B19 Camera Identification in Large Databases of Images

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After attending this presentation, attendees will be informed on different methods for camera identification, ranging from pixel defects to PRNU in digital cameras. Limitations and posibillities are discussed.

This presentation will impact the forensic science community by demonstrating the possibilities for extracting evidence from larger databases of images, such as child pornography and allow examiners to link cases to each other.

A digital camera consists of many electronic components. After the image has been formed on the image sensor, the image information will pass through all of the components before the final data file is written to flash memory. Each step in this process may add random noise to the image. Even during the image formation process itself, a noise-like pattern from the sensor may be introduced in the image. This noise-like pattern is a small but measurable systematic contribution to the signal, and is called the Photo Response Non Uniformity (PRNU) pattern. The visibility of this signal is limited and may be a small difference depending on the intensity of the signal. In practice, this means that well illuminated images will result in a better extraction of this signal compared to when the image is dark. Extraction of these patterns is done with complex filters, such as wavelet filtering.

The PRNU pattern itself can be determined from the image and it preferably is done with images with no discernible textures (flat field image, for example from a grey surface). In the past, the influence of strong compression was examined, and it appeared as though it was still possible to extract the PRNU pattern; however, it initially turned out to be more complicated than once thought. The examining of the PRNU pattern for forensic use is well researched by Jessica Fridrich and others.

There is a standard working procedure for the examination of PRNU in casework. The examiner will compare the retrieved pattern with one or more images. It will also be determined if the pattern is specific for the sensor (i.e., device characteristic) and determine the influence of possible class characteristic signals in this signal (i.e., brand or model characteristic). For this reason, at least three, and preferably ten cameras of the same make and model were used to validate the method for PRNU comparison.

In practice, it is not always possible to have the camera for casework; however, it is possible to determine if a set of images have been made with the same camera or different cameras based on the PRNU pattern. By comparing the pattern from a questioned image with the pattern from a set of reference images made with a suspect camera, it can be determined whether the questioned image was produced with the suspect camera or not. This works when the image is authentic, but fails when the image underwent any spatial transformations (e.g., rotation, shearing, resizing) because the “fingerprint” is desynchronized, unless the same transformations are applied to the reference material. It is also possible to alter the image such that the PRNU pattern is filtered out, although this is complicated and time consuming.

Other techniques for camera identification also exist, mainly based on statistical features. However, these approaches often involve time

consuming feature extraction and SVM training and only work on the classification level.

With this research, the influence of aging of cameras was also examined. This research also showed that matching based on a PRNU pattern within a two-year time frame for different models and brands of cameras was still successful. Also heating the cameras to 50°C, and freezing to -20°C, did not significantly alter the PRNU pattern within the tested cameras.

The use of large image databases, such as child pornography and other databases of relevant images will require significant processing power. For these, it is important to have a better pre-selection, based on other information, such as quantization tables of images which can be extracted instantly. The results of the examination based on images that were downloaded from online photo websites are demonstrated, and groups of cameras between the different images are found. For a good comparison, it is important to have the most original images, or to know exactly what kind of operations have been conducted on the image. Since in casework the ground truth may not be known, it is important to draw conclusions based on a Bayesian framework.

PRNU, Camera Identification, Image Comparison

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