Technical Notes

X-ray scanning: optimising systems for security services

Nick Fox, CTO of 3DX-RAY, evaluates the benefits and drawbacks of different x-ray scanning techniques in security applications

X-ray technology has been used in security applications for a long time. X-rays offer you the unique ability to see inside a closed container without having to open or damage it in anyway. This alone gives a strong indication as to why x-ray scanning has been deployed so readily by security organisations the world over. However, that is not to say that there is one, simple way of using x-rays in security applications. Instead there are a range of techniques that can be used. The question is, which of these techniques best serves the main concerns of security operatives - delivering high quality, clear images quickly and reliably?

Transmission vs backscatter

At the most basic level there are two ways to create images using x-rays - either through transmission or scatter. Whereas transmission x-rays pass through an object unhindered, scatter x-rays, as the name suggests are deflected in many directions by the object. As a result transmission x-rays require the x-ray generator and detector to be on opposite sides of an object, whereas with scatter techniques, the generator and detector can be placed on the same side of the object - referred to as backscatter. Clearly in certain security scenarios using backscatter would be an advantage, but unfortunately it comes at a cost. As the x-rays are scattered both by the object being screened and the air in between the detector and the object, there will inherently be blurring on the final image.

Transmission x-rays are a more straightforward proposition. Having a straight line of x-rays passing through the object ensures that the final image does not include any stray scattered x-rays. As a result, image quality is a lot sharper. It also means that the x-rays can usually penetrate through the entire object and that all concealed objects are imaged, which is not always the case with backscatter.

Higher quality scans can also be processed. Dual Energy X-ray Analysis (DEXA) can be used to distinguish between materials within the object under investigation. This is often

represented in baggage scanning machines as a false colour image. This useful technique provides the operator with an instantaneous 'map' of the material content of a bag or other item - easily identifying those materials which are dense organic (potential explosives), or wiring and electronics (predominantly copper and aluminium), and clearly indicating areas that are too dense for x-ray inspection and could be used to conceal other threats.

Line scan vs full field

Clearly using transmission rather than scatter techniques, delivers significant benefits to security operatives. However, transmission x-rays can again be broken down into two main techniques: line scan imaging and full field imaging. With line scan imaging, x-rays are formed into a narrow linear beam. An object passing through the beam is scanned as a series of 'slices' that together form an image of the whole object. On the other hand full field imaging creates a wide beam that can cover a whole object.

Clearly full field imaging is able to produce images 'faster' as line scan techniques require relative motion between the x-ray detector and the object. However, for full field imaging there is a limit to the size of the detector that can be economically produced; whereas line scan imaging is completely scalable. By simply adding more elements the detector can be extended to whatever size is required. This means anything from bags to whole vehicles or cargo containers can be scanned in one pass with no loss of image quality. This is obviously an advantage in security scenarios where determining if an object is a threat quickly is crucial, particularly in situations involving potentially explosive devices. To scan larger objects with full field imaging would require the operative to take several scans and then for these to be collated digitally.

3D vs 2D

Whether using line scan or full field techniques, traditionally x-ray machines have only produced 2D images. However, more modern techniques have enabled 3D, or stereoscopic, images to be produced in real time. Of course 2D images help security operatives and can alert staff to threats far more effectively and safely than physical searches. Nonetheless, 3D images enable the operator to see a bag or container as you would see the real world in 3D. Obviously this gives significant advantages. First and foremost giving operators genuine 3D images significantly increases the probability of detection. In fact, trials with the US Government's Transport Security Administration (TSA),

using 3DX-RAY's own 3D imaging technology, showed a greater than 10% improvement in probability of detection. There is also a reduction in false alarm rates with 3D x-ray imaging, as operators are able to analyse images far more easily.

This is a critical benefit of deploying 3D imaging technology, as it makes it easier for operatives to interpret the images. With 2D images it takes a certain level of training and experience to recognise what individual objects are - recognising shoes and other common objects in a 2D x-ray scan can be difficult to do quickly at first. With 3D imaging however, it is much easier for new operatives to recognise these common objects, and so it is easier to analyse the image and focus on anything out of the ordinary. The result is that operatives using 3D systems require less initial training and there is a reduction in the time to competency, meaning a reduction in supervision requirements. This helps security teams to get up to speed quicker, and to provide the required level of security more easily.

Image quality, scalability & usability

When security services use x-ray scanning technology their requirements are clear - high quality images that need to be delivered quickly and reliably. As I have explained, line scan imaging can deliver the image quality as well as being flexible enough to be built into any system, whether it has been designed to scan bags or large cargo containers. As a result line scan technology is extremely cost effective. 3D scanning is a newer development but it provides significant benefits for security organisations. In particular it helps to improve operator performance, by making sometimes complicated x-ray images easier to interpret, training times can be shortened and the day to day decisions of operatives are better informed, quicker and more reliable as a result.

So, despite the options available, x-ray technology can be deployed intelligently and cost effectively. However, in order to achieve this it is important to understand what the exact requirements of each individual application are. By taking these specific requirements into account it is possible to deliver optimised scanners to provide the best-fit solution for any security scenario.