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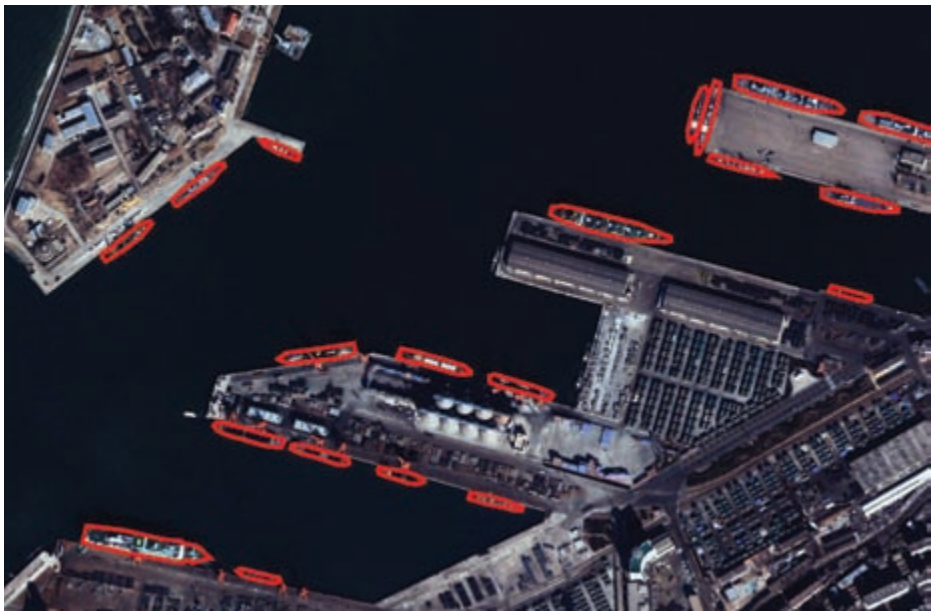
Remote Sensing in Defence and Security

Dr. Clive Farquhar reviews the role of Earth Observation imagery as a decision-support tool.

The use of remote sensing as crucial intelligence for defence and security applications has been proven for decades. From using observation balloons in World War One, high-altitude spy planes in the 1960s to the deployment of Earth observation satellites in the 1970s, remote sensing has been extremely effective in observing areas for military purposes.

There are countless obvious benefits to remote sensing in defence and security applications. Satellite imagery can quickly collect strategic information on large geographic areas that cannot be surveyed manually. Further, a satellite sensor's ability to monitor an area of interest on a repeated, regular basis allows analysts to easily track changes which occur over time in dynamic environments, such as battlefields. Remote sensing also allows the ability to extract information not apparent in a simple visual interpretation of an image, both by the ability to monitor in non-visible spectra and by using various image analysis techniques to highlight and identify areas of interest. Some practical and common applications of these capabilities include locating camouflaged vehicles, mapping terrain and conditions and tracking troop movements.

In addition to instrumental applications in active defence scenarios, remote sensing imagery can also provide relevant information which is suitable to other security operations such as border control, illegal crop detection, maritime security and piracy, and in rapid response to emergency and natural disaster events. For many years the European Union has used imagery for such purposes, particularly within the Global Monitoring for Environment and Security (GMES) program, a progressive initiative to further the science of Earth observation. GMES has also effectively employed imagery in other instrumental situations, such as to aid enforcement of nuclear non-proliferation treaties, in the GMES G-MOSAIC program.



ENVI can be used to extract features of interest from imagery. In this scene ENVI was used to extract ships for maritime security.

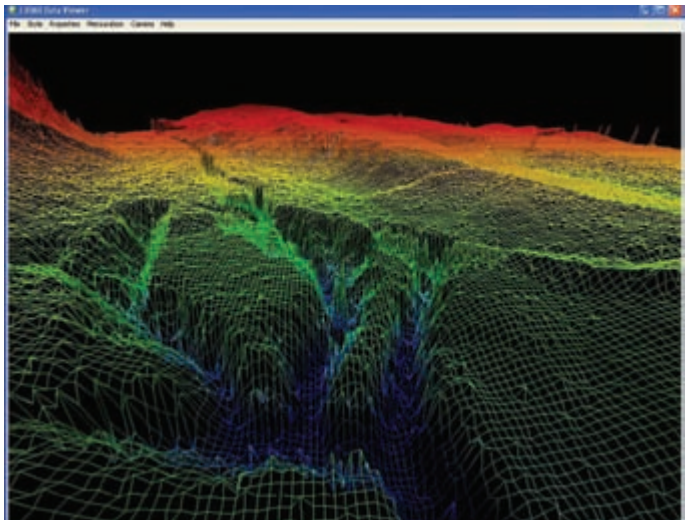
Imagery's advantages for defence and security

A key role of imagery is in mission and intelligence planning. Land cover maps, vegetation analysis and topographic information derived from imagery are highly useful for determining appropriate troop activity and movements. Viewing such information within a 3D environment increases terrain understanding for both analysts and combatants.

In the extremely dynamic environment of defence, image analysts and personnel in the field need to access up-to-date information about their surroundings quickly and easily so they can make informed decisions. Modern image dissemination technology such as Image Access Solutions (IAS) from ITT, provide a unique solution to the challenge. IAS uses the latest, proven methods to compress an image and deliver it to mobile devices quickly, even over limited bandwidths, providing crucial information in a timely manner.

Once imagery is received by decision makers, it can be used for a variety of purposes, from visual interpretation of the image and what is obvious to the naked eye, to analyzing its individual pixels in order to derive hidden information. Advancements in image analysis software over many years have made it possible to use information from an image which is outside the visible spectrum, effectively uncovering what was once hidden. The non-visible elements of an image can be used to detect the presence of disturbed earth, to find thermal anomalies that can indicate buried ordnance, or to highlight changes that have occurred over time – all of which are extremely useful in monitoring military activities.

Software such as ENVI uses the non-visible spectra in an image to its fullest extent, allowing users to determine what was once impossible without sending troops on dangerous and expensive missions to remote areas. Now, defence professionals can easily determine specific intelligence such as detecting camouflage netting, discovering Improvised Explosive Devices (IED), a major threat to combatants and non-combatants alike, and identifying airplane landing strips.



A high performance, 3-dimensional LiDAR viewer in ENVI was used to map river bed locations to aid in planning of military operations

TanDEM-X (TerraSAR-X add-on for Digital Elevation Measurement) opens a new era in spaceborne radar remote sensing. Pictured above: TanDEM-X and TerraSAR-X in formation flight. Source: DLR

Because time is a critical element to defence and security scenarios, recent software advancements have been made specifically to shorten the time it takes to receive an image, such as with IAS, and to process and analyze an image in order to provide information to decision makers. Previously, using an image required extensive training in image analysis, but software solutions such as ENVI provide a suite of automated tools that save time and require little training to produce highly accurate results. This convenience, coupled with the advanced scientific capabilities inherent to the software, give users an advantage on and off the battlefield.

Remote Sensing for tomorrow

The use of imagery and the intelligence it provides will surely continue to grow with future advances in remote sensing technology. A key improvement is the ever-expanding image library, thanks to continuing acquisition by established satellite sensors and the commencement of new satellite missions. 250 Earth observation satellites are expected to be launched over the next decade by a variety of civilian and military bodies, improving the ability to acquire regular imagery.

New satellites will also exhibit technical improvements over their predecessors that increase the amount and quality of information that can be derived. Recently, satellite sensors with sub-meter spatial resolution has become common-place, a trend that continues with the 2013 launch of GeoEye-2, a commercial satellite with 25cm resolution.

Spectral resolution will also increase, with the planned deployment of more hyperspectral sensors, which can identify individual types of paint on military vehicles. RADAR systems have also become more established in recent years, a trend that continues with the recent launch of TanDEM-X, which permits collection of a global topographic dataset with better than 12m spacing and vertical accuracy of below 2m. Other expected hardware advances include UAVs, which have been successfully deployed in many recent conflicts.

Continuing software advances focus on increasing automation and use of workflows, both to ensure standardisation of image products and to make it easier to extract useful geospatial information by analysts with variable technical expertise. Other key development areas will include information extraction by fusing various data sources together and improved systems to disseminate imagery to critical decision-makers on the ground, as well as improved analysis techniques for alternate data types, such as LiDAR and SAR.

It is clear that imagery has a very strong role to play in defence and security applications. Remote sensing has the ability to provide relevant and timely information that can be used in both the planning and execution of military operations. In addition, such information can be used to ensure adherence to nuclear non-proliferation treaties and monitoring security issues such as border control and piracy. It is expected that such techniques become more integral operational systems with continued advances in hardware and software.