Biometrics, Image Capture and Enhancement

Primus J. Tillman

Assistant Professor, College of Business and Technology
East Tennessee State University

Every time the terror alert level is raised, image capture and enhancement also becomes an issue. Homeland security is a very real dilemma that requires the most modern technology and tools available to help prevent a recurrence of the events of September 11, 2001. But the best technology and tools are useless without enough trained, skilled, and experienced persons who can use them swiftly and accurately. This is where educational institutions, such as East Tennessee State University; educators, such as Professor Primus Tillman; and technology, such as Adobe's Premier, After Effects, and Photoshop enter the picture to use and teach image capture and enhancement technologies.

Biometrics uses individual characteristics, such as fingerprints, voice, and face recognition to detect and detain dangerous personnel. The technology uses finger scan, iris scan, face scan, voice scan, and other identity techniques as authentication devices. Image enhancement uses computer hardware and software to identify people from video and still image captures. Combined, they comprise a valuable deterrent to homeland security threats.

Homeland security is not the only fertile field for biometrics, image capture and enhancement. The last couple of years saw a dramatic upsurge in the number of surveillance cameras being used as a tool in businesses and law enforcement agencies for keeping real-time track of events in both private and public places. Closed Circuit Television (CCTV) has matured significantly from its initial purpose of enabling companies to protect their property. After the attacks of September 11, 2001, policymakers, corporate executives, security and intelligence services are turning toward video surveillance technology as a weapon against terrorist threats and as a response to the public and private demand for more security.

Image capture and enhancement technology presents a dichotomy: balancing the loss of civil and personal liberties with the gain in public and private security. How does the ability to use face recognition techniques to detect potential national security threats weigh against the potential for a government agency to spy upon innocent citizens unaware that their actions are under surveillance? How does the ability of federal, state, and local law enforcement agencies to maintain huge databases of faces and names balance with Fourth Amendment assurances of security within the home? Does a reduction in criminal activity justify the loss of privacy engendered by the collection and storage of personal information in databases maintained by government agencies?

For example, the real, or perceived, increase in crime and several high-profile school campus shootings have prompted widespread appeals for improved video surveillance in airports,

schools, and public parks, and in private, corporate and government buildings—in other words, everywhere people tend to congregate in all public and private places. Every professional sporting event now conducts searches and crowd surveillance. Could the Rose Bowl, the Super Bowl, or the NCAA Final Four afford to ignore the possibility of a terrorist attack at such well-attended events?

Airports and other arrival and departure points have long relied on obsolete and outmoded equipment. But current threat levels mandate an immediate upgrade to and extensive use sophisticated surveillance equipment and techniques to rapidly detect and deter terrorist activity. The value of image capture and enhancement has already been proven by the number of *persona non grata* who have been identified and refused entry into the United States, possibly preventing additional terrorist attacks.

Las Vegas, Nevada, depends heavily on security and surveillance technology. For decades, gaming establishments in Las Vegas, Atlantic City, and Colorado have successfully relied on state-of-the-art surveillance and image capture and enhancement equipment to prevent theft, expose cheating, and deter employee misconduct. Of course, the enormous amount of money available in these locales contributes to the ability to purchase and use the best equipment available, and employ the most skilled specialists, whereas most areas and agencies do not have the resources.

More and more, video cameras are the instrument of choice to record criminal acts as they occur. The increase in videotape usage to record criminal acts, while contributing to solving crimes, has created a corollary problem for law enforcement: how to obtain usable images from cheap, poor-quality videotape. Law enforcement agencies without the manpower, technical skills, or equipment to enhance videotape images often resort to expensive outside consultants.

Currently, many poor-quality cameras and surveillance techniques produce low quality images. At the commercial level, businesses use equipment that produces low-resolution, grainy, black-and-white images that are difficult to enhance, analyze and interpret. Enhancing these images requires a skilled, experienced technician who has the proper tools. Many businesses have installed low-end, multiplex systems with multiple lenses and multiple angles, so that when the screen image is blown-up, the resolution is poor. These cameras cannot capture images more than a few feet away.

Therein lies part of the problem: Without high-end, quality, reliable equipment and trained specialists to use the equipment, there is a tremendous potential for mistakes. Airports, hotels, convenience stores, and other public places commonly use low quality surveillance tapes that require significant enhancement before they are usable in apprehending criminals high quality imaging tools can be significant additions to law enforcement agencies, if they have the equipment, the personnel trained to use it, and the policies and procedures in place for using it.

A single camera, single lens approach to capturing images thirty or forty feet away is more effective. But monetary constraints limit the sophistication of the technology being used. That is where Assistant Professor Tillman has contributed his skills and abilities to several law

enforcement efforts in eastern Tennessee, which, except for Knoxville, is primarily rural, by enhancing low-quality images so that they are acceptable in the pursuit and prosecution of criminals. However, the need is increasing for more trained and qualified technicians.

Adobe Photoshop and Premiere are currently among the most accessible and powerful tools for imaging. Law enforcement agencies are using them for many purposes: video image enhancement, forensic odontology, latent print enhancement, jury presentation, accident and crime scene reconstruction, photographic comparison and analysis, just to name a few. It is important to remember, however, that results — not the tools and techniques used to obtain the results — define the process.

Tools and techniques are only the means to the end, and they will only improve and become more sophisticated over time. Image capture and enhancement will become faster and more accurate, contributing to improved law enforcement, forensics, and other uses. Users should not make the mistake of becoming enamored of a set of applications or equipment, but must be ready to adapt to changes.

Even when image enhancement and analysis contributes to the successful apprehension of a criminal, the judicial system faces another, major impediment to the successful prosecution of the case in a court of law. While digital image analysis and enhancement have been around since the 1970s, their use in law enforcement has been limited because the technology was not sophisticated enough to provide images of sufficient detail to eliminate the potential for reasonable doubt when presenting a case to a jury, without resorting to highly educated, highly skilled — and therefore high-priced — experts. The first instance of a court in the United States admitting digitally enhanced video images as evidence was the Lori Auker abduction and murder case in Point Township, Pennsylvania in 1989. A specialist enhanced the images provided by an ATM video camera that provided detailed information, including the make and model of the car within two years and contributed to the conviction of the perpetrator.[1]

Since then, law enforcement agencies have realized the value of image capture and enhancement, and it became obvious that there is more demand for the technology than there are qualified personnel to use the technology or the funds available to exploit the technology. The need is for a widespread, uncomplicated, inexpensive, easily obtainable technology that combines computer hardware and software to capture an image, digitize the picture frames, enhance features, and provide output in video, hard copy, or digital file media. The objective is to provide image capture and enhancement technologies that a layman can use to obtain digital images for two reasons: pursue lawbreakers and present evidence in court.

Adobe also realizes the law enforcement benefits of image capture and enhancement technology to the extent of establishing the Adobe Law Enforcement Users Group to "…assist our members who serve their communities and the victims we are sworn to protect." The ALEUG was formed to support military and civilian law enforcement efforts to use Adobe Photoshop and Premiere for forensic purposes."[2]

Businesses use video capture technology as a means of crime prevention or criminal apprehension. For example, every automated teller machine has at least one video camera in place to record customer transactions. Las Vegas casinos have video cameras installed in every conceivable location to observe transactions, identify cheaters, and prevent fraud. The criteria for an acceptable image capture is an image enhancement technology that provides enough detail for a person to successfully interpret the image in a short period of time — that is, to identify, select, and zoom in on selected frames and enhance the selected images to high resolution, accurate, reliable, and legally impeccable standards.

In the face of the dramatic upsurge applying image capture and enhancement as a tool for refining national security, for increasing public and private security interests, and for improved law enforcement, the problem has been finding, educating, and deploying qualified persons to use the tools and technology. Professor Primus Tillman and his students at East Tennessee State University have arrived at a solution to the problem of making videotape image enhancement available, affordable, and technically feasible for law enforcement agencies to use on a routine, day-to-day basis. They have devised a practical and effective process in which authorities can use consumer-level technology to capture, enhance, index, and publish images gathered from surveillance cameras.

Another element of using image capture and enhancement is the ability to store, retrieve, and interpret captured images. Image enhancement uses computer hardware and software to create a digital image, enhance all or part of it, and save the image as video, hard copy or a computer file that is subsequently stored or filed somewhere. The problem is that, while law enforcement agencies routinely use image capture and enhancement technology, there is no single protocol or standard for storing or sharing the technology among the wide variety of agencies at the federal, state, and local level. For example, the Automated Fingerprint Identification System (AFIS) is a huge database that is available to all law enforcement agencies at all federal, state, and local levels; however, there is no corresponding image capture and enhancement database. In an effort to develop a set of national standards and protocols, the Scientific Working Group on Imaging Technologies (SWGIT), has developed a set of guidelines and other working documents that are available at the SWGIT Web site, http://www.theiai.org/swgit/.

Key considerations include the media on which images are recorded and stored. For instance, a writable CD-ROM provides several advantages and satisfies several criteria. A standard computer with a CD burner is the only equipment necessary for producing non-erasable, usable digital images on writable CDs that are acceptable as evidence; images will not fade, as do hard copy photographs; CDs can contain large amounts of data, but are small enough to be easily transported, secured, and stored; CDs can be password protected to prevent unauthorized disclosure,

Altering a conventional image, such as a video or roll of film is relatively easy with today's editing technology. But writable CDs with embedded serial numbers are an effective deterrent to image alternation.

Another advantage is that the software necessary to produce images is standard, readily available, inexpensive commercial software such as Adobe Premiere, Adobe Photoshop, and Pictron Media Gateway Suite. Police departments and other agencies can have functioning image enhancement departments in a very short time without a long learning curve.

Among the issues that SWGIT is addressing are the selections of storage media, the documentation of darkroom and digital image processing techniques, the selection of digital image compression methods, and the preservation of chain of custody, all of which relate to quality. SWGIT recommends using lossless image compression as a means of saving media storage space instead of the commonly used lossy JPEG format. If lossy compression is used, the highest quality storage option should be used to minimize information loss, which reduces the ability to enlarge, enhance, or analyze an image and identify terrorist or criminal activities.

Education is partly a matter of finding a need, a need for more and better-trained image capture and enhancement specialists, and filling the need. The shortage of specialists provides an entirely new focus on, and motivation for, educating students in the field of image capture and enhancement. This focus enables students to become experts in the field of image enhancement for crime prevention and solution, for national security, and for commercial surveillance and security.

Not only do educational institutions such as East Tennessee State University satisfy a need and fill a void by creating a new field of employment opportunities for graduating students. They can immediately put their knowledge to work in education, business, technology, law enforcement, and even medical fields.

Image capture and enhancement, along with biometrics, is a science of today and the future. They will provide better tools to use during these times of turmoil and rapid changes. The technology is immediately available to be used in upgrading homeland security, providing more effective law enforcement, and improving business and industry security. Going forward with the use of the technology will require more and better-trained specialists, which requires more educators and educational institutions with the resources and skills to provide the knowledge of how to use the technology.

---

[1] Image Capture and Enhancement Comes to the Courtroom, http://www.acq.osd.mil/bmdo/bmdolink/pdf/ima.pdf
[2] Adobe Law Enforcement Users Group, http://www.aleug.org/index.html

PRIMUS J. TILLMAN is currently the lead in the Interactive Multimedia area of the Department of Business and Technology at East Tennessee State University. Before coming to ETSU, he served at the Memphis College of Art. He previously served as the Multimedia Specialist for research and development at Federal Express corporate headquarters. His specialty is teaching interactive multimedia, 3D and supporting corporate and industrial development projects.