Chapter 7
Digital Image Forensics Based on CFA Interpolation Feature and Gaussian Mixture Model

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ABSTRACT

According to the characteristics of the color filter array interpolation in a camera, an image splicing forgery detection algorithm based on bi-cubic interpolation and Gaussian mixture model is proposed. The authors make the assumption that the image is acquired using a color filter array, and that tampering removes the artifacts due to a demosaicing algorithm. This article extracts the image features based on the variance of the prediction error and create image feature likelihood map to detect and locate the image tampered areas. The experimental results show that the proposed method can detect and locate the splicing tampering areas precisely. Compared with bi-linear interpolation, this method can reduce the prediction error and improve the detection accuracy.

1. INTRODUCTION

In recent years, with the popularity of smart phones and high-performance digital acquisition equipment widely used, digital images are becoming more and more common. At the same time, the image editing tool can easily modify the image content. So this prompted us to study the authenticity of the image recognition technology. For example, image splicing is commonly used as a method of tampering with two or more images and it is common in image tampering types.

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Considering in previous papers, the color filter array (CFA) demosaicing algorithm can be divided into two categories as fingerprints to be analyzed, i) an algorithm designed to estimate the parameters of the color interpolation algorithm, and ii) an algorithm designed to evaluate the presence/absence of a demosaicing trace. Given that the second category focuses on forgery detection (inconsistency in CFA interpolation reveals the existence of forgery regions), the algorithms in the first category are mainly used to classify different source cameras, but sometimes they can also be used to detect tampering.

The color filter array interpolation exists in most cameras, and tampering operations often cause interpolation operations, which makes the study based on the interpolation of image blind evidence technology possible. Popescu (Popescu & Farid, 2005) expounded the main CFA interpolation algorithm, and for the linear interpolation model, the interpolation coefficient was calculated by using the Expectation Maximization algorithm, and the Fourier transform of the probability map was used to further judge whether the image experienced over interpolation operation. Gallagher (Gallagher, 2005) obtained the second order difference of the image and used the periodic characteristic to detect the image interpolation. The algorithm is limited to bilinear interpolation. Wang Bo (Wang, Kong, You, & Fu, 2009) used the covariance matrix to successfully detect the color filter array interpolation. The above three methods can only detect non-adaptive algorithms. For the adaptive interpolation algorithm, Bayram (Bayram, Sencar, & Memon, 2006) used the periodicity between pixels introduced by CFA interpolation as a classification feature. Peng (Peng, Zeng, Lin, & Kang, 2015) found that irregular sampling and interpolation operations resulted in local linear correlation changes and proposed an algorithm that could effectively detect resampling anti-evidence based on autocorrelation coefficients. Li (Li, Xue, Wang, & Tian, 2015) described the local correlation of the CFA interpolation pattern by establishing a Gaussian model and calculated the posterior probability model of the CFA interpolation and then tampering. In summary, there are many academic achievements in blind forensics of slicing images, especially based on image interpolation. However, many algorithms have some limitations, for example, they can't automatically locate and detect tampered areas, and their accuracy is not high.

This paper is based on the continuity principle that the splicing operation destroys the internal characteristics of the image. It is necessary to interpolate the given image to predicted or estimate its original image. In order to reduce the prediction error, improve the detection accuracy, the image is predicted by bi-cubic interpolation, and then the image feature is extracted based on the variance of the prediction error. Gaussian mixture modeling (GMM) is carried out on the image features of different positions, and the parameters in the model are estimated by EM algorithm. Thereby the tampered area can be detected and located.

The rest of this paper is organized as follows: Section 2 offers an overview of CFA interpolation and Gaussian mixture model. Section 3 gives the proposed approach in detail, while experimental results and conclusion are given in Section 4 and Section 5, respectively.

2. BACKGROUND OF CFA AND GMM

This section gives a brief introduction to the relevant knowledge that can help to understand the analysis method based on CFA interpolation and Gaussian mixture model.