International Journal of Digital Crime and Forensics
Volume 10 • Issue 4 • October-December 2018

Digital Image Splicing Detection Based on Markov Features in QDCT and QWT Domain

Ruxin Wang, School of Data and Computer Science, Guangdong Key Laboratory of Information Security Technology, Sun Yat-sen University, Guangzhou, China

Wei Lu[1], School of Data and Computer Science, Guangdong Key Laboratory of Information Security Technology, Sun Yat-sen University, Guangzhou, China

Jixian Li, School of Data and Computer Science, Guangdong Key Laboratory of Information Security Technology, Sun Yat-sen University, Guangzhou, China

Shijun Xiang, College of Information Science and Technology, Jinan University, Guangzhou, China

Xianfeng Zhao, The State Key Laboratory of Information Security, Institute of Information Engineering, Chinese Academy of Sciences, Beijing, China

Jinwei Wang, School of Computer and Software, Nanjing University of Information Science and Technology, Nanjing, China

ABSTRACT

Image splicing detection is of fundamental importance in digital forensics and therefore has attracted increasing attention recently. In this article, a color image splicing detection approach is proposed based on Markov transition probability of quaternion component separation in quaternion discrete cosine transform (QDCT) domain and quaternion wavelet transform (QWT) domain. First, Markov features of the intra-block and inter-block between block QDCT coefficients are obtained from the real parts and three imaginary parts of QDCT coefficients, respectively. Then, additional Markov features are extracted from the luminance (Y) channel in the quaternion wavelet transform domain to characterize the dependency of position among quaternion wavelet sub-band coefficients. Finally, an ensemble classifier (EC) is exploited to classify the spliced and authentic color images. The experiment results demonstrate that the proposed approach can outperform some state-of-the-art methods.

KEYWORDS

Ensemble classifier, Image splicing detection, Markov features, Quaternion discrete cosine transform, Quaternion wavelet transform

INTRODUCTION

In recent years, with the rapid development of image editing software and processing technology, it has become easy to tamper digital images without leaving any visual trace. These tampered digital images can have a bad influence on people's lives if they are used maliciously. Therefore, the research on the effective identification of tampered images has drawn more and more attention, and some novel and effective detection methods have been proposed recently.

At present, the approaches of digital image authentication can be divided into two categories, referred to passive detection methods (Luo, Qu, Pan, & Huang, 2007; Elwin, Aditya, & Shankar, 2010; Birajdar & Mankar, 2013) and active detection methods (Vyas & Lunagaria, 2014; Panchal & Srivastava, 2015; Stamm, Wu, & Liu, 2013). Active detection methods embed specific information

DOI: 10.4018/IJDCF.2018100107

into digital image. When verifying the authenticity of images, the hidden information can be extracted from the suspicious images, and then compared with the original one. Compared with the active detection methods, passive detection methods can validate the authenticity of image without any prior information about the source image. So, it has attracted more and more attention recently.

Although any visual trace will not be left in tampered images, image tampering operation would inevitably destroy the statistical characteristics of the original image. Based on this idea, lots of researches on variety of image tampering have been done (Xue, Ye, Lu, Liu & Li; Yang, Zhu, Huang, & Zhao; Ding, Zhu, Yang, Xie, & Shi; Yang, Zhu, Huang, &Zhao). The image splicing tampering and copy-move tampering are two common problems in image tampering. Copy-move tampering detection of image is to detect whether there exist two or more similar regions in a single image, and it will locate the similar regions when they exist. Recently, some novel methods about copy-move tampering detection are proposed (Yang, Li, Lu, & Weng, 2017; Li, Yang, Lu, & Sun, 2016; Chen, Lu, Ni, Sun, & Huang, 2013). Splicing tampering detection of image is to detect whether a source image is formed by splicing two or more images. (He, Lu, Sun, & Huang, 2012; Zhang, Lu, & Weng, 2016; Li, Ma, Xiao, Li, & Zhang, 2016). This paper mainly researches splicing tampering detection of digital image.

In recent years, lots of image splicing detection methods based on Markov feature have been proposed. Shi (Shi, Chen & Chen, 2007) proposed a method based on natural image model which includes two statistical features: moments of characteristic functions and Markov transition probabilities. The statistical features can be obtained by applying block DCT to the source image. And the detection accuracy rate of the proposed methods can achieve 91.87% on the DVMM dataset which introduced in (Ng & Chang, 2004). Significantly, we can observe that the detection accuracy rate of Markov feature is better than moment feature and Markov feature has the better contribution rate in the whole method. He et al. (2016) proposed a scheme based on expanded Markov feature. Expanded Markov features which obtained from the transition probability matrices in DCT domain are used to capture the correlation of block DCT coefficients, and more Markov features are obtained from wavelet coefficients across positions, scales and orientations characterize three kinds of dependencies in DWT domain. To handle the large number of features, they utilized dimensionality reduction method of SVM-RFE to reduce the dimension of obtained features and SVM classifier was used to classify spliced image and authentic image. The detection accuracy rate of the proposed method can achieve 93.55% on the DVMM dataset. Zhang et al. (2016) proposed a method based on improved Markov features of inter-block by dividing the DCT coefficient according to the frequency ranges in DCT domain. And additional Markov features are obtained from Contourlet transform domain to capture more splicing information. The detection accuracy rate can achieve 94.10% on the DVMM dataset. In (Li, Ma, Xiao, Li, & Zhang, 2016), a novel image splicing tampering detection method based on Markov feature in QDCT domain is proposed. The method processes color image pixels in a holistic manner and the detection accuracy rate of the proposed method can achieve 92.38% on CASIA TIDE V2.0 dataset.

There are also some methods proposed based on other models, Dong (Dong, Wang, Tan, & Shi, 2009) proposed an image run-length statistical features based approach to detect image splicing tampering. And the improved method is similar to this method introduced by He (He, Sun, Lu, & Lu, 2011). In (Bahrami, Kot, & Fan, 2013; Rao, Rajagopalan, & Seetharaman, 2014; Bahrami, Kot, Li, & Li, 2015; Bahrami & Kot, 2014), they used inconsistency of blur degree or depth information of an image to detect image splicing tampering. In (Bahrami, Kot, Li, & Li, 2015), they can use the blur type differences of the regions to locate splicing tampering regions. Limitation of these methods is that they are more suitable for blurred images.

Inspired by the Markov feature based scheme of digital image splicing detection, a color image splicing detection scheme based on Markov feature of quaternion component separation (QCS) in QDCT domain and quaternion wavelet transform (QWT) domain is proposed in this paper.