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Forensic Science Research Paper

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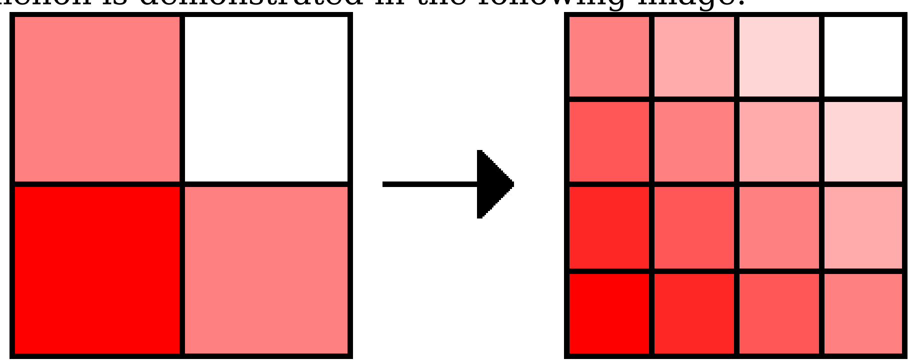
The Emergence of Digital Imaging in Forensic Science

A recent survey of American teenagers conducted by MIT indicates the today's teenagers rank the personal computer as the most important invention of the 20th century. Truly, this remarkable device has changed aspects of nearly every area of science. This holds true for the area of forensic science, where computers are being integrated into almost all aspects of forensics. One particularly recently developed technology is the utilization of computers for digital imaging. Digital imaging consists of using a computer to analyze, interpret, or create digital images and video. The main example of this technology is involved with preparing video from surveillance cameras, both motion and still, or even regular cameras. Computers can be used to enhance the quality and visibility of the pictures or videos taken, allowing them to be used in the courtroom.

One of the most commonly utilized aspects of forensic imaging is the analysis and cleaning of images and video in connection with a crime. Surveillance cameras normally have notoriously bad quality from a number of factors, including poor resolution, incorrect contrast, being out of focus, blur from motion, and image noise from dust, dirt, or electrical connections. Of these problems, the very low resolution of the camera is oftentimes the largest challenge. This produces a grainy, oftentimes hard to see picture. When the tape is digitized into a computer for analysis and enhancement, zooming is next to impossible, because the individual elements of color (pixels) cannot be magnified without loss of quality. A solution to this problem is to 'mathematically interpolate' sub-pixel values. (Kovesi) This phenomenon is demonstrated in the following image:



As you can see, the image on the left has been 'enhanced' to show a higher density of pixels. This will enable the forensic scientist to zoom in closer to an important part of an image, such as a burglar's face or a vehicle's license plate.

In many videos, especially when the camera or the subject is moving, a motion-blur can is recorded on the film. Various techniques exist to try and restore the image. One such algorithm, the Richardson-Lucy algorithm, initially tries to calculate the direction of the motion's blur, and then takes the average of a few pixels around each point, and uses that to adjust the point's actual value. Che-Yen Wen PhD. and Chien-Hsiung Lee B.S. wrote a paper "Point spread functions and their applications to forensic image restoration," which appeared in the Forensic Science Journal, vol 1, 2002. In the paper they describe a method of mathematically describing the image degradation, which is known as a 'point spread function' (PSF). They propose that by applying the mathematical inverse of the original PSF, that the distortion can be removed, rendering a clear image. They demonstrate the effectiveness of their algorithm by taking an image from an actual forensic case, and trying to determine the original image. (Wen) A simplification of their method can be demonstrated by the following series of three images, which were created using The Gimp, a free and open source program freely available from the internet:

In this series of images, the original image is on the left, the blurred image is in the center, and the image with a 'sharpen' filter applied is on the right.

Of all the varied problems that can plague a surveillance video, large amounts of noise on the tape can lead to very frustrated investigators. One potential pitfall in the course of the investigation is that repeated viewing of a standard magnetic video tape can reduce the quality with each subsequent viewing. In this case, digitizing (copying to computer) is best preformed the first time the original is played. If the tape can be played without damaging the tape, then multiple digital copies can be created, with the final version created from the average of all the copies. If the picture has little movement, such as a night shot, then adjacent frames can be combined to collectively reduce the noise. (James 2003)

The other common problems with surveillance video can also be similarly rectified, with varying degrees of success.

Jeff Glickman of Phototek Imaging, a Portland, Oregon based forensic imaging company, tells of a case where a video store robbery and murder was caught on surveillance camera. Unfortunately, the burglar had taken great care not to show his face to the cameras in the store. Fortunately, one of the cameras managed to catch a few seconds of the robber's face. "Glickman viewed more than 11,000 frames of video over six weeks to isolate the single video frame that could recover the suspect's image. Nearly 600 man hours were required." The picture taken from the video was distributed to members of the NYPD, and the murderer was tried, convicted, and sentenced to three life terms in a New York prison. (Glickman) When a positive identification depends on evidence from a video or image, forensic image analysis is of vital importance.

The future of forensic imaging technology is quite exciting. At the website of Clarifying Technologies Inc, they have an interesting look toward the future. They note that the tremendous increase in raw computing power has started to allow for live filtering and restoration of full-motion video in real time. They also remark on how increased understanding of human perception and algorithms have helped the development of more advanced filters, such as adaptive filters that learn from frame to frame. (Clarifying Technologies)

Altogether, forensic imaging techniques have enabled many unsolvable cases be resolved. Whether using the latest software tools to mathematically and algorithmically remove problems with the video image, or doing back research on cold cases, the day-to-day life of a forensic image analyst is filled with excitement and new discoveries.

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