Hide and Seek: On Land

Warfare has always been about signatures: finding your enemy's, and controlling yours. Whether that be a visual signature, heat signature, radar signature, or another kind – if you can't seek out the enemy, you can't defeat them. And if you can't hide, you may, in turn, be seen and defeated.

This age-old game of 'hide and seek' remains fundamentally the same, but the onset of the Information Age has altered its dynamics – multiplying the number of challenges and opportunities around detection. New technologies, open source intelligence, and advanced sensors provide more defence and security information than ever before.

Detailed information is pieced together from networks of sensors stationed in multiple locations and operating on different parts of the EM spectrum – resulting in improved situational awareness. Better processing hardware coupled with improved AI algorithms can fuse raw data and analyse it to ultimately create actionable intelligence.

On the other side of the equation – materials science drives the development of systems that are almost entirely resistant to radar and infrared detection, and even ones that can even disguise themselves, chameleon-like, against their visual backdrop. Advances in passive sensing allow craft to detect enemies with greater accuracy, all without giving their positions away.

On the macro scale there is growing global instability, more sophisticated adversaries and an increasingly noisy electromagnetic backdrop. Hide and seek now happens on more fronts and in more ways than ever before – playing out in underhanded grey zone conflict, and the ever-evolving race between sensors and stealth technology.

The land is arguably the oldest domain of conflict. From early man, stalking foes in the underbrush with a stick, spear or a sling – to today's forces trying to hide a special operations unit behind enemy lines, or a frontline command centre from enemy surveillance – the importance of stealth and detection remains throughout land operations.

From 'passive' to 'active' camouflage

In the natural world, camouflage is a product of evolution that has allowed living things to blend in with their surroundings for millions of years. Military camouflage is much more recent. Indeed, it only really gained momentum when firearms became more accurate in the 19th century.

Significant advancements in conventional camouflage have been made – a comparison of, for example, the simple earth-toned uniforms worn by rifle units in the 18th century with Crye Precision's Multicam family of patterns is stark. But such patterns are inherently static, and cannot change to match their environment. The next generation of camouflage may not be quite so limited.

As first reported in TechWatch Live for DSEI 2021, Korean researchers have recently developed an 'artificial electronic skin' for a soft robot, allowing it to adjust its hues almost instantly and automatically to match the background colours it crawls over.

This is an example of 'biomimetics' (or 'biomimicry'), a field of research that draws upon inspiration from nature to mimic biological processes and apply them to modern technology.

n the near future, the Korean team plans to add a vision system on the robot, so that the artificial skin can also generate patterns autonomously. Besides its use in robotics and land-based platforms, the technology could conceivably be implemented in clothing.

Such developments will be enabled by tiny pixels (roughly a million times smaller than those used in smartphones), grains of gold a few nanometers across that can be easily manufactured at scale, and placed within durable, flexible plastic film that can fit around surfaces.

Finding underground foes

Detecting subterranean foes has always been a challenge. Finding (and clearing) hostile controlled subterranean spaces has been a recurring challenge from the Roman siege of Ambracia to the more recent actions in the jungles of Vietnam, the Zhawar Kili cave complex in Afghanistan and the tunnels under the city of Darayya in Syria.

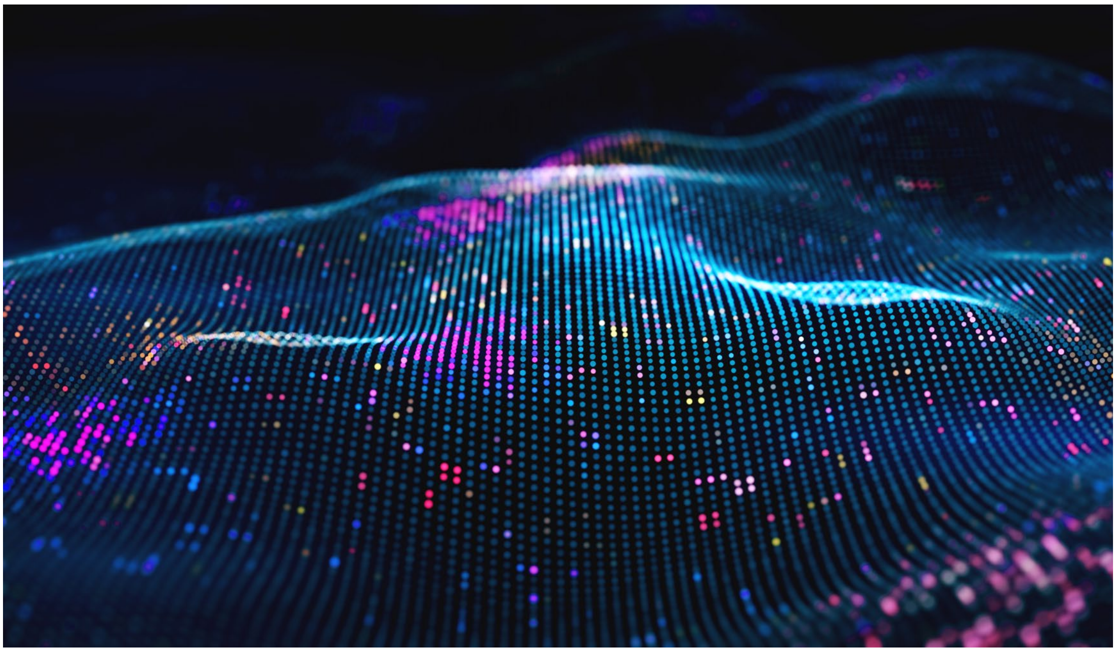
Quantum gravimetry, which uses the quantum interference of matter waves to measure the local value of gravitational acceleration – promises to alleviate some of the challenges of detecting such complexes. Whilst not yet in the position for frontline deployment, working models exist – for example, Glasgow-based M Squared claims to have produced the UK's first working quantum gravimeter.

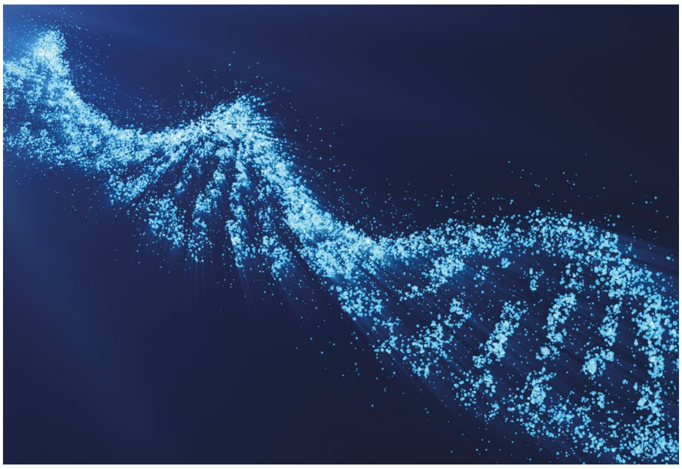
A related form of gravity sensing, 'quantum gravity gradiometry', may be better suited to use on moving platforms, however, it operates at shorter ranges than gravimetry – making its use as a stand-off technique unrealistic at the current time.

Dust as a sensor

Back on the surface – situational awareness in the land domain has been made easier by aerial and space-based intelligence, surveillance and reconnaissance (ISR) assets. However – drones cannot remain on station forever, and due to their orbital paths, satellites can't maintain persistent coverage either. One novel solution comes in the form of 'smart dust'.

Smart dust describes miniature, self-powered sensors – which, once deployed, could create a range of novel platforms and sensor possibilities. For example, ad hoc sensor networks of dust could be spread across a battlefield to provide detailed situational awareness. In 2020, researchers demonstrated a 98 milligram sensor system that can be mounted onto the back of a moth or small drone and remotely dropped from up to 72 feet, where it can operate for days.





DNA facial recognition: promising but hugely controversial

As reported in the Maritime piece in the Hide and Seek series – detection is just one part of the seeking equation. The other is classification. And there are few places in which this is more evident than in grey zone conflict, where adversaries are often disguised in plain sight.

One way in which this could be addressed on land is through the potentially controversial technology of 'DNA facial recognition', which we first reported in TechWatch 1. Here, a team of Belgian and American engineers have built a database-scanning algorithm which can link faces to DNA found at a crime scene.

Linking a specific human face to the individual's DNA remains a challenge and is still very much the stuff of science fiction. The truth is that the shape of our face is not just determined by thousands of genes, but also by our diet, age, environment, and socio-economic background.

However, researchers have brought such a possibility closer by devising a method that provides a range of possible reference faces from a DNA sample – making it possible to rule people out, at least.

So whilst they may not have uncovered the 'holy grail' for crime-fighting or identifying disguised combatants, the researchers have built a powerful tool which will become more accurate as more genes are identified. There are, quite obviously, many ethical and privacy hurdles that must be addressed before this technology has any hope of widespread adoption.

Laser>Radio?

Another, somewhat less controversial technology that could have implications for stealth and sensing on land is free space optical communications (FSOC).

Not exactly a new technology – FSOC could arguably be said to back to ancient times, with the use of reflected light and smoke signals for messaging. Of course, such relatively primitive forms of communication have long since been supplanted by radio frequency (RF) transmissions on the battlefield. Although, as we'll see, FSOC could be making a comeback, albeit in a new format.

Radio communications (which propagate in all directions) can be intercepted and decrypted, with often disastrous consequences for recipient and sender. But even if the message itself is never deciphered, detection of the message presents a vulnerability. For example, keying a radio transmits energy – which can be tracked back to the source of the radio transmission.

> Modern FSOC may offer a way to avoid being detected altogether. It uses laser light – a much more powerful and precise means of information transfer – in which digital data can also be embedded. Instead of radiating outwards (like RF) in FSOC, a single beam of laser light is beamed from one point to another.

This makes it extremely difficult to detect, let alone intercept. However, one of the main challenges to FSOC's successful use on land is around retaining line of sight between sender and receiver during transmission.

Continuing with the sensing theme, a software-defined multifunction system with FSOC capability could also function as a sensor, using its LIDAR for tasks such as target-marking, range-finding and 3D imaging.

QINETIQ

QinetiQ
Cody Technology Park
Ively Road, Farnborough
Hampshire, GU14 0LX
United Kingdom
innovation@QinetiQ.com

www.QinetiQ.com/hideandseek

QINETIQ/21/03502