W16 Forensic Image Processing

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The goal of this presentation is to provide a working knowledge of forensic image processing to enable an analyst to apply the optimum image processing algorithms to surveillance video and digital photography.

This presentation will impact the forensic science community by providing basic forensic image processing skills for the analyst. Surveillance video is nearly ubiquitous and a successful analyst is one who is familiar with forensic image processing and how to use it.

Contrast: A histogram can provide information about the amount of contrast in an image. Since image contrast is the difference in brightness between pixel values in a scene, the shape of the histogram is directly related to image contrast. For example, an image with a high level of contrast will have a broad-shaped histogram, but an image with low contrast will have a narrow histogram.

Pixel values in an image can be redistributed to a different range in an output image (i.e., histogram modification). This process has the effect of "stretching" or "compressing" the intensity range in the output image. If the pixel values are stretched to the full available range, then all pixel intensity values are utilized. This process can optimize the contrast and brightness of the output image.

Spatial Filters: Spatial filtering, or convolution, is an aspect of image processing. The process of filtering involves a moving window of array coefficients (i.e., weights). The size of an array, or kernel, is usually an odd number of pixels such as 3 x 3, 5 x 5, or 7 x 7. As the kernel is incrementally positioned through an image, the value of the pixel at the center of the kernel is multiplied by the value of the corresponding pixel in the image. For a given kernel position, all the kernel values are multiplied similarly and summed to produce a new output image. The next kernel step associates the next image pixel with the center of the kernel, and this process continues for the entire image.

The value of an output pixel from spatial filter is a function of the adjacent pixels in the original image. Spatial filters can be used to isolate the high and low frequency components of an image. High frequency components can be removed by either a low-pass filter or a rank filter.

Low-Pass Filters: Low-pass spatial filters are typically used to minimize Gaussian, or random noise. Ideally, the frequency of the noise is different from the frequency of the information in the image. The output pixel from a low-pass filter is a weighted sum of the adjacent pixels in the input image.

Edge Operations: Edge operations are types of spatial filtering in which each pixel is replaced with a weighted sum of the adjacent pixels. The type of edge operation is controlled by the weights that are applied to each of the adjacent pixels. For example, vertical or horizontal edge detection can be performed by choosing specific weights. There are two general objectives for edge operations: (1) increase image contrast; and, (2) detect edges within an image.

Smoothing: Image noise suppression via smoothing is a fundamental procedure in image enhancement. The trade-off for noise suppression is image blurring, which can be problematic for edges in a digital image. Noise suppression is usually accomplished with an averaging filter or a Gaussian filter.

Reference(s):

1. Borengasser, M., 2018. *Forensic Image Processing*, in preparation.

Image Processing, Surveillance Video, Digital Photography

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