Chapter 16
A Secure Data-Hiding Approach Using Particle Swarm Optimization and Pixel Value Difference

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ABSTRACT

In this chapter a novel data hiding approach by combining Particle Swarm Optimization (PSO) and Pixel Value Difference (PVD) has been proposed. Pixel-Value-Difference (PVD) method of Steganography uses the difference between pixels within an image to hide secret data. The proposed method is a block-based adaptive steganographic approach, which selects M×N block of pixels from cover image and embed secret message within pixels using Pixel-value-difference and LSB substitution method. PSO is used to select most appropriate areas within the image for hiding secret information. Results obtained using the approach show that distortion due to data embedding is negligible. The proposed approach is compared with existing methods in terms of bits per pixel. This method could be applied to hide any digital secret data for secure transfer over internet.

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INTRODUCTION

Steganography is an old art of data hiding. It differs from cryptography, in cryptography presence of hidden data is noticeable, whereas in Steganography nobody except the sender and receiver could be able to know about hidden message. Modern Digital Steganography uses a covering media (like image, video, sound etc) to hide secret information using some secret process.

The best-known image steganographic method, LSB (Least Significant Bit) replacement introduced by Sharp,T. (2001). This method works in the spatial domain. Curran,K. and Bailey,K. (2003) analysed seven different image based steganography methods on LSB bit replacement. Chan,C.K. and Cheng,L.M.(2004) proposed another method, which substitutes equal number of bits from each pixel of the cover images for hiding the secret message. Chang et al.(2002), Thien,C., Lin,J.C.(2003) proposed that LSB substitution is the most commonly used method which directly replace the LSB bits of pixels from the cover image with secret bits. LSB substitution algorithm is the simplest scheme to hide message in a host image. Therefore this method suffers from steganolysis threats. Halder,T. and Karforma,S. (2013), Halder,T. and Karforma,S. (2014) introduced indexing over the existing LSB matching scheme. Here the secret message is not stored within the LSB bits directly, instead bits are distributed by matching / replacing bits within the whole image. An index is used to remember the positions where bits are hidden.

Other than LSB methods Wu,D.C., Tsai,W.H. (2003) proposed a method known as 'Pixel value differencing'. In the method a non-overlapping block of two pixels are chosen from the cover image. Difference between the pixels are used to hide secret message. The absolute Difference value between the pixels point out smooth and edge areas. More number of bits could be hidden in edge areas rather than smooth areas.

Chang, K.C.et al.(2003) proposed a method named Tri-way pixel-value-difference, where blocks of four pixels are chosen to create three pairs. This could hide more number of bits when compared with Wu and Tsai's method.

Khodaei,M. and Faez,K.(2012) proposed another algorithm based on PVD method. In this approach non-overlapping block of three pixels is chosen in raster scan order then within the block of 3 pixels the middle pixel is altered with secret bits using 3-LSB replacement method. Therefore Optimal pixel adjustment process(OPAP) (Chan,C.K & Cheng, L.M.2004) is applied on that pixel to reduce embedding error. After altering the middle pixel the difference between first and middle and middle and last is used to hide secret data using PVD. Following this approach they achieved better capacity with good PSNR value. The main problem with this approach is that they used raster scan order to select pixels which ignore other surrounding edges except the left and right one of the middle pixel. This algorithm is also not flexible while selecting block size, only 1×3 size blocks could be selected to embed data.

Chi-Shiang Chan et al. (2014) therefore extended Khodaei and Faez's work (2012) for flexible number of blocks. Block of size M×N could be selected. Here the value of M and N vary between 1 and 7. Another important change is that in this algorithm pixels are not scanned in raster scan order which is a better utilization of all edges while hiding bits. Each block is manipulated such a way that middle pixel of each block is used to embed bits directly using 3-LSB substitution and OPAP. Difference between other pixel values with middle pixel is calculated and thereafter PVD method is applied to hide secret bits.

Heriniaina,F. and Sang,J. (2011) applied PSO with already existing LSB Steganography in order to search suitable area within an image for hiding secret bits. This method belongs to DCT domain. This

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