Source Camera Identification using Photo Response Noise Uniformity

Mrudul S. Behare
Dept. of Electronics and Telecommunication Engineering
Government College of Engineering
Aurangabad (MS), India
mbehare@gmail.com

A.S. Bhalchandra
Dept. of Electronics and Telecommunication Engineering
Government College of Engineering
Aurangabad (MS), India
asbhalchandra@gmail.com

Rajesh Kumar
Dept. of Forensic Science
Govt. Institute of Forensic Science
Aurangabad (MS), India
rajeshkumar512@gmail.com

Abstract **– Nowadays, technology of digital media is increasing rapidly, as the price of mobile phones or any other digital imaging devices is reducing and functionality is increasing, which is making digital imaging very much cheaper in every-day life. Also extraordinary tools and filters of image processing are easily available in these devices and those are easy-to-use which provides effective impact for manipulating the images and can be misused. As a result, in recent years source camera device identification has received great importance. The Photo Response Noise Uniformity is a unique pattern which can be used for identification of source device from captured data like images or videos. As identification of video acquisition devices is one of the considerable problems faced in multimedia forensics, so this paper presents work related to source device identification using PRNU fingerprint .The proposed method aims to classify videos to the respective source devices using simple statistic based algorithm. Extraction of PRNU is performed using denoising filters.**

Keywords— Photo Response Noise Uniformity (PRNU), Sensor Pattern Noise(SPN), classification, source device identification, correlation, Denoising filter, MATLAB

I. INTRODUCTION

One of the major common problems with the multimedia forensics is source of video and image gaining devices. Whenever an image is uploaded or sent from one device to another then finding the origin of that image is very difficult. As the cost of mobile phones or any other digital imaging devices falls down and functionality increases, this is making digital imaging very much cheaper in every-day life As a result, tampering of videos, authentication images such illegal things take place and which leads to increase in crime rate. To avoid misuse of data, it needs to be protected. Also if crime happens then the source of that acquisition device needs to be obtained. Hence, unique patterns for the particular device are used as a feature in the device identification process. Such unique patterns are nothing but device identical noise.

In this paper, Photo Response Noise Uniformity is used for source device identification purpose. PRNU is very unique and identical feature which is unique for every device like camera phones, cam recorders, digital cameras etc. Therefore, PRNU feature can be considered as a fingerprint in identifying source device. PRNU is nothing but the fixed pattern noise (FPN) introduced by camera device itself at the time of manufacturing that particular device. This pattern is an almost invisible artifact which makes the device different from others. Various techniques are used for the extraction of PRNU noise. Many filters are considered and using them extracted PRNU is used for further processing.

II. RELATED WORKS

PRNU extraction using digital filtering operation, by taking average of all PRNU factors, a PRNU fingerprint is obtained [1]. Wavelet denoising filter is used to remove scene contents which are treated as external noise. PRNU of device is affected due to scene contents of image. Hence, these scene contents are needed to be removed from image so that only device noise can be obtained. Dataset used in this work, videos were originally recorded by Smartphone, uploaded to social networks, downloaded from Twitter and Facebook [1].

Camera identification based on joint decision of SPN and peak to correlation energy ratio(PCE) is another method proposed by[2], in which PRNU extraction is performed using Wavelet denoising filter[2], firstly frames are extracted from video then PRNU is calculated. PRNU is extracted using wavelet denoising filter which deletes all the noise and remains with only original frame, then the noise free frame is subtracted from obtained frame to extract PRNU. Then clustered PRNU is calculated for each frame. When reference frame and query frame gives high correlation value then they both are considered as from same device and when the correlation value is low then they show different camera devices. Hence, by calculating peak to correlation energy ratio for each frame, detection of source device is performed. Dataset used in this paper is created by taking videos from 10 camera device [2].

Video source identification is performed by using a sensor pattern noise and wavelet transform taking out from key frames of video [3]. The proposed technique in [3] includes key frame extraction, sensor noise extraction, feature extraction, training of classifier and prediction. Algorithm used includes, video split into individual frames then first frame is considered as a key frame then difference between current frame and the reference frame is calculated then to select frame with a change in scene, color histogram correlation is calculated. When difference between key frame and a selected frame is equal to or greater than user defined threshold value then that particular frame is selected as next key frame. Histogram correlation is compared to compare and find similarities between two frames. The feature used for identification is sensor pattern noise (SPN). This SPN is separated into RGB channels, reference sensor pattern noise is obtained from constant brightness and uniform dispersion images and then average is calculated [3]. SVM classifier is used for classification process.

Scene contents of image results into contamination of sensor noise, therefore, Sensor pattern noise enhancement is performed in [4] by assigning less weights to strong components of signal, in order to attenuate scene details of image. Dataset used in this work contains wide variety of indoor and outdoor scenes. 1200 photos of 6 different camera devices are taken.

Techniques considering device identification of audio and visual data includes, multi-modal approach in which microphone recognition is using blind estimation of frequency response and video camera detection is using video features related to CFA (color filter array) interpolation. Features used for microphone detection are, average of normalized log power spectrum of microphone frequency response and blind estimation of amplitude of microphone frequency response [5]. Center portion of particular size of image/frame is considered for calculating fingerprints and support vector machine algorithm is used for classification.

To identify source of particular image, certain features are to be obtained considering camera characteristics. Color features, quality features, image characteristics of frequency domain are various features considered for source device identification [6]. SVM based classification is performed among different camera make and also different models with the same make.

Source camera identification using sensor pattern noise is calculated by obtaining reference pattern noise of the device which is estimated by taking average of noise extracted from number of images using denoising filter. By calculating correlation factor between reference and query images, identification is performed [7]. Correlation value helps to distinguish among the images of same or different camera device.

Identification of source device of transmitted videos or images by extracting PRNU patterns of camera [8]. By computing Peak to correlation energy, the PRNU pattern of original videos and videos transmitted from one device to another are compared, also the PRNU patterns of original videos are compared with each other to check the likelihood to discover if the videos create from the same device or not [8].

Using generalized noise model, source device identification can be performed on natural images. A statistical test approach is proposed in [9], likelihood ratio test (LRT) is used for identification. The generalized noise model gives better accuracy to distinguish a natural image got by different digital camera device.

Akshatha et.al [10], images are denoised using wavelet denoising filter and this output is fed to support vector machine classifier for identification. Images with same make and model are classified using this technique based on wavelet denoising filters [10].

Signal dependent noise model based on pixel information is designed in [11], statistical distribution of pixels for JPEG images is used as a fingerprint in this method. Based on variance of pixels noise unique fingerprint is developed. LRT is considered in identification process [9, 11].

Balamurugan B et al [12] proposed the enhancement of PRNU pattern for better identification of source device. 300 images of 6 different cameras are used for experimentation.

Maximum likelihood estimator is derived for estimation of PRNU fingerprint in [13]. JPEG compression, denoising, resizing is performed in this method.

III. SYSTEM DEVELOPEMNET AND DISCUSSION

In this paper, source camera identification is performed based on correlation values of RGB channels of images. Reference PRNU pattern is used as a ‘fingerprint’ in this process. Correlation is calculated individually for red, green and blue channels of each image which provides better accuracy.

To recognize source of query image, various methods are available as mentioned in Section II. In this paper, correlation is calculated as based on [7]. Proposed algorithm includes following steps: 1. Denoising of images 2.Extracting PRNU patterns 3.Calculating reference PRNU pattern 4.Calculating correlation values with each reference PRNU pattern 5.Analysis and comparison of obtained correlation values 6.Calculating accuracy.

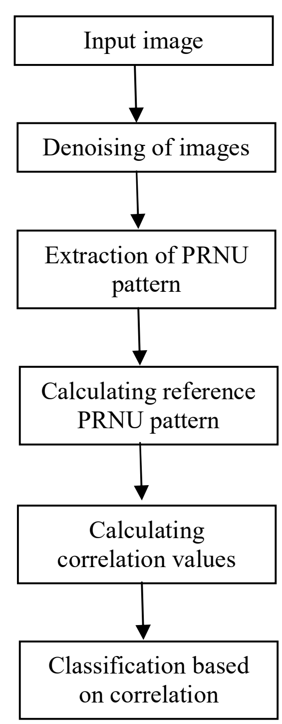

Fig.1: Flowchart of proposed system

As mentioned in flowchart, denoising of input images is obtained using sigma denoising filter. Sigma filter is used for denoising of image, as it allows channel-wise denoising. Whereas guassian filter denoises the whole image. But for better accuracy, sigma filter is used. PRNU extraction method includes denoising of images and then based on Lukas et. Al [7], PRNU is obtained. By averaging PRNU pattern of training data, reference PRNU pattern is obtained. This reference PRNU is nothing but the fingerprint.

Correlation value of each channel for each image with the reference PRNU is obtained and compared. Channel-wise correlation is calculated, after that sum of all correlation values for each channel of a single image is stored for further comparison with reference PRNU pattern. In such a way, a matrix is obtained where all the reference patterns for number of devices and testing data is stored. All values are used for comparison purpose whenever query image obtains.

In this paper, 800 natural images of 5 different camera brands having 25 different models are used from Dresden Image Database [9]. From 800 images, 125 images are kept aside as a testing data which includes 5 images of each 25 model. Remaining 675 images are used for training purpose like calculating reference PRNU pattern. Size of image is set to 2592x1994, which is obtained by resizing all images. As different camera model captures image with its default size so, resizing need to be done. After resizing extracted PRNU also comes into fixed size so that averaging and obtaining reference pattern becomes easy. Sometimes, flat field images and natural images are also considered and compared for betterment of reference PRNU pattern. Scene contamination is present in natural images, hence, extraction process of PRNU patterns is quite lengthy in case of natural images. Channel-wise extraction is beneficial, as green channel of image contains somewhat greater amount of PRNU pattern. As a result, channel-wise correlation value changes.

IV. RESULTS

After making analysis over all 25 reference patterns of 25 devices, the query image from testing data classifies correctly after comparing the correlation values. 125 images are used for testing the designed model. As calculating correlation value is a statistical way, the accuracy obtained is 100 percent. Graphical user interface is programmed and made as a product of this algorithm. Resizing of all images is performed before extracting PRNU. Extraction of PRNU is obtained after applying sigma denoising filter. Reference PRNU pattern is achieved by averaging PRNUs of training data for each individual camera device [7]. Channel-wise correlation is calculated which gives better results. Because individual hannels' correlation gives very minute details of image noise pattern which increases accuracy.

Guassian filter gives overall correlation value of an image, which does not give proper correlation as obtained by using Sigma filter, and hence it affects accuracy. Sigma filter achieves correlation more precisely as it performs channel-wise operation. Following table describes correlation values obtained by using both filters.

Query image	Gaussian Filter (Correlation Value with respective ref. pattern)	Sigma Filter (Correlation Value with respective ref. pattern)
CanonIxus55_1	0.0085	0.0735
CanonIxus55_2	0.0196	0.0813
CanonIxus70_1	0.0048	0.0574
CanonIxus70_2	0.0013	0.0235

Table 1: Correlation values using Gaussian and Sigma

V.CONCLUSION

In this paper, we present a source camera device identification model based on PRNU extraction using denoising filter. The Photo Response Noise Uniformity is a unique pattern which can be used for identification of source device from captured data like images or videos. By averaging extracted PRNU reference pattern is generated which is nothing but a fingerprint. Channel-wise correlation achieves better results.

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