Blighter® Surveillance Systems

Coastal and Harbour Security White Paper

By Mark Radford, Co-Founder & CTO - Blighter Surveillance Systems Ltd

Introduction

Protecting coastlines from intruders is a growing concern for nations around the world. Each country has its own unique set of problems – illegal immigration, asylum seekers, smugglers, terrorists or pirates. However, they all have a common attribute of the intruder having to approach a coastline by boat. Some slowly and covertly, while others may choose to reach the shore as quickly as possible. Nevertheless, detecting that intruder day or night and under all weather conditions is the goal of most governments and security organisations concerned with coastal and harbour security.

The Blighter radar is optimised to detect and locate these coastal intruders either in small, slow boats or in fast motor boats and under almost all weather conditions. The Blighter radar includes unique algorithms for differentiating the boats from waves and detecting very slow or static objects on the water surface. The Blighter radar's compact size, just 0.6 m wide and low power consumption allows it to be deployed on existing infrastructure or on temporary or mobile platforms (see Figure 1). Integrated with cameras and other tracking systems, Blighter can detect, locate and then allow the operator using cameras or other sensors to identify the intruder from other legal water users such as fishermen, water taxis, and pleasure boats.

The Blighter radar's PESA (Passive Electronic Scanning Array), Doppler and FMCW (Frequency Modulated Continuous Wave) technology offers zero maintenance, ultra high reliability, low power consumption, covertness and an ability to detect and locate small covert boats in the complex coastline region. Additionally it can provide conventional long range boat and ship tracking functions integrated with AIS (Automatic Identification System).

Figure 1 - Blighter coastal security radar mounted on trailer-based mobile surveillance platform (Deployed at the Truman Dam, MO, USA)

Problem Description

The principal challenge for any coastal surveillance system is detecting small and slow moving boats in poor weather conditions including rough seas and rain. In many parts of the world, local fishing boats – Pangas and Dories (see Figure 2) – are used as the preferred method of moving people and equipment between shorelines. The traditional fishing boats are generally compact in size, low-lying in the water and have very little structure above the water, many being made of wood. These boats present a very small target size to radars and camera systems. Also it is not uncommon for a boat to be so heavily loaded with people that it lies mostly submerged in the water.

In some regions, where an individual person is involved, such as an asylum seeker or smuggler, it is possible for that person to swim ashore, possibly from a nearby island or perhaps a neighbouring country. Generally any person taking this type of action will have planned their action and therefore it is most likely that they will carry with them a bag in which to hold dry clothes or smuggled goods. Such an intruder can also be detected by security radar systems like Blighter under appropriate conditions.

Figure 2 - Typical 'Panga' or 'Dory' style fishing boat

Weather Conditions

Weather is the biggest challenge for intruder detection systems. Waves in particular are dynamically changing in position, size and appearance. Without careful sensor design waves can hide or obscure the intruder from detection by radar and cameras.

Rain also serves to reduce the effectiveness of sensor systems. In the case of camera systems, rain simply blocks the visible image of the intruder, but for radar, without careful design, the rain not only attenuates the radar signal but also creates false targets due to the reflectivity and motion of the pockets of rain.

Fog is the third major challenge for some coastal sensor systems and in particular camera systems, though thermal imagers and some high-end laser range gated camera systems do now offer a fog-busting capability. However, the small water droplet size in fog makes it almost insignificant to radar systems, making them the sensor of choice for foggy conditions.

It is worth noting that many intruders, wise to sensor limitations in poor environmental conditions, choose to exploit bad weather to evade detection. In some parts of the world, immigrants and smugglers only become active during heavy rains or high sea states. The sensors therefore need to operate at the very time when most are compromised by the complexity of the environment.

Remote Infrastructure

The final challenge for many remote surveillance systems is the task of finding a suitable location on which to site the surveillance platform, typically consisting of an equipment cabin, mast, sensors and then some source of power and remote communications. The remoteness of many ideal surveillance sites makes the challenge of installing traditional larger and power hungry systems near impossible. It is just not possible to build concrete bases for masts or supply mains power. Compact, lightweight, low power systems have a light footprint for installation potentially being tripod mounted and operated from solar or wind power. Satellite communications (SatCom) is an available option for almost all sites, but is expensive and has a number of major technical disadvantages including poor latency (communication delay) and marginal operation in heavy rains. Alternatively, sensor systems that require only low bandwidth communication can make use of lower cost and more effective direct radio links including microwave communications links.

Traditional Coastal Surveillance Systems

The issue of unwanted coastal intruders is not new; every country has its own stories of mass migration by sea, smuggling or invasion/terrorism. Until recently there has been no reliable means of detecting these intruders. Many coastal surveillance systems, comprising of a VTS (Vessel Tracking System) or Maritime radar and perhaps a long-range camera system, are designed to detect, track and coordinate cooperative targets. VTS systems typically track larger boats and ships, checking their shipping routes, helping to avoid collisions and coordinating access through channels and into ports.

Mandatory AIS systems on board each ship provide further confirmation of presence even in poor weather conditions. The VTS system may also provide an additional safety function helping to coordinate search and rescue. These functions are well defined in IALA Recommendations V-128. Significantly though, these traditional coastal surveillance systems are specifically not designed to detect small, uncooperative targets like the small fishing boats or canoes used by the smugglers etc., and so remain undetected.

Traditional coastal radar systems lack the sophistication to be able to detect small targets, especially in the presence of sea clutter produced by waves (see Figure 3). They use high power pulses derived from valve based Magnetrons, or more recently an equivalent high power transmission using a solid-state transmitter. Simple sea clutter filtering using MTI (Moving Target Indication) filters crudely removes the unwanted reflection from waves, but essentially conventional coastal radars use lots of power and simple size based target vs. clutter thresholding to detect the relatively large targets. This simple technique is enhanced through the use of very large antennas, measuring many metres across that focus the radar beam into a narrow field of view thus reducing the relative amount of sea clutter that the radar sees at any moment.

In poor weather conditions, and especially heavy rain, the traditional coastal radars have no method of filtering out the characteristics of the rain reflections. Using the same simple size thresholding method used to differentiate targets from sea clutter; these radars again raise the threshold to avoid false alarms from rain back-scatter. This immediately reduces the sensitivity of the radar at the very same time as the targets of interest are being attenuated by the same 'wall of rain'. Traditional coastal surveillance radars suffer significant degradation in performance when it rains, making even large boats and ships invisible.

Figure 3 - Coastal surveillance radar

Another significant disadvantage of conventional coastal surveillance radars for security applications is that they are designed to detect large ships at very long range of many tens of nautical miles. Such radars generally do not detect targets at short ranges suitable for detecting intruders approaching a shoreline. The transmission waveforms of these radars, especially solid-state pulse-compressed, create a blind zone that may range from a few hundred metres up to several km. This is the very region in which significant illegal intruder activity occurs. Some modern maritime radars use multiple waveforms in quick succession to detect both long and short range targets, but this waveform switching reduces their overall efficiency.

In summary, coastal or maritime surveillance radars for VTS type applications do not address the requirements for covert intruder detection at short range and under poor weather conditions. Other technology is available, but has limited effectiveness when used on its own, especially without radar. Cameras and thermal imagers can be used under reasonable weather conditions but the challenge is in detecting the small target of interest in the first instance. Sonar systems can detect surface movement of boats and potentially swimmers, but their range is limited to around 1 km and they are very sensitive to environmental conditions, especially water density changes relating to temperature and salinity. These alternative sensors should therefore be considered to be secondary systems that may be cued or alerted as a result detections from the radar.

Background to Blighter

Blighter Surveillance Systems delivers an integrated multi-sensor package to systems integrators comprising the Blighter radars plus cameras, thermal imagers, trackers and software solutions. Its ITAR-free systems are used worldwide in commercial, government and defence markets in area and asset protection for national border security, homeland security, critical infrastructure protection such as airports, seaports, dams and harbours, and in military applications.

Blighter radars are optimised for coastal and harbour security to detect small and slow moving targets under poor environmental conditions (see Figure 4). Blighter is not a VTS or marine channel surveillance radar, though it does provide some of the key capabilities of such radars.

The Blighter C400 series builds on the heritage of the original Blighter Ground Surveillance Radar, but adds new features that allow it to offer unique capabilities for coastline surveillance for security applications. C400 series radars include a sea clutter filter able to remove the unwanted radar signal produced by waves using both velocity and amplitude characteristics. Blighter radars also extract non-moving targets from their Doppler signal processing systems allowing them to detect static boats that are moored up or drifting.

The Blighter radar is based on state-of-the-art set of technologies. Blighter uses a PESA (Passive Electronic Scanning Array) antenna system allowing it to scan up to 360°, in steps of 90°, in azimuth with absolutely no movement inside or outside of the radar system. With no moving parts and entirely solid-state technology, Blighter offers ultra high reliability, a long maintenance interval of up to five years and an in-service life of up to 15 years.

Blighter's PESA e-scan modules use a unique waveguide structure to achieve the azimuth beam steering. Unlike traditional AESA (Active Electronic Scanning Array) antennas, which use multiple power-hungry power and phase control elements, Blighter's unique PESA units require just one efficient transmitter and one receiver unit per radar unit. Due to this compact and simple architecture, Blighter uses e-scan modules on both the transmit and receiver paths resulting in exceptionally low sidelobe levels, which allows the radar to operate in complex environments such as dockyards and harbours

Figure 4 - Blighter C400 series coastal security radar (Point Loma, San Diego, CA, USA)

Background to Blighter - *continued*

without detecting phantom targets from large targets outside of the radar beam.

Interchangeable Antennas

The e-scan modules inside the radar units can be configured with user interchangeable external antennas. For coastal security applications the M10S long-range antenna is recommended as its 10° elevation beam can achieve long detection ranges over the water surface, whereas the W20S antenna is more suited to the ground variant Blighter radar for use in hilly terrain. Both antenna types allow the Digital Beam Forming of the E-scan modules to optimally scan the radar beam in only the direction of interest and with no wasteful overspill.

PESA E-scan

Blighter's combination of technologies including PESA e-scan and Doppler, which are all controlled through sophisticated Digital Signal Processing (DSP) and Waveform Generation (WG) units, allows a wide diversity of radar waveforms and azimuth scan speeds. The Blighter radar allows both fast scanning simultaneous with Doppler velocity filtering using its 'Coactive Doppler fast-scan capability'. Traditional non-Doppler radars can scan fast, whereas traditional Doppler radars rotate slowly. Blighter achieves the best of both capabilities.

FMCW

Blighter's FMCW transmission technology is an alternative to the traditional Magnetron pulse transmitters or solid-state pulse-compression transmitters used by older radars. Key attributes of FMCW include an enormous instantaneous dynamic range in the receiver channel, allowing small targets to still be detectable alongside large targets or sea clutter. FMCW is also very efficient allowing considerably less transmitter power to be required. The FMCW transmission is like a whisper compared to the shout from traditional coastal surveillance radar's high power pulsed transmitters. It is reassuring to know that Blighter's low power FMCW transmission cannot be detected on conventional 'speed radar warning detectors' meaning that intruders are not aware that they are being monitored.

DSP

The Blighter radar unit contains an integrated Digital Signal Processing (DSP) unit that provides all the functions performed by a stand-alone radar processing unit in traditional systems. The integrated DSP provides the FMCW, Doppler, thresholding, constant false alarm rate (CFAR), plot extraction and target filtering functions. The output from the Blighter radar is a low bandwidth digital data stream over a standard Ethernet interface.

Radar Target Tracking

The tracking function used to correlate multiple Plots from persistent targets is performed by BlighterTrack, a modern Multiple Hypothesis Tracker (MHT) which allows it to optimally form and maintain tracks under complex conditions. It is highly configurable, including zone based parameters, allowing different tracking parameters at different locations. For example at long distances from shore, the Tracker could be optimised for slow ship movements. Along the shoreline, the tracker can be optimised to remove false alarms and allow for more dynamic target characteristics including, for example, jet skis or power boats.

How Blighter Solves the Problem

The key feature of Blighter radar's capabilities for coastal surveillance stems from its Doppler Signal Processing engine. On each and every radar scan all targets and sea clutter are measured and characterised by their Doppler velocity. As colour is to CCTV images, Doppler is to radar detection. Doppler adds a third dimension to target detection, so not only are targets identified in Azimuth (PESA) and Range (FMCW), but they are also discriminated by Doppler velocity – the relative speed of each object. This allows valid targets on the water to be discriminated and separated from the sea clutter (see Figure 5).

The Sea Clutter filter automatically classifies the sea clutter and removes it, leaving only targets of interest. Traditional Doppler radars, i.e. Ground Surveillance Radars (GSR) also use Doppler filtering but to remove ground clutter. Blighter uses an advanced non-moving target detection filter to extract the static targets from the Doppler filter enabling it to detect static boats, buoys and other key features in a port or secure coastal environment.

The Blighter radar operates in the internationally recognised and approved Ku radar band, at around 15 GHz. Ku Band offers some unique advantages for security applications. Firstly, the high frequency used means that the radar, including its antennas, has twice the performance of an equivalent sized X band radar. Secondly, the Ku Band is considerably less congested than X band, where many cheap maritime navigation radars fill the radio waves with interference thereby reducing the performance of other X band radars.

It must be remembered that Ku Band is adjacent to X Band. Both are affected by heavy rain, but being essentially analogue detection systems, they gradually degrade in performance rather than the abrupt cut-off experienced with digital satellite TV. Although the rain losses for Ku Band are a little higher than X Band, the effect of extra antenna gain from the Ku band antennas, as described above, makes performance of X and Ku band very similar in rain. The Blighter radar includes a special 'Rain Filter' built into the integrated signal processor that enables it to continue detecting valid targets while suppressing unwanted target-like signals produced by the rain clutter itself.

The Blighter radars' FMCW transmission technology, combined with sensitive Doppler target detection means that the radars requires only a fraction of the transmitter power used by traditional security type radars systems and dramatically less than classic Maritime/VTS radar systems. Blighter transmits only 4 Watts of power, just a little more than a cell phone and equivalent to a modern LED light bulb, yet it is able to detect a small boat sized target at ranges up to 10 km away. This low power transmission requirement also means that the total power

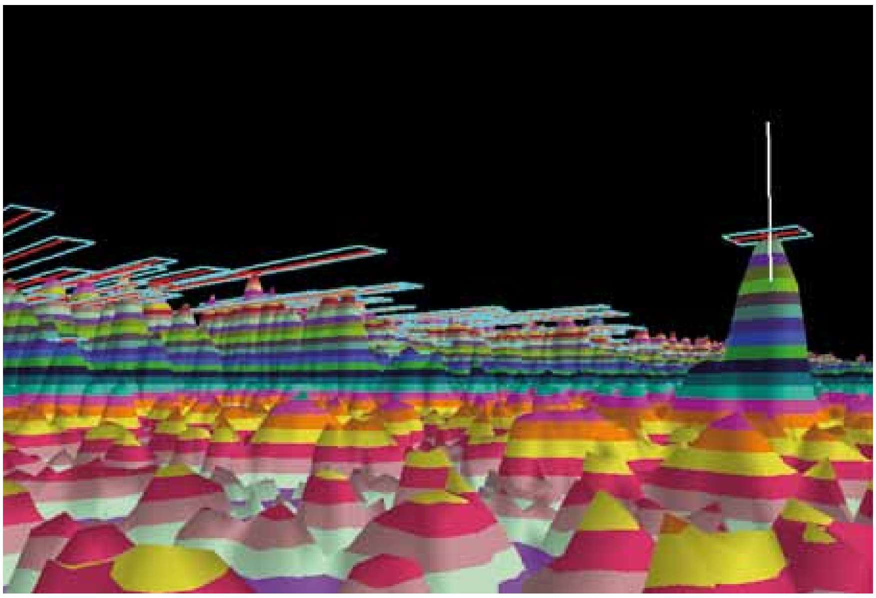

Figure 5 - 3D Doppler view of sea clutter and target

How Blighter Solves the Problem - *continued*

consumption is a fraction of other radars. Blighter consumes just 100 Watts of power enabling it to be operated continuously from battery-backed solar or wind powered generators. One square metre of solar panel in full daylight can provide enough energy to operate Blighter, though of course additional panels are required to charge batteries for operation through the night and in poor weather conditions.

The integrated Digital Signal Processing circuits in Blighter provide most of the radar processing functions performed by remote ‘Plot extractor’ systems in other radars. The process of plot extraction dramatically reduces the data bandwidth such that instead of needing to distribute raw radar video with a bandwidth requirement of 10 to 20 MHz, Blighter’s processed Plot output is a mere 10 kbits/s. This narrow band data requirement enables simple, low cost and low latency distribution via many communication systems. Typically a simple Ethernet connection may be used, over copper or fibre, to carry multiple Blighter radar channels. But for remote operation, mesh radio systems, point-to-point microwave links or even SatCom can be used. If video from camera systems is required then Blighter’s data channel will piggy-back on the video data channel consuming just a small percentage of the bandwidth required for video.

Unlike conventional maritime and VTS surveillance systems, Blighter’s Ku Band PESA technology means that it is incredibly compact in size. The main radar unit containing PESA e-scan modules, Transmitter, Receiver, Waveform Generator, Signal Processor and PSU is contained in a single unit about the size as a large briefcase. A variety of antennas attach to the front of the radar unit depending on coverage required, but even the antennas are narrower than the radar unit at about 0.5 m.

A typical coastal security configuration for Blighter will consist of two radar units; a Main and Auxiliary, interconnected to form a single 180° e-scan C422 radar. These two units can be mounted to the side of an existing structure, such as a tower, mast or building, without any requirement to move or rotate. Existing coastal surveillance radars use enormous multi-meter long antennas that must be mounted atop the mast to allow 360° rotation of the antenna (scanner). For many remote radar sites, especially temporary ones, Blighter’s compact size and lightweight means that it can be hand-carried and installed without any lifting gear or specialist transport. Furthermore, it can if required be mounted temporarily on tripods or other temporary structures.

As Blighter scans, it uses its PESA, Doppler and FMCW technology to immediately detect potential intruders and show them on an overlay map. As well as predicting the position of the target through extrapolation of the target’s heading and speed, the BlighterView HMI also records all historical target data.

For a coastal security system the ability to look at target history over long periods allows forensic analysis of the target’s route up to the point where an alarm was generated. Such history may show the island from where the boat travelled or may show unusual behaviour at sea during, for example, an exchange of goods or personnel at sea. For immediate viewing, the BlighterView HMI includes a user selectable tracking history display in steps up to 10 minutes or more. As all data is recorded to hard disk, a BlighterView Playback application allows the operator to rapidly search through archived recordings, with quick access to the previous 30 minutes worth of data.

When looking over water, or land in the case of port security systems, there are typically areas where traffic is permitted and other more secure areas where traffic is unexpected or prohibited. With BlighterView HMI the operator can create a large number of zone areas to either exclude and therefore hide the radar detection or generate operator alerts (visual, audible and/or reactive).

This powerful zoning feature in the BlighterView HMI gives the ability to not only overlay different types of zones, with different priorities, but also the ability to program the zones to be sensitive to target size and/or speed. As an example, it is therefore possible to exclude (hide) large patrol boats and other visibly obvious targets but generate alarms for only small slow moving boats, such as kayaks or Rigid Inflatable Boasts (RIBs) which may pose a security threat. The alert zones can be prioritised and coloured to create layers of protection, allowing early detection at long ranges, initial warning of a possible intrusion at medium ranges and then full red alert with audible and visible alerts.

Integration with Other Cameras and Sensors

Almost every security radar solution requires the interaction of a camera system in order to observe the object initially detected by the radar (see Figure 6). Blighter is no exception, it provides early warning of intruders over long ranges and potentially thousands of square km. Additionally, it attempts to classify the target by assessing its key radar characteristics - the radar cross sectional (RCS) area and Doppler velocity. Although this target classification helps the BlighterView HMI to filter different classes of target, every operator wants to see the intruder with their own eyes.

BlighterView HMI includes an extensive long-range camera control panel with lots of functionality to provide automatic, semi-automatic and manually initiated cueing of the camera system to observe the target or targets of interest. Typical 'cameras' include multi-sensor electro-optic camera systems including daylight colour, night time thermal imager, often a wide field-of-view 'context' camera and sometimes a Laser Range Finder (LRF), though this is less necessary with radar providing accurate range measurement. Each alert zone can be configured to cue a selected camera either to a fixed point in the zone, the target position in that zone, or to initiate auto-tracking. Some camera systems include a video tracking capability, which BlighterView HMI supports.

Figure 6 - Blighter radar with integrated camera system (Port of Felixstowe, UK)

BlighterView HMI Command & Control (C2) Software

The Blighter radar is a powerful security device when used on its own allowing day and night surveillance of huge areas of water and warning the operator of anything that is a potential threat. However, the capability of Blighter is multiplied by the inclusion of other sensor information including cameras, as described above, and also other situational awareness sensors.

The majority of remote sensors are coordinate based and so one of BlighterView HMI's key components is its mapping system (see Figure 7). BlighterView HMI uses the internationally renowned Envitia MapLink Pro application toolkit. The MapLink Pro framework on which BlighterView HMI is based allows a variety of open-source, commercial and military maps to be displayed with auto zooming to greater detail as commonly used by Google Earth. In addition to these 2D surface maps, the framework allows a variety of 3D data to be used. This can provide auto tilting of cameras to adjust for camera mounting height and the elevation of targets on land thereby allowing the camera to keep the target in the centre of frame. Using this global mapping coverage with a variety of coordinate systems include Lat/Long (WGS84), MGRS (Military Grid Reference System) and UTM (Universal Transverse Mercator), the BlighterView HMI can readily receive and display positional information from other sensors.

BlighterView HMI is able to control most long-range 'camera' systems. Typical camera systems for surveillance comprise of multisensory systems containing daylight, and possibly low-light, colour camera, a thermal Imager, cooled for long range or uncooled for shorter range low cost applications, and possibly a combination of other complementary sensors including a wide field of view 'Context' camera allowing the operator to assess where in the large picture he is looking. Laser range finders (LRF) are often integrated with camera systems, and serve to confirm the range of the target being detected

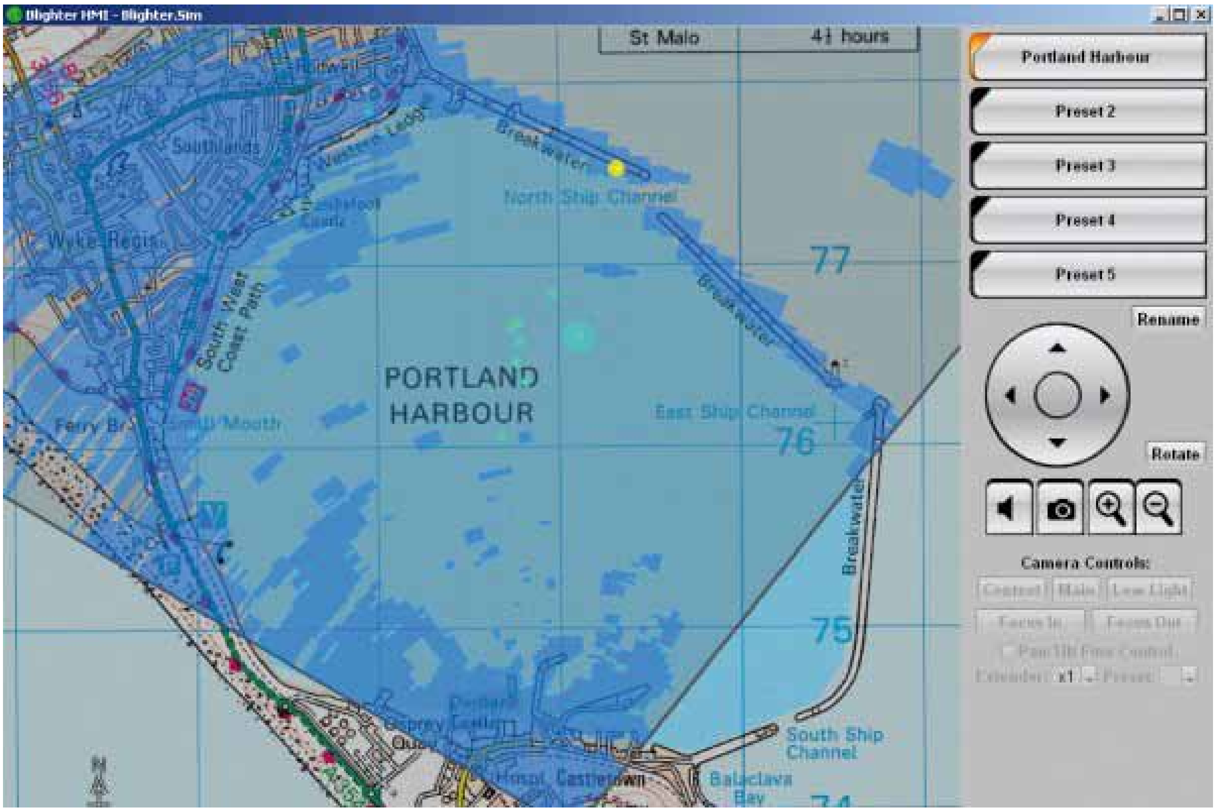

Figure 7 - BlighterView HMI command & control (C2) software

BlighterView HMI Command & Control (C2) Software - *continued*

on the radar. Some high-end camera systems include range-gated laser illuminated systems that can illuminate a specific range segment, allowing it to look through precipitation. Here the range provided by the Blighter radar allows it to precisely set the range gate, field of view and focus of the laser gated camera.

Over water, AIS is typically used to provide information about cooperative boats and ships fitted with AIS transponders. Such information includes position, heading, speed and often other characteristics of the boat. This can be displayed on BlighterView HMI to overlay on the radar display. However the use of AIS with a coastal security radar like Blighter is limited as the targets have willingly fitted AIS. Most usefully, AIS allows radar targets associated with the AIS information to be ignored as they are not a threat. In some coastal installations there can be huge numbers of legal boat users including fishermen, water taxis, pleasure boats and even jet skis.

For coastal installation, especially where port or harbour security forms an integral part of the system, BlighterView HMI is able to integrate PIDS (Perimeter Intruder Detection Systems) into its display. Typical PIDS systems include fence and ground based fibre detection systems, microwave barriers, PIR, detectors and other Unattended Ground Sensors (UGS) including seismic, proximity, PIR (Passive Infra-Red) and simple trip wires. BlighterView HMI is able to display all types of PIDS either as a single point on the display or a line of sensors for linear array type sensors.

BlighterView HMI can simply add layers of sensor information into its framework allowing it to be expanded to accommodate new sensors types now and in the future. Displaying many sensor types can create a confusing display, especially if each sensor has an inherent false alarm rate. If required multiple geo-sensors may be integrated into a sensor fusion system (Blighter Fuse) allowing alerts from multiple sensors on the same target to be displayed as a single unified alert. This reduces operator workload, simplifies the display and can be used to reduce false alarms if multiple alert filtering rules are applied.

Ideally multi-target fusing would allow targets to be validated and their positional accuracy to be improved beyond the accuracy of any one sensor. However, consideration must be made for the diverse nature of different detection systems as the timeliness of a detection warning and the measurement accuracy and resolution of each sensor can give rise to incorrect target association in the fusing application. For example, multiple targets detected on one sensor may be correlated with just a single target on another lower resolution sensor, and low-latency radar target outputs may not accurately correlate with the position of tracking systems that use Sat Com, GSM or other high-latency communication systems.

For this reason, Blighter Fuse can be very beneficial to simplify presentation of targets and reducing operator workload, but consideration should be given to the risk of hiding valuable ‘raw’ unfiltered sensor information. BlighterView HMI can usefully enable or disable the display of all layers of information so for long range surveillance where accuracy is not essential, the fused sensor information only can be displayed. At shorter ranges or in critical areas, all raw sensor information can be displayed allowing detection and interception of intruders at the earliest opportunity. For the latter situation a higher skilled operator would be required.

Use Case

This use case gives an example of a high value coastal installation that requires protection over the sea from terrorists trying to infiltrate the site by boat in order to cause damage and destruction.

The basic Coastal Security system comprises of a network of two Blighter radars systems (see Figure 8), two long range 'camera systems' each comprising of Daylight camera, Thermal imager and wide-angle context camera. A conventional CCTV security system provides security monitoring on and around the site. On site there is a Command and Control centre that brings together all of the remote sensor information and integrates it for display on operator consoles. Conceptually, the system can be expanded to include other sensors including AIS, Fence detection systems, and swimmer detection sonar, however for the purposes of clarity, only the key sensors are described here.

The two Blighter C400 series radars are configured to each provide 180° of electronic scanning in azimuth. Although, at its limit, the Blighter radar fitted with M10S long-range antennas is capable of detecting a 1 m² RCS target at over 10 km, in practice it is beneficial to place the two radars closer together to ensure an overlap of coverage and extend the range of coverage between the two systems. For example the two radars may be separated by 10 km meaning that each radar can just detect small targets adjacent to its neighbour and extend coverage out to sea to a minimum of 8.6 km. The other benefit of this considerable overlap is that it overcomes the shadowing effects of local infrastructure including jetties and other coastal infrastructure.

The Blighter radars may be installed on towers slightly inland, enabling the radars to provide coverage of the beach area also. A typical installation may use a 20 metre surveillance tower in order to achieve the necessary long range detection, in which case the Blighter radar is capable of detecting a walking person as close as 100 metres to the tower. Blighter's wide elevation beamwidth coupled with a unique feature called 'Shadow Boost' enables targets that would normally be underneath the radar's elevation beam to be detected. This feature typically halves the minimum detection range under the radar.

Figure 8 - Blighter C400 series radar with M10S antennas

Use Case - *continued*

When operating, the two radars will be synchronised such that their scans are offset by typically 90° to one another. This allows a common target to be updated on the display at twice the frequency of a single radar and with a fixed time offset making the target updates evenly spaced on the display. The radars can use both NTP (Network Time Protocol) and GPS (Global Positioning System) synchronisation allowing larger networks of radars to be synchronised using either a networked time reference or if not networked then the space based GPS timing reference.

In operation the Blighter radars will use its advanced FMCW and Doppler signal processing technology to detect targets of interest both on the beach and over water. Moving targets are naturally extracted by the Doppler filters and the non-moving targets are also extracted from the zero velocity filter allowing static targets such as moored boats to be detected and tracked. Sea clutter, in the form of waves, has very distinct size and velocity characteristics so the sea clutter filter forms a size-velocity notch to remove these unwanted radar returns.

The minimum size of targets to be detected by the radar is an operator choice. Under normal conditions the radar sensitivity would be set typically to about 1 m^2. This enables the radar to detect targets such as jet skis, kayaks, and small, low lying RIBs, but exclude smaller unwanted targets such as wildlife including birds and jumping fish and also any small floating debris, e.g. flotsam. Under poor environmental conditions and especially high wind conditions it may be necessary to raise the threshold setting to prevent the clutter from producing too many false alarms. Under flat-calm conditions, with no waves, the radar sensitivity can be increased allowing targets of RCS as small as 0.1 m^2 to be detected. At this level of sensitivity, swimmers with some additional floatation or backpack can be detected, however Blighter's principle role is not swimmer detection and experience from sites around the world indicates that other real world targets including jumping fish, birds on the surface, diving or low flying, other floating debris and fishing markers or marker buoys all create so many unwanted detections that operation at this level of sensitivity for extended periods is too onerous for most operators.

The two Blighter radars can detect land, sea-surface and low flying targets day and night under most environmental conditions. Once detected, the BlighterView HMI provides basic target information to the operator, including target RCS, velocity and a simple indication of target type. However for the operator to clearly identify the target and in particular count the number of personnel on the boat, then the long range Electro-Optic system must be used. The BlighterView HMI integrates a range of professional long-range cameras and Thermal Imagers enabling all of the major controls, including position control, zoom, focus, and some camera specific functions. Zones set up in the BlighterView HMI can be associated with individual EO systems, so the optimum camera can be used for specific areas of sea or land. The zone settings also provide a selection of camera actions. When triggered, the EO system can either point at a fixed position, or the radar target location or, more usefully, it can be made to automatically follow the radar tracks of a target. Due to inherent delays, or latency, in the radar and video processing channels, the track following function predicts the most likely position of the target to maximise the chance of the target being in the centre of the video window. The system includes a joystick enabling the operator to take control of the camera system allowing him to more precisely follow and zoom in on the target.

Each console operator has their own unique login to the BlighterView HMI and with specific permissions for BlighterView HMI functions. The BlighterView HMI includes full and automatic logging of all radar data, zone events and operator actions with full time-stamping. Of course the principal use of the integrated Blighter system is to detect and intercept intruders live, however in instances where some level of forensic analysis of the intruder's route is required, the BlighterView Playback application allows the operator or supervisor to replay the historical data checking both the target history and the operator's actions.

Summary

Blighter-based coastal and harbour security systems offer six key benefits:

- Ultra high reliability and zero-routine maintenance for 5 years thanks to Blighter's solid-state, PESA e-scan technology
- The Sea Clutter Filter enables Blighter's Doppler signal processing unit to uniquely filter out sea wave clutter returns in both velocity and amplitude
- FMCW transmission provides a single waveform measurement of both short and long ranges with optimum efficiency.
- Compact size and low power consumption allowing easy installation in difficult to access areas and without infrastructure such as mains power.
- Low data bandwidth requirement allowing remote operation over narrowband wireless links or SatCom.
- BlighterView HMI integrates multiple Blighter radars, camera systems, AIS and other sensors into a simple, intuitive Command & Control (C2) interface.

About the Author

Mark Radford is the Co-Founder & CTO of Blighter Surveillance Systems. He has been working in the radar industry since 1985, initially as a designer of high performance signal processing solutions for naval radar systems and later as a system designer and development manager.

Since joining in 2000, Mark has been involved in various radar development projects including the specification, design and development of the Blighter radar, a unique electronic-scanning FMCW Doppler surveillance radar.

Mark's experience in the radar industry allows him to provide customers with advice on the use and specification of radars for ground and water based intruder surveillance systems.

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