MODERN DAY

FORCE, BORDER AND PERIMETER PROTECTION

Rupert Swinhoe-Standen considers the use of 360º pulse radar in advanced surveillance, security and detection systems for border security and critical infrastructure protection

INFORMATION DOCUMENT

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The use of 360⁰ pulse radar in advanced surveillance, security and detection systems for border security and critical infrastructure protection

Area or line surveillance has typically been achieved using a range of techniques and sensors which may promise a great deal but which all have limitations in one way or another.

For example, solid barriers and wire fences can provide a strong physical barrier. When lined with passive sensors, both beneath the ground and along the fence line, and linked to microwave intrusion detection systems backed up with CCTV, they can also provide an excellent alert and alarm capability. However, what they do not provide is early warning.

There is no development of a situational awareness picture. The threat is already on your doorstep by the time the system alarms.

Moreover, where the requirement is for surveillance of a large area, or where the terrain inhibits the construction of perimeter fencing, or where earlier warning that humans are operating near a restricted area, then an alternative approach is clearly needed.

Situational awareness is now a core requirement for security operations, and those charged with border and perimeter protection and control are increasingly turning to RADAR (an acronym for RAdio Detection And Ranging). Using the lower end of the microwave area of the electro-magnetic spectrum, rather than the higher frequencies, much longer detection ranges are possible as well as the penetration of cluttered environments such as sand storms, heavy rain, snow and fog.

There are now various radar manufacturers worldwide offering radar sensor devices as well as, in some cases, the software required for the application of border and perimeter security, surveillance, force protection and intruder detection. But not all radar devices are the same.

For maritime purposes typically, low cost systems have been used which operate with magnetron devices for navigation, safety at sea, vessel traffic management and coastal surveillance. At the other end of the scale are multi-million dollar military grade systems providing long-range surface search and air surveillance. However, several years ago Kelvin Hughes Limited, based in London, UK, launched a solid-state radar (removing the need for a magnetron) called SharpEye™ and targeted the technology at the commercial marine market. Later with the development of an X-Band variant, the naval market was able to benefit from the technology in terms of a new highly capable situational awareness and navigation radar.

Whilst the introduction of solid-state, low power yet highly capable coherent pulse radar has revolutionised the maritime radar domain, it could be argued that solid-state technology has been around for much longer in the form of land-based applications such as flat panel array radars or dishes. However, most flat panel and dish type radars are designed for short range detection and they "look" in one direction only with a limited field of view depending on the resolution being set by the operator.

Flat panel systems are able to 'steer' the transmission of high frequency energy beams and 'stare' in a given direction from the face of the antenna and, by focusing the energy in a concentrated area, thereby delivering potentially more mean energy on target. Often these systems offer higher angular accuracy and resolution. However, the discrimination between two targets is often similar to X-band pulse radar.

Most flat panel and dish type radars when used for border and perimeter security applications operate in the Ku, K or Ka-band. However, these are potentially limited in range and highly susceptible to inclement weather such as heavy rain or sand storms. In addition, these systems normally operate on a continuous wave (known as FMCW – Frequency Modulated Continuous Wave) as opposed to 'pulse radar'. In general, X- band radars will outperform Ku, K or Ka-band radars in an identical environment.

Kelvin Hughes has recently applied the principles of its SharpEye™ system to produce a lightweight mobile radar, the SharpEye™ SxV, which is designed to overcome some of the problems referred to above in relation to border and perimeter surveillance applications.

There are a number of important differences between this technology and traditional approaches. First, pulse radar (as opposed to FMCW models) gives simultaneous short, medium and long-range transmission and detection.

Kelvin Hughes SharpEye™ SxV security and surveillance radar and integrated camera mount

Second, the provision of a rotating antenna provides 360-degree radar coverage. To achieve the same with a flat panel phased array system, for example, you would have to add more radars at the appropriate angles to get the area coverage. The single sensor required for a 360-degree radar cuts down considerably on cost, infrastructure and complexity.

Third, the system operates in operator selectable frequencies within the X-Band, a frequency lower than the Ku, K and Ka bands typically used, thus considerably improving its ability to penetrate and work in bad weather. With its Doppler processing of the received pulse

return, the receive module of the radar is able to process out (or filter) clutter without radar picture degradation, through the application of complex algorithms. ('Clutter' is a term used to describe unwanted returns such as rain, snow, sand and moving grass or, in a maritime environment, sea waves that may be hiding a target).

X-band pulse radar outperforms FMCW radars in a number of other areas too. Importantly they are less susceptible to interoperability issues or jamming where FMCW are, due to their broad transmission frequency.

A key disadvantage is platform integration. FMCW is susceptible to nearby signal reflectors such as metal structures. These could be from the structure of the radar and camera mount, the protected fence line or buildings. Solid-state pulse radar overcomes this because it is not continuously transmitting and receiving. To deal with transmitting and receiving in unwanted areas, a technique known as "sector blanking" is used. This is where the radar controls when it is transmitting and receiving within its 360-degree cycle.

A distinct advantage of the new solid-state technology is its size and portability. It is now possible to produce and deploy a radar system small and light enough for multiple field-based scenarios. A critical infrastructure location surrounded by a fence line or a wall can be protected with 360-degree radar coverage either from a central mast or at optimum positions on the perimeter. The elevated radar provides early warning of planned intrusion as well as the apparent point of breach. Should a response unit not be able to prevent an incursion, the radar will still track and follow intruders inside the compound, providing key information on the intruders' intended destination.

SharpEye™ SxV fully self-contained lightweight radar

For border patrolling, radars can be mounted on a retractable mast fitted to a vehicle. Surveillance can then be conducted over a very wide area, with the surveillance patrol able to move its position based on intelligence, covering known incursion points and areas frequently targeted by intruders. Patrols can operate from fresh locations to confuse intruders with a random patrol pattern.

The use of solid-state electronics also means that peak power can be significantly reduced which, together with the pulsed waveform, makes it much less likely that anyone observing the frequency spectrum with detection devices will be able to detect the radar.

Of course, in order to determine a response to a potential threat detected by the radar, the precise nature of the target should be classified properly. Simple CCTV or powerful electro-optical cameras can be combined with the radar on the same mast, providing an integrated solution. Control and integration software is then used to take the radar video (pre-processed with the clutter removed) and provide targets on a screen overlaid with a geo-

referenced map. Day and night cameras can be directed onto targets and areas of interest. Imagery from the cameras is sent to the command centre or control room. Stills and video can be captured for use in immediate response decision making, for future reference and sent to other mobile devices.

At DSEI 2013 in London, UK, Kelvin Hughes launched their latest innovation in situational awareness software. CxEye^{TM} is designed to support the novel features of their SharpEye™ radar, providing the power to integrate situational awareness radar with state-of-the-art camera technologies and other sensors. It provides a means of command and control, and can be networked through multiple iterations of the software into a much larger real time C4I.

Running on a windows platform the software is compatible with touchscreen interfaces. It displays radar video on a main screen area under laid with geo-referenced maps. Integrated into the software is aerial imagery, and accepts open source maps and raster maps with fully customised local information. In the top right corner is a real time video display showing the feed from one of a number of selectable electro-optical cameras with a picture-in-picture feed from a second camera.
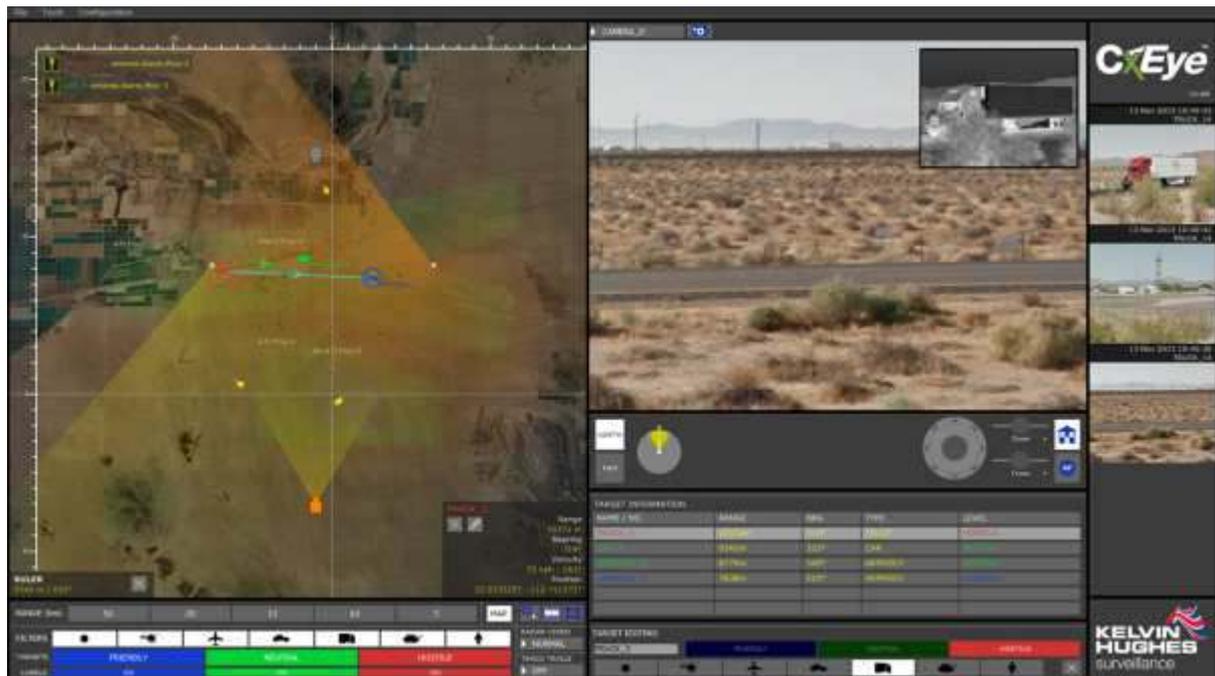
CxEye^{TM} Command and Control / Radar and Camera Integration Software

Up to four radars can be supported by each software station (node) whether the station be a command and control room, a semi-permanent surveillance node (perhaps deployed on a section of border) or in a mobile vehicle with the software operating on a laptop. There is potentially no limit to the number of cameras and other sensors that can be selected through the software if they are available on a LAN or WAN and the software is connected to the network.

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CxEye^{TM} can be configured also as a multi-station C2 (command and control) whereby five standard nodes feed into the C2 configured software giving twenty radar sensors into a system.

The slew-to-cue functionality enables the operator to simply 'touch' with his finger on the screen a target of interest on the radar image and the camera for the area selected will immediately pan and zoom, focus on the target, and maintain a visual track of that target. The software automatically applies a "radar" track identifier to the target, providing visual information on the movements of that track over time. With the radar providing longitude and latitude coordinates of each moving target, plus its speed and direction, it is much easier to coordinate a response. The camera enables visual identification of a target detected by the radar, enabling the Operator to classify the target and the Commander to respond.

The premise of the software is to assist the Operator to evaluate and coordinate a response through a 'detect, recognise, identify and then classify' methodology. Each track can be categorised on screen with clear symbols and 'tote' table information. The table prioritises threats depending on range direction, speed and its area. The classifications of the target tracks are hostile, neutral, or friendly, then sub-categorised as a walking person, car, truck, armoured vehicle or aerial target (helicopter or plane).

The software provides clear and unambiguous situational awareness, providing early warning from the radar, detailed picture evidence from the camera and the continuous tracking ability of the radar. Swift and simple classification of all tracks establishes what is happening, where and who is doing it. A clear 'situational picture' facilitates a controlled response.

In summary, there are significant security advantages to the use of modern pulse radar systems for land-based surveillance. Much improved situational awareness, early warning (as opposed to simply intruder alert), operational flexibility and adaptability, as well as reduced risk of detection by ESM equipment, are all key benefits. There can be significant cost benefits too. Only one 360-degree radar is required to achieve full coverage of a protected area as opposed to multiple sensors and, because of the high reliability of today's solid-state electronics, maintenance costs are significantly lower than those associated with traditional radar devices.

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Rupert Swinhoe-Standen is the Regional Sales Manager for Kelvin Hughes Security Systems.

Following 17 years British Army experience culminating in command in the Royal Artillery, Rupert has garnered a wealth of commercial defence industry experience over 12 years operating both in the UK and overseas. He has extensive experience of the LAND, STA and C4I environment, having worked as a "practitioner" in both peace and war, as a MOD staff officer and as a commander of specialist troops.

Rupert's defence sales, marketing and business development experience is similarly UK as well as international. He has recently joined Kelvin Hughes Surveillance business, focusing on surveillance and security solutions.

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