Chapter 9
Blind Detection of Partial-Color-Manipulation Based on Self-PRNU Estimation

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ABSTRACT

This article describes how to detect color manipulation which is a commonly used method in the field of digital image forgery. The difficulty that hue forgery does not change the image edges, shapes and gradations brings certain challenge to authenticity detection. Current methods utilize the PRNU from multiple un-tampered images, requiring the camera type to be known. However, the increasing varieties of digital devices greatly complicates the preparation of prior knowledge. This article proposes a blind detection method for partial color manipulation based on self-PRNU of suspicious image, eliminating the necessity of acquiring camera information. The authors estimate the PRNU of suspicious image by removing the regions due to its texture complexity. The tamper region is detected by calculating the correlation between estimated PRNU and residual noise. As to partial manipulation detection, an introduced threshold of connected components is used to reduce the false positive. The experimental results show that the method can effectively detect and locate the partial color manipulation.

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INTRODUCTION

With the rapid development of the Internet and the widespread popularity of digital images devices, digital images have become our main source of information. At the same time, since the advent of a large number of low-cost, easy to operate image editing software, people can easily modify the digital images, which makes the images are suspected the truth of the fact that as the event record. So, the detection of the images authenticity becomes more and more important. Modern digital images can be tampered by a lot of ways, such as image synthesis, inpainting, enhancement, the computer generated and paintings, etc. To cope with that, the image tampering detection algorithm for various tamper methods has also made some achievements, the main methods include the detection of image copy-and-move based on principal component analysis (Fridrich, 2003), a double JPEG compression testing (Farid, 2009), the fuzzy inpainting operation (Hsiao, 2005), tampering detection based on pattern noise and photo-response non-uniformity noise (PRNU) (Lukas, 2006; Mo Chen, 2008; Chierchia, 2010; Chierchia, 2014), tamper detection based on color filter array (C. H. Choi, 2011), etc.

In a variety of tampering strategies, one of which is color modification. Hue is the main property of color, so the tampering of the color will mainly modify the hue value. In HSV color space, H represents hue. The value ranges from 0 to 360. S represents the saturation value. The value ranges from 0 to 1, where V represents the brightness, and the value ranges from 0 to 1. The modification of the hue is the rotation of hue value in the HSV color space. This tampering strategy does not modify the image texture, edges, lighting functions, and so on. It is relatively difficult to detect the color change.

Chang-Hee Choi (2013) in 2013 first proposed a camera color filter array (CFA) based detection method. The algorithm estimates the hue modification using the neighborhood correlation (C. H. Choi, 2011) induced by the color filter array (CFA). They proposed a simple measure to detect the CFA mode changes, by calculating the number of adjacent pixel which meets the interpolation conditions and the number of pixels obtained by the original camera. Based on this, the algorithm requires the CFA Bayer pattern of the suspicious image to be known before detection. At the same time, some basic processing of image, such as image scaling and JPEG compression, will destroy the demosaicing trace of the original image, which will destroy the CFA Bayer pattern. Therefore, this algorithm doesn't have a good accuracy for detecting the image after resizing and JPEG compression processing.

Jong-Uk Hou (2014) proposed a robust color modification detecting scheme based on the sensor pattern noise. The method utilizes the noise extraction algorithm proposed by Lukas (2006) to obtain the reference pattern noise by averaging the pattern noises of R, G, B channels extracted from multiple images taken by known cameras. The original suspicious image is rotated at 1-degree interval to create 360 duplicates from which the noise residuals are extracted through a wavelet-based denoising filter. The correlation between the noise residuals and the reference pattern noise is analyzed to obtain the restore degree of the hue manipulated image. This method can resist image scaling and JPEG compression.

The hue modifications detecting scheme is further improved by Jong-Uk Hou (2016). The improvement involves using the hill-climbing algorithm that skips unnecessary intervals to optimize efficiency, and a partial forgery detector that employs the two indicators: hue modification degree and correlation to assist the recognition of the forged region. Besides, an equation with two thresholds is adopted to reduce false positives.

The current methods (Choi, 2013; Hou, 2014; Hou, 2016) can effectively detect image hue modification, however, the drawbacks of requiring source camera information and multiple images taken by the source camera are inevitable. Such shortcomings cause tedious preparation of the prior knowledge due