C1 Large-Scale, Common-Source Identification of Digital Camera Images

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After attending this presentation, attendees will be aware of a method for large-scale, common-source identification of a digital camera with possibilities to improve the speed of identification.

This presentation will impact the forensic science community by showing that large-scale camera identification is possible on a standard desktop computer in forensically relevant time while still maintaining a high degree of accuracy.

Photo Response Non-Uniformity (PRNU) noise, present in images made by a digital camera, can be used to identify the source camera of an image or link images with a common source. PRNU is caused by imperfections of image sensors during the manufacturing process. Due to these imperfections, each pixel on a camera sensor gives a slightly different signal, even when receiving the same amount of light. PRNU noise is systematic, meaning that it is approximately the same for every image made by a specific camera. Therefore, it can be used to identify the source camera of an image.

Many cases, such as child pornography cases, have large numbers of images (>10,000) from unknown sources. To identify a common source between these images, all the images have to be compared to one another. For example, a case with 10,000 images results in approximately 50 million comparisons. Using the original method, it would take roughly one year of computation time on a desktop computer with a 2.3 GHz quad core Central Processing Unit (CPU). For practical purposes, this is too long; therefore, two methods have been proposed in the past to decrease the computation time of camera identification.

The first method is to reduce the number of pixels used for the comparison of the PRNU patterns. Instead of taking all pixels of an image, only a percentage of the pixels are selected. The second method reduces the bits per pixel to store the data. Both methods reduce the information and, therefore, the computation time needed for the camera identification process. Applying these methods to a case with 100,000 images reduces the calculation time to approximately one day instead of one year; however, these methods were designed for cases where a suspect device is available to generate high-quality PRNU noise patterns.

Experiments on single-image comparison showed that applying these methods results in a low sensitivity: approximately a true positive rate of 0.65 at an experimental false positive rate of zero. To counter the negative effects of reducing the information, an algorithm was developed. This algorithm increases the sensitivity to approximately 98% at a small fraction of the total calculation time.

The idea behind the algorithm is that the PRNU noise pattern becomes clearer when multiple images of the same camera are used to estimate the PRNU noise pattern. The assumption is that the two images with the highest correlation above a certain threshold have a common source. The PRNU noise pattern of these images is then averaged for a clearer pattern. More images are added to this pattern, if their correlation with this averaged pattern is above the threshold. Images that would normally fall below the threshold, even though they are from the same source, are now added to the averaged pattern; while other images (originating from a different source) that were above the threshold by random chance, are now excluded.

This package of methods allows for large-scale, common-source identification on standard desktop computers, available to any forensic scientist, in a reduced amount of time.

This method can be combined with the quantization tables in JPEG files as a pre-selection measure as well as using Graphics Processing Units (GPUs) to improve the speed with larger databases of child pornography cases. Practical results of a large database of images are presented.

Image Comparison, Camera Identification, PRNU

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