With unblinking eyes

Adam Baddeley peers at the work that is being done in airborne IED detection

WHEN looking for a needle in a haystack, it is counter-intuitive to assume that it would be best to do so at altitude in a fast moving aircraft. Improvised electronic devices camouflaged underneath household rubbish are, like needles haystacks – or anywhere for that matter – notoriously difficult to spot. That is what makes them so deadly. Nevertheless, US counter-IED (C-IED) organisations are increasingly giving IED detection equal billing to jamming in their procurement schedule, with the Joint IED Defeat Organization (JIEDDO) recently adding increasing numbers of airborne sensor R&D projects as part of the push to "attack the network". The US has embarked upon a series of programmes, initiatives and extemporised deployments – giving forces a "persistent stare" capability to provide an airborne umbrella of imagery and signals intelligence, as well as traditional jamming designed to detect, analyse and act against the movement of people, equipment and vehicles used to emplacement of IEDs.

Norse omniscience

One of the trailblazing airborne counter-IED organisation is the US has been Task Force ODIN (Observe, Detect, Identify, Neutralise), a battalion sized unit that is part of the US Army's 25th Combat Aviation Brigade using rapidly-fielded Advanced Concept Demonstration-rated equipment to meet an immediate need. Charted in August 2006 and deployed in November 2006, its role is to collect and collate imagery and signals intelligence (SIGINT) derived from several airborne platforms under its control, follow their movements and trace the bomb-making network. This work is undertaken by analysts on the ground and in the air from the Aerial Reconnaissance Support Team (ARST) platoon which provides a core of imagery and multi-source analysts for both real-time and after-action analysis.

The platforms used by TF ODIN comprise: Warrior-Alpha, a modified GA-ASI MQ-1 Predator Unmanned Aerial Vehicles (UAV) with a 36-hour endurance, conceived as a precursor to the Army's Extended Range/Multi-Purpose UAV; Constant Hawk, a converted Shorts 360-300 Sherpa fixed wing cargo aircraft manned pre-TF ODIN by elements 345th Military Intelligence Battalion during the aircraft first deployment to Iraq in 2006; and the C-12 Huron, configured as either Aerial Reconnaissance Multi Sensor (ARMS) or Medium Altitude Reconnaissance and Surveillance System (MARSS-II) depending on the modular mission payload it carries. Payloads are both DoD and bespoke collection systems using off-the-shelf components, which are contractor owned and operated. Constant Hawks, flown by Army Reserve pilots, are equipped with the Highlighter sensor package – an IMINT solution detects change over time in terrain beneath a selected route of flight. The ARMS solution is provided by the Sierra Nevada Corporation.

Imagery can be sent from TF ODIN aircraft direct to patrols and other platforms using a datalink to the Panasonic Toughbook-based 'One

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With unblinking eyes

IED detection is technically possible, but works best when the locals help ©DoD

System Remote Video Transceivers' on board the ubiquitous HMMWV, Stryker and Army C2 assets such as the UH-60 Black Hawk-based Army Airborne Command and Control System. The TF ODIN platforms are also equipped with designation capabilities if that is required, and co-operate with the 25 Aviation brigades AH-64D to supply a kinetic solution to enemy IED-layers. The results have been noteworthy with more than 2,400 insurgent bombers claimed killed using direct ODIN intelligence and a further 141 captured. With its unalloyed success in Iraq, TF ODIN is going to Afghanistan…

Outside Valhalla

Outside of this dedicated Army unit, the USAF, USN and USMC have deployed a number of airborne assets from the beginning of operations in Iraq and Afghanistan.

USN and USMC Northrop Grumman EA-6B Prowler and the USAF Lockheed Martin EC-130H Compass Call platform, are often called upon to use their assets to perform "courtesy burns" along routes patrols are due to take, knocking out remotely operated IEDs along the roadside.

SIGINT platforms are in similar position. The Boeing -RC-135V/W Rivet Joint provides the epitome of the EW family's airborne goods chain, followed with the USN's EP-3E. The most numerous platform on the ground is the Guardrail SIGINT system, which has been adapted to the local Iraqi insurgent-communications situation with the advent of the Guardian Eagle upgrade.

Some solutions are platform agnostic, integrating equally air and ground solutions such as DARPA's Information Exploitation Office. This began its "Persistent Operational Surface surveillance and Engagement" programme in 2005, designed to survey an area in real-time to identify change. The DoD has looked far and wide for solutions, funding nascent technology to accelerate its maturity. Advanced Ceramics Research (ACR) and Stolar Research Corp have been funded under the Small Business Innovative Research (SBIR) initiative which matched the latter's hand-held gradiometer technology, which uses radio wave broadcasts to detect conductors such used in IEDs and tunnels with ACR's Silver Fox unmanned aerial vehicle. The combination first flew in 2005, making successful detection at low altitudes shortly afterward in the US. Elements of the solution was tested as part of Task Force Troy (Iraq) in Baghdad with funding continuing under SBIR into 2008.

Another SBIR recipient is Spectral Sciences, who use infra-red spectroscopy to detect buried IEDs by identifying the infra-red markets that denote disturbance to solid and plant life. As many insurgent devices seek to eliminate easily detectable material such as metals in favour of Styrofoam, wax, plastics and other inert materials, developing sensors to measure change in their surroundings offers a major route forwards, which again relies on regular reconnaissance and extensive databases.

Vialogy, a California-based lab working with the Department of Energy-owned Oak Ridge National Laboratory, has developed Reverse Photo-Acoustic Spectrometer (REPAS) technology which uses acoustic, millimetric and laser beams to test for explosive residue at stand-off ranges out to 100m on the ground, and up to 500m from an airborne platforms, although this would be many years off. To identify those technologies that could be of use in this and other pressing areas, the Army's Engineer Research and Development Center has kicked off the Multi-Domain Unified Surveillance Systems Architecture (MeDUSSA) contract with Ares Systems Group who are tasked with feeding this technology to the Army who have recognised shortcomings in finding technologies outside of the government laboratories.

Private-sector Valkyrie

Raytheon's new Rapid Initiatives Group (RIG) has developed three new programmes which have direct application for counter-terrorism and IED detection in Iraq and Afghanistan, although their immediate application has been in response to civil disaster in the US. The original technology from these programmes derives from small partner companies being supported by the RIG to bring the system very rapidly to market, sidestepping conventional procurement and development schedules, which is the key role of the unit.

A 3D Ortho-rectification programme dubbed "low-altitude forensics" by Frank Prautzsch, Director Business Development for the RIG, Raytheon Network Centric Systems, can detect

changes down to the level of tyre-type and shoe size from an altitude of 6,000ft. He added that the DoD was fully aware of this capability, which is also being marketed internationally. The system takes an image taken from an angle and manipulates the image to remove terrain distortions and present it as if taken from a 90-degree vertical perspective. Raytheon are providing mission system integration and a high speed processing solution which compares, at a pixel level, the real-time image taken from an airborne platform with pre-existing imagery. The systems identify relevant changes and automatically bringing them to the attention of the user. Partners are providing GIS software and the sensor platform.

In San Diego, the prototype capability was shown to insurance companies during the October 2007 fires, and the interest in the level of detail it provided was such that they provided additional funding to support the extension of coverage. More than 800,000 acres of the affected area are now mapped. This is allowing assessors to observe damage to property from a desktop, speeding up the response. Imagery from the system has also shown details such a tyre tracks and footprints around two unusual burn patterns indicating arson, which have been passed to the police.

A second, unnamed programme has developed TRL 7 airborne ground-penetrating radar capabilities, capable of detecting any item with a reflective surface up at significant depths including through asphalt. By sidescanning, the system creates a 3D image of the object and also presents the operator with information on the object's depth and angle of burial. Working internally with Raytheon Vision Systems, RIG has developed the Eagle 300 payload for urban surveillance which completed its final demonstration in late October. The systems consists of 12 cameras mounted across four independently rotating sections, designed to provide a 360-degree video scan every ten seconds across a 20km search radius with software capabilities to track and dwell on objects. The 40kg payload is designed to be mounted on a pole or aerostat, with an airborne variant with 180-degree coverage now in development. Raytheon are now readying what Prautzsch called an "ITAR-compliant system" for production.

Elevation gives a far better chance of detecting IEDs than on the ground ©DoD