Chapter 1
A DFT-Based Analysis to Discern Between Camera and Scanned Images

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ABSTRACT

Digital images are generated by different sensors, understanding which kind of sensor has acquired a certain image could be crucial in many application scenarios where digital forensic techniques operate. In this paper a new methodology which permits to establish if a digital photo has been taken by a photo-camera or has been scanned by a scanner is presented. The specific geometrical features of the sensor pattern noise introduced by the sensor are investigated by resorting to a DFT (Discrete Fourier Transform) analysis and consequently the origin of the digital content is assessed. Experimental results are provided to witness the reliability of the proposed technique.

1. INTRODUCTION

Digital images are nowadays used in the majority of the application fields in place of "old" analog images because of their easiness of usage, quality and above all manageability. These favourable issues bring anyway an intrinsic disadvantage: digital content can be simply manipulated by ordinary users for disparate purposes so that origin and authenticity of the digital content we are looking at is often very difficult to be assessed with a sufficient degree of certainty. Scientific instruments which allow to give answers to basic questions regarding image origin and image authenticity are needed (Chen, 2008). Both these issues are anyway connected and sometimes are investigated together. In particular, by focusing on assessing image origin, two are the main aspects

DOI: 10.4018/978-1-4666-1758-2.ch001

to be studied: the first one is to understand which kind of device has generated that digital image (e.g., a scanner, a digital camera or it is computer-generated) (Lyu, 2005; Khanna, 2008) and the second one is to succeed in determining which kind of sensor has acquired that content (i.e., the specific camera or scanner, recognizing model and brand) (Chen, 2008; Khanna, 2007; Gou, 2007). The main idea behind this kind of researches is that each sensor leaves a sort of unique fingerprint on the digital content it acquires due to some intrinsic imperfections and/or due to the specific acquisition process. Various solutions have been proposed in literature among these the use of CFA (Color Filter Array) characteristics (Swaminathan, 2008) is quite well-know, nevertheless two seem to be the main followed approaches. The first one is based on the extraction, from images belonging to different categories (e.g., scanned images, photos, etc.), of some robust features which can be used to train a SVM (Support Vector Machine). When training is performed and whether features grant a good characterization, the system is able to classify the digital asset it is asked to check. The second approach is based on the computation of fingerprints of the different sensors (this is particularly used in sensor identification) through the analysis of a certain number of digital contents acquired by a device (e.g., images scanned by a particular scanner, photos taken by a camera and so on). Usually fingerprints are computed by means of the extraction of PRNU noise (Photo Response Non-Uniformity) (Chen, 2008; Mondaini, 2007) through a digital filtering operation; PRNU presence is induced by intrinsic disconformities in the manufacturing process of silicon CCD/CMOSs. After that the PRNU of the to-be-checked content is compared with the fingerprints and then it is classified. In this paper a new technique to distinguish which kind of device, a digital scanner or a digital camera, has acquired a specific image is proposed. Because of the structure of CCD set, the (PRNU) noise pattern, left over a digital image, will have a completely different distribution: in the scanner case it should show a mono-dimensional structure repeated row after row in the scanning direction, on the other hand, in the camera case, the noise pattern should present a bi-dimensional template. On the basis of this consideration we construct a 1-D signal and by resorting to a DFT analysis, which exploits the possible existence of a periodicity, understanding which has been the acquisition device. The paper lay-out is the following: Section 2 introduces a characterization of the sensor pattern noise and the periodicity is discussed, in Section 3 the proposed methodology is presented and Section 4 describes thresholds selection based on ROC curves. In Section 5 some experimental results are brought to support theoretical theses and conclusions are drawn in Section 6.

2. SENSOR PATTERN NOISE CHARACTERIZATION

PRNU (Photo Response Non-Uniformity) noise is quite well-known as being an effective instrument for sensor identification because it is deterministically generated over each digital image it acquires. Such a noise is therefore an intrinsic characteristic of that specific sensor. The extraction of this noise is usually accomplished by denoising filters (Mihcak, 1999) and information it contains are used to assess something on the sensor characteristics. If we focus our attention on the acquisition process, it is easy to comprehend that when a photo is taken by a digital camera, basically a PRNU with a bi-dimensional structure is superimposed to it; on the contrary, when a digital image is created by means of a scanning operation the sensor array which slides over the to-be-acquired asset located on the scanner plate leaves its mono-dimensional fingerprint row by row during scanning. So in the last case, it is expected that a certain periodicity of the 1-D noise