Homeland Security
Science and Technology

TechNote

U.S. Department of Homeland Security
SAVER
System Assessment and Validation for Emergency Responders

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

Located within the Science and Technology (S&T) Directorate of DHS, the SAVER Program conducts objective assessments and validations on commercial equipment and systems, and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, contact the SAVER Program Support Office.

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NUSTL

Mobile X-ray Systems for Search and Inspection

Driven by the need to intercept explosives, weapons and other illicit materials before they can be smuggled aboard commercial airliners or into a restricted area, the technology used in x-ray systems for search and inspection has advanced significantly. Carefully designed x-ray sources that minimize stray radiation are used with sensitive high resolution detectors and sophisticated image processing software to interrogate objects such as hand luggage and baggage with transmitted, reflected (backscattered) or two x-ray energies. All of the advanced features developed for baggage scanning systems are now available in van-mounted mobile systems, and some are available in lightweight hand-carried systems. Emergency responders might be able to take advantage of this new technology to deal with threats encountered in the field.

Background

X-rays were discovered in 1895; they are electromagnetic radiation with a photon energy of 120 eV to 120 keV (kiloelectron volts; the high energy limit is loosely defined) and are generated by the impact of energetic electrons on a dense metal target or by radioactive decay. Their power to improve health care by imaging internal organs and bones was immediately recognized and drove the rapid development and deployment of x-ray imaging technology, including the development of computer aided tomography (CAT scans) to generate three dimensional images. As x-ray sources and radiographic film improved other non-medical applications such as non-destructive testing and quality control were developed. This x-ray technology base has been applied to the development of equipment for search and inspection to increase personal security.

Current Technology

More recently, radiographic film has gradually been replaced with compact, sensitive solid state detectors, and the x-ray generated images digitized using computed radiography or digital radiography. Light weight battery powered x-ray sources can now be used in place of radioisotopes or vacuum tubes, giving much better control over the energy and intensity of the x-ray beam and duration of exposure; typical portable sources generate x-ray energies less than 270 keV and can penetrate up to 1 inch of steel. These new technologies have enabled the development of handheld and van-mounted mobile x-ray search and inspection equipment that can be used under field conditions.

Conventional x-ray images are generated from transmission x-rays, those that pass through an object. It is now possible to create images from x-rays that are reflected, or backscattered, from objects. Less dense materials more efficiently backscatter low energy x-rays and thus are differentiated from high density materials, improving the chances of identifying explosives and drugs.

It is also possible to differentiate between low and high density materials by taking images of the same object at two different x-ray energies. This takes advantage of the rapid imaging capabilities of digital radiography and the fast processing capabilities of modern portable computers.

Rapid image processing can also be used to identify and display threatening material automatically using color highlighting to reduce human error; suspicious objects in the image can be enlarged in real time.

Computed Radiography

Medical imaging and nondestructive testing is often done using image plates, actually a flexible plastic sheet coated with a photostimulable phosphor (PSP) crystal, typically barium fluorobromide. Although image quality is excellent, because of the size and weight of the image plate reader this technology might not be ideal for security applications.

Digital Radiography

Digital radiography (DR) uses a variety of sensor technologies to produce digitized images indirectly but rapidly from x-ray signals. One approach uses electronics constructed on amorphous (non-crystalline, or disordered) silicon deposited on a flat glass panel. The panel is then coated with a scintillator (gadolinium oxysulfide) that generates light when illuminated with x-rays. The light is detected with an array of photodiodes; amorphous thin film transistors couple each photodiode to the readout electronics. Spatial resolution (the smallest detail that can be seen in the image) is 0.005 inches, determined by the diameter of the photodiode; the data can be read and an image generated in less than 3 seconds. Amorphous silicon sensor arrays on glass panels can be as large as 20 inches by 16 inches, which is more than adequate to image most suspicious objects.

Other scintillators (e.g., sodium iodide) and detectors (e.g., charge coupled devices) may be used in DR systems, with trade-offs in such factors as cost, resolution, sensitivity, plate size, and mobility. One problem with all field deployed DR systems is the cost and durability of the fragile flat panel detector.

Other Considerations

Equipment considered for acquisition should be evaluated according to ASTM F792-08. Emergency responders should be trained and drilled periodically in the use of any specialized equipment, including mobile x-ray systems. They should develop a Concept of Operations (Con Ops) that determines how any data will be used and follow a Standard Operating Procedure (SOP) that defines in detail the actions to be taken to deal with the threat. In addition, x-ray systems should comply with standards set by the U.S. Department of Justice (NIJ Standard 0603.01) and operated in accordance with federal and state radiation protection standards.

Emergency responders may need to deal with suspicious packages in the field. These should be considered to be explosive devices and handled using robotic equipment (figure 1). To provide event emergency security, it may be appropriate to deploy van-mounted x-ray scanners (figure 2) combined with robotic equipment (figure 1).

Figure 1. Mobile x-ray system consisting of a remotely operated x-ray source and flat panel detector deployed with robotic equipment.

Figure 2. Mobile x-ray system deployed in a van.

Conclusions

Modern x-ray technology provides high resolution imaging that can differentiate between organic and metallic objects and identify some possible threats automatically. The challenge is to evaluate and then choose appropriate equipment, develop operations and training procedures and understand how to use data produced by these instruments.

References and Resources

ASTM F792 - 08 Standard Practice for Evaluating the Imaging Performance of Security X-Ray Systems
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