Kirstine Wilson asks whether handheld backscatter or dual X-ray imaging technologies can better enhance onsite inspection of suspect bags and packages

INSIDE INSPI

Following the Charlie Hebdo attacks earlier in the year, the number of suspect bags reported has proliferated due to an escalation in security levels and heightened alertness from the general public. Although incidents involving suspect packages generally turn out to be false alarms, each occurrence requires due consideration by either a police or military team. Responses to incidents can often involve the deployment of field-portable X-ray imaging equipment to initially confirm the presence of a threat via visual inspection, though in other instances it will involve an immediate neutralisation or "render safe" response.

Over the past three years, in the UK alone, bomb disposal experts were called out to nearly 2,000 tasks involving suspected non-military improvised explosive devices (IEDs.) Over 50 per cent of these callouts turned out to be false alarms or had already been defused. But, while intelligence work uncovers a high percentage of planned threats, the 2005 London bus and subway backpack bombs and the 2013 Boston Marathon bombings should remind us that bombs hidden in bags and packages continue to be such an effective terrorist tool. The detection of explosives and IEDs therefore remains a key priority.

So what non-invasive imaging technologies are available to police and first responders to help reduce the number of call outs to military teams while increasing the effectiveness of search operatives and improving detection capability in the event of a genuine threat? Traditional transmission X-ray systems play an important role in revealing the inner detail of found items such as packages and bags. The can

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display crucial information regarding the functional IED components, allowing the operator to identify them by their shape, as well as revealing the locations of these component parts. This allows for a safe and successful disposal of the device.

For a routine responder, X-ray imaging gives the operator either a fast clearance of a false threat or valuable knowledge that he can pass on to a military response unit for eventual device disposal. Such systems can be deployed manually or remotely via an RoV. Some flat panel transmission X-ray systems also have the ability to recognise and separate out in colour any organic and inorganic material contained within an item.

One novel technology recently introduced into the marketplace is handheld backscatter X-ray imaging.

ECTION

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Flat-panel X-ray systems are still essential tools for suspicious bag inspections

Backscatter X-ray technology has been around for many years in the form of conveyorised X-ray systems in prisons and vehicle-scanning portals at customs checkpoints. But backscatter technology has only recently developed to allow for a handheld device that will check for the presence of organic material in bags, packages and behind wall panels or other non-metallic material. Transmission and backscatter X-ray imaging are fundamentally different from one another but both are highly effective detection technologies in the right situation. The difference between the two types of system is how they interact with the materials they encounter.

X-ray energy will do one of three things when interacting with a material: it will either pass through it, become absorbed or scatter back (Compton Scattering). These basic principles form the basis of X-ray imaging. In transmission X-ray systems, as the X-rays pass through the object some of the energy will become absorbed by the matter, the result of which is detected by an imaging panel placed behind the object. The detection panel collects the information and uses computer processing to convert it into a black and white image. Objects with greater X-ray density will absorb more X-rays and image better than objects with lower density, creating a high contrast image with several thousands of visible grey scales.

In "dual energy" transmission X-ray systems, two spectrums of energy are passed through the object. This gives information not only on the X-ray absorption characteristics of the object (its density) but also the atomic number of the material. The technique is based on the fact that high atomic mass materials, such as metals, have different X-ray absorption characteristics that low atomic mass materials such as explosives. The use of two different energies enables the high and low atomic mass materials to be distinguished.

X-ray data is obtained at both X-ray energies, and the two separate images are computer processed to compare low-energy and high-energy X-ray absorption. The displayed results characterise and identify the various materials by their shape. These X-ray systems also use colorisation software to separate materials into those which are likely to be organic (explosives, narcotics), inorganic/metal (batteries, detonators, cartridges) or something in between (plastics/ceramics) and the resulting image is displayed on a monitor for visual identification.

With Compton Scattering, when X-rays hit an object they scatter off molecules in all directions. Backscatter X-ray systems collect the X-rays that scatter in a backward direction from the target to the source and translate them into high contrast real time black and white images.

One useful characteristic of backscatter X-ray systems for suspect baggage detection is that they interact most efficiently with materials on the lower end of the atomic number spectrum – that is, low density organic materials rather than those at the higher end of the spectrum such as metals. In this way, backscatter X-ray systems are great at detecting organic threats such as explosives, including difficult-to-detect liquid explosives, contained within a bag or package. The image appears as a bright white object on a black background.

For safety reasons, handheld backscatter units need to work at lower voltages than transmission X-ray systems. The benefit in one respect is that they are truly handheld and safe for the operator working close-up, but on the other hand they are not able to penetrate deeply. But it is the unique ability of backscatter technology to highlight high density, low atomic number material such as explosives, while ignoring any superimposed objects and

clutter in a bag, to produce a very high contrast image that makes it a very powerful threat detection tool.

Released to the market in 2014, the first handheld backscatter systems have been highly successful at finding concealed drugs inside materials such as vehicle panelling, boats, walls and prison mattresses. They are now finding their way into the security field as a search tool for quickly identifying hidden explosive material.

The benefit such systems is that, unlike transmission X-ray systems, access to both sides of an object is not required, as the operator needs simply sweep the handheld unit alongside the entire object of interest at a few centimetres distance. The scanning process takes just a few seconds and an image of the scan target displays in real time on a small companion tablet connected to the imager via a wi-fi linkup. Other benefits relative to portability are the ability to scan in tight places and at non-traditional angles, or to positions so objects close to a wall or can be checked safely without the chance of accidental contact.

From a technology perspective, backscatter allows the scanner to leverage the contrast between organic and metallic objects which could be leveraged by the "trained eye". From a "use case" or concept of operations perspective, these traits allow for a tiered or layered inspection approach where the system could be the first step in the inspection of an unattended bag, before moving to other methods of dealing with the threat (using transmission X-ray, calling the explosives unit, evacuating the area, or detonation).

The value to a first responder is the speed and convenience at which searches and checks of items can be carried out., as well as the advantage of a small radiation exclusion zone. Unlike transmission X-ray, the clearance distance in front of the imager is only three metres. Because backscatter X-rays reflect back to the handheld imager, there is no safety standoff required behind the imaging system, which means the operator can use the equipment in close proximity and in areas that are difficult to reach.

For an event where multiple bags will likely need to be checked (such as a marathon) backscatter X-ray has no physical set-up, enabling immediate operation and a very fast point-and-scan solution; the operator passes from bag to bag within just a few seconds to carry out basic confirmatory search.

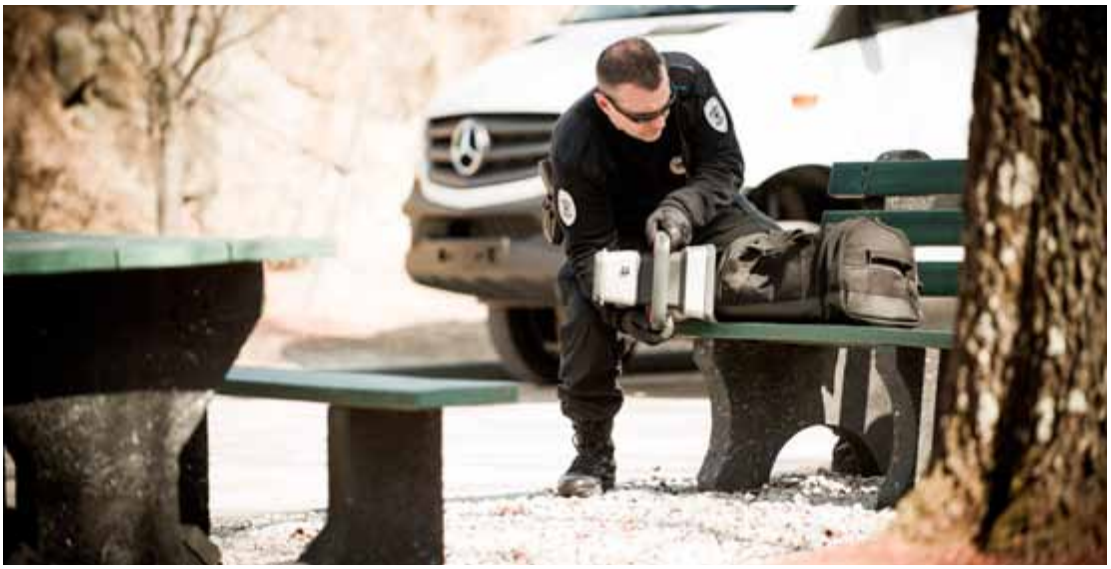
Its ability to ignore clutter, caused by superposition of objects in a conventional X-ray image, also makes backscatter a complementary tool to IMS-based explosives detection systems. The chaotic collections of compounds, people, light and noise at big events create a very challenging environment for analytical detection systems, and reliably spotting explosives, without generating a high degree of false alarms, is a huge technical problem. Backscatter gets around this problem by providing an easy-to-interpret image and focusing solely on organic compounds.

In the event that backscatter imaging detects organic material, the operator may make a response decision based on other contextual information about the suspect bag. In other scenarios the backscatter imager may be used as a rapid single-sided confirmatory check for the presence (or absence) of organic material; a transmission X-ray system can then be deployed to gather additional details about the exact nature of the threat and its construction.

On the other hand, where transmission X-ray really has its advantages is in its ability to actually "see" inside a bag, to zoom in on areas of interest, to confirm the presence of a detonating device, to reveal circuitry and wiring, to identify the location of a power source, to penetrate through a dense object that may be obscuring another object and to reveal both organic and non-organic objects. All this is vital information for IED confirmation, neutralisation and post-blast forensics.

So which of the two imaging technologies should search teams focus on? The answer is that for, suspect baggage detection, a multi-tiered approach is always going to be the most effective. By deploying complementary field-portable equipment that combines both fast confirmation backscatter X-ray for explosives detection and high-detail transmission X-ray imaging techniques for device detection and analysis, search operations can be significantly enhanced. This optimises the time spent on task for the operator and increases efficiency in the onsite detection of suspicious packages and explosive threats.

Kirstine Wilson is Sales and Marketing Manager at Scanna, a leader in X-ray screening and detection products for the security market with more than 20 years' experience in recommending X-ray screening solutions to defence, security and commercial organisations.



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Hand-held backscatter systems like the AS&E Mini Z can rapidly screen items and people for weapons and explosives