial domain techniques. The basic idea in LSB is the direct replacement of LSBs of noisy or unused bits of the cover image with the secret message bits. Till now LSB is the most preferred technique used for data hiding because it is simple to implement offers high hiding capacity, and provides a very easy way to control stego-image quality [1] but it has low robustness to modifications made to the stego-image such as low pass filtering and compression and also low imperceptibility. Algorithms using LSB in greyscale images can be found in [2, 3, 4].

The other type of hiding method is the transform domain techniques which appeared to overcome the robustness and imperceptibility problems found in the LSB substitution techniques. There are many transforms that can be used in data hiding, the most widely used transforms are; the discrete cosine transform (DCT) which is used in the common image compression format JPEG and MPEG, the discrete wavelet transform (DWT) and the discrete Fourier transform (DFT). Most recent researches are directed to the use of DWT since it is used in the new image compression format JPEG2000 and MPEG4, examples of using DWT can be found in [9, 10].In [7] the secret message is embedded into the high frequency coefficients of the wavelet transform while leaving the low frequency coefficients sub band unaltered. While in [8].The advantages of transform domain techniques over spatial domain techniques are their high ability to tolerate noises and some signal processing operations but on the other hand they are computationally complex and hence slower [9]. Some of these techniques try to achieve the high hiding capacity low distortion result by using adaptive techniques that calculate the hiding capacity of the cover according to its local characteristics as in [2, 5, 7, 8]. However, the steganographic transform-based techniques have the following disadvantages; low hiding capacity and complex computations [9, 10]. Thus, to get over these disadvantages, the present paper, the use of optimum pixel adjustment algorithm to hide data into the integer wavelet coefficients of the cover image in order to maximize the hiding capacity as much as possible. We also used a pseudorandom generator function to select the embedding locations of the integer wavelet coefficients to increase the system security.

II. Integer Wavelet Transform

Generally wavelet domain allows us to hide data in regions that the human visual system (HVS) is less sensitive to, such as the high resolution detail bands (HL, LH and HH), Hiding data in these regions allow us to increase the robustness while maintaining good visual quality. Integer wavelet transform maps an integer data set into another integer data set. In discrete wavelet transform, the used wavelet filters have floating point coefficients so that when we hide data in their coefficients any truncations of the floating point values of the pixels that should be integers may cause the loss of the hidden information which may lead to the failure of the data hiding system [9]. To avoid problems of floating point precision of the wavelet filters when the input data is integer as in digital images, the output data will no longer be integer which doesn't allow perfect reconstruction of the input image [10] and in this case there will be no loss of information through forward and inverse transform [9]. Due to the mentioned difference between integer wavelet transform (IWT) and discrete wavelet transform (DWT) the LL sub band in the case of IWT appears to be a close copy with smaller scale of the original image while in the case of DWT the resulting LL sub band is distorted. Lifting schemes is one of many techniques that can be used to perform integer wavelet transform it is also the scheme used in this paper. The following is an example showing how we can use lifting schemes to obtain integer wavelet transform by using simple truncation and without losing inevitability.

The Haar wavelet transform can be written as simple pair wise averages and differences:

$$S_{1,n} = (S_{0.2n} + S_{0.2})/2$$
$$d_{1,n} = S_{0.2n} - S_{0.2n} \qquad (1)$$

Where $S_{i,1}$, $d_{i,1}$ is the nth low frequency and high frequency wavelet coefficients at the Ith level respectively.
It is obvious that the output is not integer, the Haar wavelet transform in (1) can be rewritten using lifting in two steps to be executed sequentially:

$$d_{l,n} = S_{0.2n+1} - S_{0.2n}$$
$$S_{I,n} = S_{0.2n} + d_{l.nl2} \qquad (2)$$

From (1) and (2) we can calculate the integer wavelet transform according to:

$$d_{l.n} = S_{0.2n+1} - S_{0.2n}$$
$$S_{I.n} = 0.2n + (d1, n/2) \qquad (3)$$

Then the inverse transform can be calculated by

$$S_{0.2,n} = S_{1,n} - (d1,n/2)$$
$$S_{0.2n+1} = d_{l,n} + S_{0.2n} \qquad (4)$$

III. Proposed System

The Embedding Algorithm:
The blocks of the embedding algorithm is explained in the following steps:

Step 1: Read the cover image file into a two dimensional decimal array to handle the file data more easily.

Step 2: Histogram modification it is used to prevent overflow/underflow that occurs when the changed values in Integer wavelet coefficients produce stego-image pixel values to exceed 255 or to be smaller than 0. This problem was found to be caused by the values near 255 or 0.

Step 3: Divide the cover image into 8x8 non overlapping blocks. By this division each 8x8 block can be categorized as a smooth or complex block.

Step 4: Transform each block to the transform domain using 2D Haar integer wavelet transform resulting LLI, LHI, HLI and HHI.

Step 5: Calculate hiding capacity of each coefficient, we used a modified version of the hiding capacity function. From experiments we found that as we lower the bits used to hide the secret message in the LL sub band the resulted distortion in the stego-image becomes lower; so that we modified this hiding capacity function by using different ranges for k for the LH, HL and HH sub bands where its values are form 1 to 4. For the LL sub band the value of k is equal to 0 and in some cases the bits used is fixed to only bits to enhance the stego-image quality.

Step 6: Embed L bits of message into the corresponding randomly chosen coefficients. Random selection of coefficients provides more security where the sequence of the message is only known to both sender and receiver by using a previously agreed upon secret key.

Step 7: Apply optimal pixel adjustment algorithm, while taking into consideration that each modified coefficient stays in its hiding capacity range where each value of L is calculated according to the absolute value of the wavelet coefficients any significant change in this value will produce different value of L to be calculated at the receiver. The main idea of using the optimum pixel adjustment (OPA) algorithm is to minimize the error difference

Cryptography is the science of encrypting data in such a way that nobody can understand the encrypted message, whereas in Steganography the existence of data is conceived means its presence cannot be noticed. The information to be hidden is embedded into the cover object which can be text, image, audio or video so that the appearance of cover object doesn't vary even after the information is hidden. To add more security the data to be hidden is encrypted with a key before embedding. To extract the hidden information one should have the key. A stego object is one, which looks exactly same as cover object with an hidden information. Secure secret communications where cryptographic encryption methods are not available. Secure secret communication where strong cryptography is impossible. The military side two parties' communication can be very importance in security purpose

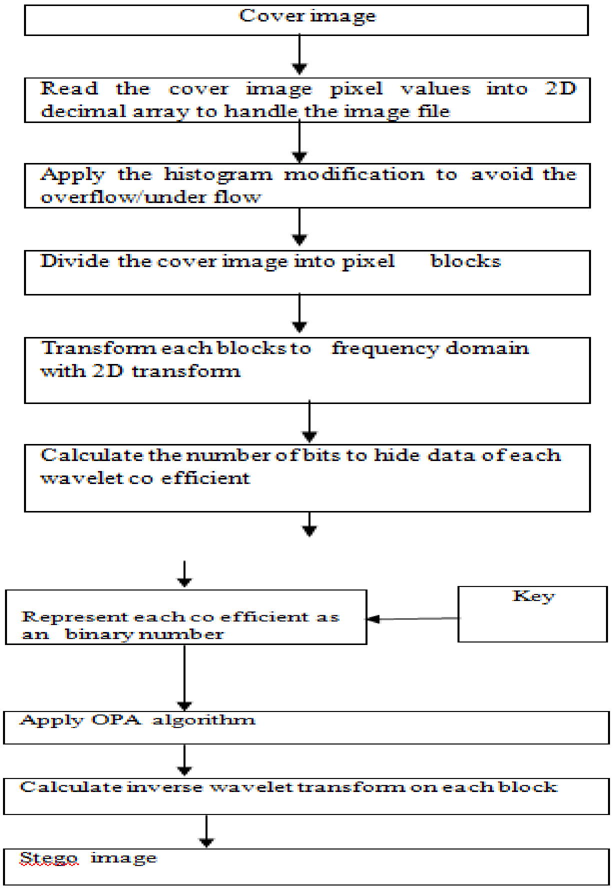

Fig: 1. Blocks of embedding diagram

Between the original coefficient value and the altered value by checking the right next bit to the modified LSBs so that the resulted change will be minimal.

Step 8: finally, calculate the inverse integer wavelet transform on each 8x8 block to restore the image to spatial domain.

The main idea of using the optimum pixel adjustment (OPA) algorithm is to minimize the error difference betweenthe original coefficient value and the altered value by checking the right next bit to the modified LSBs so that the resulted change will be minimal. The algorithm is the final step in the proposed scheme, where it can minimize the error by half.The main idea of OP A is to check the bit right next to the last changed LSBs is used to decrease the error resulted after insertion of message bits.

The Extraction Algorithm

MATLAB is a numerical computing environment and fourth-generation programming language. Developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran. Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems. At the receiver uses the extraction algorithm to obtain the secret message. The block diagram of the extraction algorithm is shown

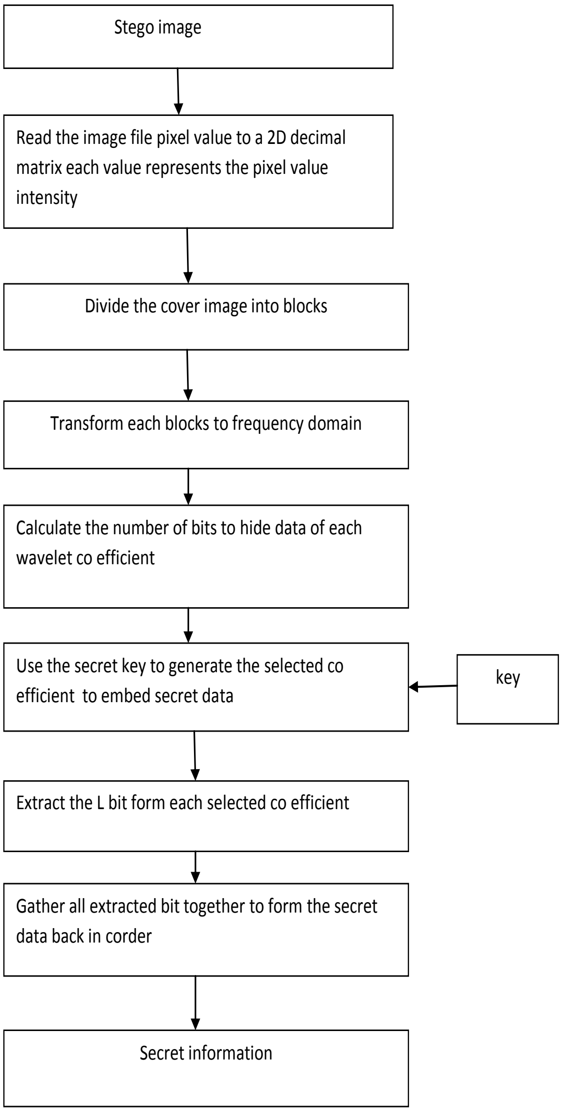

Figure2.The block diagram of extraction algorithm

IV. Conclusions

In this paper i proposed a data hiding scheme that hides data into the integer wavelet coefficients of an image. The system combines a data hiding technique and the optimum pixel adjustment algorithm to increase the hiding capacity of the system compared to other systems. The proposed system hide secret data in a random order using a secret key only known to both sender and receiver. In this method, embeds different number of bits in each wavelet co efficicient according to a hiding capacity function in order to increasing the hiding capacity without losses of the visual quality of resulting stego image. The proposed system also minimizes the error difference between original coefficients values and modified values by using the optimum pixel adjustment algorithm.

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