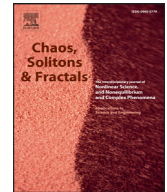




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# Radon odd radial harmonic Fourier moments in detecting cloned forgery image

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## ABSTRACT

Over the past decades, due to the progress of computing abilities and easy access to powerful photo editing software, more digital photos and images are created commonplace. Unfortunately, this technology progress may also bring with a big risk of the information security. Image region cloning is a popular and simple manner to create realistic forgery images. Most relevant researches have been carried out, but the methods based on those researches are only able to detect some simple duplicated successfully. So we present a new Radon Odd Radial Harmonic Fourier Moments (RORHFM) method. Compared with other relevant methods, this method is more robust to resist post-processed operations, such as anti-translation, anti-rotation, anti-scaling, anti-mirror operations and resisted Gaussian noise contamination. We also introduce an auxiliary circle template to slide and detect the suspicious image in order to locate the cloned region. The invariant moment features of image are extracted and analyzed by our method. Each feature of similar region is arranged orderly by Lexicographic sorting for detecting. Pearson Correlation Coefficient is applied to calculate and classify the statistical data. Then, the statistical data is searched, analyzed. At last, the original coordinates of cloned and pasted region are detected and denoted. Extensive experiments verified better robustness of RORHFM method than other relevant methods in detecting cloned forgery.

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## 1. Introduction

Over the past decades, information security, especially image information security is attracted people's widespread concern. With the advancement of digital camera, people obtain digital photos easily. Meanwhile, these digital photos or images can be easily edited or manipulated according to one's wish, without any obvious perceptible changes. There is also some one deliberately to tamper images for his nefarious purposes. Once these forgery images applied to political

events, court evidence, financial contracts, scientific discoveries, news reports and other fields will lead to serious social consequences. "The people acclaimed Silvio Berlusconi" is a cloned forgery image as shown in Fig. 1. Hence, it is necessary to introduce and develop effectively method to detect suspicious forgeries in digital image successfully. In recent years, image forensics has gradually become a significant issue in information security field.

There are different manners for forgery images. Cloned or duplicated operation is the most common manipulation in tampering digital images. This type of forgery operation is to clone interested region or content and paste it into another part of the same image to cover up the important content or obscure, misrepresent specific image information. With

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Fig. 1. Cloned forgery image of the people acclaimed Silvio Berlusconi.

the powerful photo editing software, such as PhotoShop, this forgery operation is extremely simple to execute, even for the non-professionals. And the forgery traces are difficult to distinguish by the human eyes. So it is necessary to make effort to authenticate whether a digital image is a true image or tampered after snapped by camera.

Most prior methods detected and authenticated this type of forgery operation successfully. Fridrich [1] first presented Discrete Cosine Transform (DCT) coefficients to detect cloned forgery image. This method mainly concern block matching by describing the content of the square sub-blocks. But this method lacks efficiency. Popescu et al. [2] presented the similar method, namely principal component analysis (PCA) method. PCA method is employed to reduce computational complexity and cost by dimensionality reduction. Myrna et al. [3] presented wavelet transform and Kashyap et al. [4] presented wavelet decomposition to reduce dimension representation of the image. Translation, rotation, mirror, scaling and other geometric distortion operation does not change the content of the image in image processing. However in practice, the above previously traditional methods in detecting and locating cloned regions precisely only are suitable for some simple forgery operation, such as translation operation. But the truth is that some forgers manipulate geometric distortion operation to alter and conceal some image features to render photorealistic results. The above traditional image feature extraction methods failed to detect the cloned content became inept and inefficient. Geometric moment invariants reflect highly concentrated geometric features of the image. Therefore, in the field of image cloned detection, geometric distortion including translation, rotation, mirror and scaling invariance analysis is an important research emphasis. In recent years, various kinds of geometric moment invariants have been introduced to deal with the cloned forgery and made fruitful achievements. The representatively moment invariants methods are described presented as below.

Teh et al. [5] introduced the Zernike moments (ZMs). Zhao et al. [6] presented Cartesian Zernike Moments Invariants (CZMI) method and introduced a scale invariance parameter. This improved CZMI can reduce scale errors and improve the

stability of scale invariance, even if the cloned regions were undergo large aspect ratio transforms. Chen et al. [7] presented Orthogonal Zernike Moments (OZMs) method to derive a set of combined geometric-blur invariants. Ryu et al. [8] presented Zernike moments of small image blocks to detect cloned image regions. Liu et al. [9] took another method by introducing Fourier–Mellin Transform (FMT). Bayram et al. [10] presented Fourier–Mellin Transform (FMT) to extract image features from sub-images. But this method is only suitable for small rotation transform and small resizing of the copied regions as well. Sellami et al. [11] presented improved Fourier–Mellin Transform, namely Analytical Fourier–Mellin Moments (AFMMs). In 2010, Yap [12] introduced Polar Harmonic Transforms (PHTs) which are consisted of a set of 2D transforms defined on the unit circle in the polar coordinate system. PHTs including Polar Complex Exponential Transform (PCET), Polar Cosine Transform (PCT), and Polar Sine Transform (PST) can be used to generate rotation-invariant features. Li et al. [13] used PHTs to extract the features of the circular blocks, which are then used to perform block matching and locate cloned region of the forgery image. In order to overcome computational complexity drawbacks of ZMs, Shabana et al. [14] presented to apply simple kernel of PHTs instead of ZMs. In 2011, Hu [15] presented Radical harmonic Fourier moments method to describe images. Then, Hu [16] further analyzed the computational complexity and cost of the expressed function and kernel of Radial Harmonic Fourier Moments (RHFMs), Zernike Moments (ZMs), Orthogonal Fourier–Mellin Moments (OFMMs) and Chebyshev–Fourier moment (CHFMs). The expressed function and kernel of RHFMs have simpler forms, greater efficiency and better performs than the above orthogonal moments in describing images. Meanwhile, the kernels of RHFMs apply trigonometric functions to replace exponent functions of PHTs can also cut the computational complexity and cost. Qin et al. [17] presented RHFMs to overcome the weak robustness of post-processed operations and deal well with cloned image forgery.

Radial Harmonic Fourier Moments (RHFMs) have provided an efficient tool for image forgery detection. In this paper, we mainly focus on the detection of cloned image forgery, so we establish the correlation to the same cloned regions which is appeared in one image. We devote to analyze and improve Odd Radial Harmonic Fourier Moments method to achieve the higher detected rates and more efficiency. The rest of the paper is organized as follow: in Section 2, we review the background information of Radial Harmonic Fourier Moments and Radon transform. In Section 3, we present a method which combines Radon transform and Radial Harmonic Fourier Moments, namely Radon Radial Harmonic Fourier Moments. We mainly discuss low odd order of Radon Radial Harmonic Fourier Moments (RORHFMs) to construct rotation moment invariants and extract invariance features of region in detail. Meanwhile, we present circle template to eliminate the error of scaling transform. In order to reduce the interference of background information and enhancement of our detected accuracy rates, we present improved rule for reducing interference in Section 4. We discuss experiments results and evaluate the presented scheme. Finally, the conclusions are given in Section 5.

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