B19 Examining Photo Response Non-Uniformity for the Comparison of Cameras

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After attending this presentation, attendees will learn what conclusions can be drawn from Photo Response Non-Uniformity, how to validate the method, and methods for examination and practical software.

This presentation will impact the forensic community by providing practical methods of validation and some statistical background for determining if images are made with the same camera.

Camera identification, based on pixel artifacts, has been widely known in forensic science for over a decade. Currently, sensors (CMOS/CCD) are manufactured with no pixel defects, and the Photo Response Non-Uniformity (PRNU) can be used as a comparison measure for a specific camera. The PRNU is a measure to identify cameras based on the slight variations between pixels which is characteristic for a camera and claimed not to vary in time.

For practical use in forensic science, it is important to validate the results and also the causes of the PRNU. This paper aims to answer two questions:

- Is there a practical method for measuring PRNU?
- What are the causes of PRNU and statistics behind it?

In the past a Matlab-script for reading the PRNU was developed for low resolution cameras. Since it is not easy to use on a wide scale, it was converted to Java coupled with a database of cameras. The goal of this application is to help forensic researchers and others to determine the source of a digital photographic image. To achieve this goal both the digital image(s) and the suspected source camera is needed. It is also necessary to have several other digital cameras available, preferably of the same brand and model to compare the results. This application works by extracting an average Photo Response Non-Uniformity pattern, a form of chip specific noise, from the images of interest. The correlation between the PRNU and reference patterns from several cameras is calculated. The reference pattern that has the highest correlation is most likely to be the source camera for the image of interest.

The following steps are taken during the extraction process of the PRNU:

- Blocks of pixels are averaged to reduce jpeg artifacts.
- A convolution with a small Gaussian filter is performed.
- The filtered image is subtracted from the original to get the filtered noise.
- The image edges are set to zero (convolution causes errors near the edges).
- Multiple PRNU patterns are averaged to one pattern.
- The PRNU patterns can be stored in a database and a hit list will appear with a ranking. When using this program it is important to validate the results by using several same type cameras to know how random the pattern is. The software for this database is named PRNU Compare and available from www.sourceforge.net.

Within this research an attempt is made to find a statistical measure to objectively qualify the value of the evidence, by dividing the probability density functions under two hypothesis. Based on the correlation found between the PRNU pattern extracted from the questioned image and the flat fields from the suspect's camera a Bayesian conclusion could be drawn. The results are convincing, since the correlation between two images having the same origin is much higher than when this is not the case. Due to the large amounts of test data needed to reliably estimate the density functions, it is not a practical approach. A few alternative approaches are mentioned, which may be useful for continued research on solving this issue.

Different methods for concluding the results are discussed as well as future research within the European Network of Excellence FIDIS (www.fidis.net), where an attempt is made to link cameras based on PRNU, (e.g., You Tube).

PRNU, Likelihood Ratio, Camera Identification

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