Multi-Image Hiding Blind Robust RGB Steganography in Transform Domain

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ABSTRACT

Steganography is a widely-used technique for digital data hiding. Image steganography is the most popular among all other kinds of steganography. In this article, a novel key-based blind method for RGB image steganography where multiple images can be hidden simultaneously is described. The proposed method is based on Discrete Cosine Transformation (DCT) and Discrete Wavelet Transformation (DWT) which provides enhanced security as well as improve the quality of the stego. Here, the cover image has been taken as RGB although the method can be implemented on grayscale images as well. The fundamental concept of visual cryptography has been utilized here in order to increase the capacity to a great extent. To make the method more robust and imperceptible, pseudo-random number sequence and a correlation coefficient have been used for embedding and the extraction of the secrets, respectively. The robustness of the method is tested against steganalysis attacks such as crop, rotate, resize, noise addition, and histogram equalization. The method has been applied on multiple sets of images and the quality of the resultant images have been analyzed through various matrices namely 'Peak Signal to Noise Ratio,' 'Structural Similarity index,' 'Structural Content,' and 'Maximum Difference.' The results obtained are very promising and have been compared with existing methods to prove its efficiency.

KEYWORDS

Data Privacy, Discrete Cosine Transforms, Discrete Wavelet Transforms, Information Security

1. INTRODUCTION

To find the meaning of Steganography, one has to reveal the Greek words – 'steganos' which means "concealed, covered or protected" and 'graphein' which means "writing". In summary, Steganography is the ancient art of concealing classified information into a cover object. The cover can be of the same format of the secret or of some other media. Whereas Cryptography is the science of encrypting the secret in such a way that to make it readable the recipient has to decrypt the secret with a proper key. The main advantage of steganography over cryptography is that the presence of secret is unknown to everyone except the intended recipient and hence it avoids the unnecessary attention as an object of being scrutinized despite of how secure the algorithm is.

The main objectives of steganography can be summarized as follows:

- Hide the secret effectively without revealing the existence of the secret
- Successful retrieve of the secret without any alteration
- Increase channel embedding capacity by engraving maximum bits possible to utilize the channel in the best possible manner

In a crux, intend of the proposed method is to introduce a new image steganography method which can hide multiple binary secrets in an RGB cover transforming into frequency domain. The aim is to enhance the capacity using visual cryptography and improve the security applying both DCT and DWT.

The field of steganography has been stratified into different domains according to the different types of covers because the cover can be taken as text, image, audio, video etc. In case of image steganography, the secret is embedded into the cover image. However, if the changes are directly incorporated into the cover image pixels, there is a high probability that the changes will be prone to easily detect. Therefore, the cover image is converted into frequency domain using various methods like discrete cosine transformation (DCT), discrete Fourier transformation (DFT), discrete wavelet transformation (DWT) etc. before making any alterations. Here DCT and DWT both will be discussed in detail as these two techniques are crux of the proposed method.

In addition, the fundamental concept of visual cryptography has been applied here to increase the capacity as well as to enhance the security of the confidential information. Visual cryptography is a notable encryption method which allows concealing information into images in such a way that the decryption can be performed using human vision even without the usage of a computer if and only if correct key images are overlapped. This has been discussed in section 2.1 with more details.

Furthermore, PN sequence has been used to embed the secret into the image while correlation function has been deployed to decrypt the information. The PN sequence is generated by using particular key k as the $(k+1)^{th}$ bit of the sequence is a function of k. The extraction procedure is based on the correlation between the same PN sequence used during embedding procedure and the modified pixel values. Therefore, to generate the same PN sequence in both embedding and extraction processes, key is essential. The proposed method has been thoroughly scrutinized through various standard metrics and the experimental results proves it efficacy and imperceptibility.

In this method, after applying visual cryptography to each color component of the RGB cover, DWT is applied followed by DCT and finally the secret is embedded in the mid-band region using PN sequence. For the retrieval, the reverse path has to follow.

2. LITERATURE SURVEY

Steganography is a technique of hiding secrets from the potential monitors or channels administrators so that they could not even know that a secret message is being transmitted. On the contrary, in case of cryptography, they know that a message is being sent but it is not in a readable format and hence it requires a key to decrypt the secret. This can be elucidated by a simple example: if a man who has no knowledge of ancient Egyptian languages finds a scroll written in hieroglyphics, the message is encrypted to him and he cannot understand it until he is able to decipher it. On the other hand, an elementary example of steganography would be if the message were written with invisible ink.

According to Kahn (1996), the origin of steganography is more likely to be physiological or biological. It comes from the natural instinct of animals to hide secrets such as turtles hiding their eggs in the sand or humans hiding treasures. While the term cryptography means "secret writing", steganography means "covered or protected writing". The first documented usage of steganography dates back to 440 BC when Greek ruler Histaeus shaved the head of his most trusted slaves to write secret messages on their head and finally when their hair grew back, the message was concealed. There are plenty of such examples of steganography lies in our history.

Now what differs age-old steganography from the modern ones is the format of the cover of the intended secrets. In earlier times, the preferable covers were human skin, or use of paper by writing in invisible ink, and many other simple or complex physical objects while modern steganography utilizes digital images, videos, audios as covers. As described by Swain and Lenka (2014), based on the choice of cover, digital steganography can be classified into three main categories which are - (i) image steganography, (ii) audio steganography and (iii) video steganography.

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