

Color Image Steganalysis by Inter-Color Correlation of DCT Coefficients

Mohammad Khazaei¹, Maryam Hasanzadeh²

Department of Engineering
Shahed University
Tehran, Iran

¹khazaei.m7@gmail.com, ²hasanzadeh@shahed.ac.ir

Abstract—Steganography is a branch of covert communication that aims at writing hidden messages in a digital media such as images. At the other hand, steganalysis is the science of detecting hidden data. F5 algorithm hides data in AC coefficients of JPEG image. In this paper, we propose a method to break F5 algorithm in color image by using correlation of DCT coefficients between color components. At the first step, the local error of inter-color correlations of AC coefficients are computed by comparing histograms of color components, then correlation of input image and estimated cover image is compared. The estimated cover image is created by decompressing image to spatial domain and applying lowpass filter on decompressed image, then cropping some columns and rows of resulted image and finally recompressing it to frequency domain again by DCT transform. The result of conducted experiments shows that the error of inter-color correlation for stego image is more than corresponding estimated cover image.

Keywords-steganalysis; steganography; F5; inter-color correlation; JPEG

I. INTRODUCTION

Cryptography is often used to protect information secrecy through making messages illegible. Sometimes it may be necessary to keep the existence of the message secret. The technique used to implement this, is called Information Hiding. In fact Information Hiding is the art and science of invisible communication. Steganography refers to the technique of hiding information in a digital in order to conceal the existence of the information. Nowadays digital image is one of the most common media in steganography and among digital image, JPEG format is the most popular format that easily transmitted through internet. Steganalysis is the art and science of detecting data hidden by steganography in a media. Its basic requirement is to determine accurately whether a data is hidden or not [1-2].

There are several methods that are used in steganography on the JPEG format. Although most images are colorized, but most of the researches on steganography and steganalysis have been done on grayscale image. One of the well-known steganography methods is F5 algorithm [3]. Fridrich et al. for breaking F5 algorithm on grayscale images, compare the histogram of low frequencies AC coefficients of input image with corresponding estimated cover image [4]. We aim at steganalysis of F5 in color images.

We can represent color image in many color space such as RGB or YCbCr. There exists inter-color correlation between color components in a color space. However, most of the color image steganography algorithms embed their data in cover without considering this correlation. So we can predict that the stego image have less inter-color correlation in comparison with cover image. San et al. shows that there exists inter-color correlation between luminance and chrominance components in wavelet transform by measuring Euclidean distance from large luminance coefficients to large chroma components coefficients [5]. Cai et al. used correlation of wavelet transform of YCbCr to determine clean images by using linear and nonlinear prediction models [6].

In this paper, we propose a method to detect F5 algorithm by using inter-color correlation between DCT coefficients of color components in JPEG images. For input image and estimated cover image, we compute error of correlation by comparing histogram of low frequencies AC coefficients between color components locally and compare them to each other. To create estimated cover image, decompress image to special domain and apply lowpass filter and then crop some rows and columns, finally recompress it with the same quantization matrix.

The rest of the paper is as follow, The F5 algorithm is described in Section II. The proposed method is explained in Section III and in Section IV demonstrates the experimental result. Finally Section V concludes the paper.

II. THE F5 ALGORITHM

The F5 steganographic algorithm was introduced by Westfeld [3]. F5 algorithm embeds the data to non-zero AC DCT coefficients. Guided by their χ^2 attack, they challenged the paradigm of replacing bits of information in the cover image with the secret message while proposing a different paradigm of incrementing image components to embed message bits. Instead of replacing the LSBs of quantized DCT coefficients with the message bits, the absolute value of the coefficient is decreased by one. The authors argue that this type of embedding cannot be detected using their χ^2 statistical attack (in spite of Jsteg algorithm).

In the embedding process, the message length and the number of non-zero non-DC coefficients are used to determine the best matrix embedding that minimizes the number of