Operational Experience and Research Directions in Military Night Vision Equipment

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Over the last twenty years, significant progress has been made in the technical development of night vision equipment. There are a number of different approaches. Image intensifiers amplify ambient light so that it can be presented via phosphor displays including those embedded within night vision goggles. This technology relies upon light from the stars or moon, as well as from man-made sources, such as the background light generated from cities. These applications are, typically, light weight and low cost. They are suitable for individual soldiers using head-mounted or weapon-based attachments. However, there are disadvantages. For instance, individuals can become dazzled and disoriented when systems fail to react fast enough when they are exposed to bright sources of light, such as the beams of a truck. Current research on image intensification focuses on improving the response to longer wavelength signals, on increasing the sensitivity and reducing the noise generated during the amplification process and on improving the presentation of images through increasing the field of view and available resolution.

A second area of interest focuses on detecting electro-magnetic radiation that is not visible to the human eye. Living and man-made objects tend to emit radiation, for instance in the form of heat, that can also be detected and amplified. The net result is that viewers can distinguish these objects from their background without the need for ambient light sources. An important benefit of these thermal imagers or infrared viewers is that they can be used in environments that would otherwise defeat image intensification systems. These include adverse meteorological conditions, such as mist and fog, as well as the smoke that characterises many combat environments. Significant improvements can be obtained by cooling the detection equipment within these applications; in simple terms this increases the sensitivity to differences in the temperature emissions from objects in a scene. However, cryogenic cooling systems increase the size, cost and complexity of the devices. Research is investigating ways of extending the resolution and field of view of these systems, for instance through multi-spectral imaging.

A third class of night vision systems relies on what have been termed ‘active’ techniques. Rather than rely upon emissions from the objects in a scene, these systems emit signals that are then reflected or refracted back to the viewer. For instance, infrared lights can be used either to mark targets or to flood objects with emissions that cannot be directly seen by the human eye. However, these light sources can be seen through the imaging systems mentioned in previous paragraphs. Laser systems provide a further example of active vision systems. These emit monochromatic electro-magnetic radiation in the visible, near infrared and short, mid and long wavelength infrared. They have been used, for instance, by the US Army Research, Development and Engineering Command for range finding, target designation, navigation between obstacles, detection of chemical/biological clouds and to create interference with electro-optical sensors.

Considerable progress has been made in the military application of these image intensification, increased spectral range and active imaging techniques. However, arguably the greatest area for innovation has been in sensor and data fusion. The aim is to help soldiers combine direct night-vision observations with synthetic overlays providing information about the speed, heading and potential identification of targets on the future battlefield. The aim is to increase the soldier’s situation awareness and to support decision making in increasingly dynamic and complex environments. There are also a range of more specialist application areas that have received considerable attention. In particular, many night vision techniques are being extended to support the identification of improvised explosive devices. Active vision techniques, sensor fusion mechanisms and image intensification can all be employed to increase the information that is available about a potential threat.

These technologies are being applied to address a range of problems that affect the military application of night vision systems. Since 2001, the US Army has reported more than 50 brown out-related incidents. Three out of every four of these mishaps was caused by dust thrown up by helicopter rotors. The strong majority of these incidents happened at night when night vision goggles further restricted the crews’ peripheral vision. As we have seen, image intensification systems will not penetrate the debris during ‘brown outs’. Techniques that rely on an increased spectral range can also yield anomalies where cold ground appears deceptively far away to an aircrew on approach to a landing zone. In consequence, the US Army’s Sandblaster project is exploring the use of active laser-based radar where beams scan the ground and process the signals that are bounced back to a helicopter. Other approaches rely on sensor fusion using terrain maps and triangulation between multiple infrared images of a landing site taken in the seconds before a brown-out occurs. It remains to be seen whether these techniques can reliable be deployed to address what remains a significant technical limitation for night operations.

Night vision technology acts as both a mission enabler but also as a risk factor in military operations. This can be illustrated by their use in counter insurgency operations in urban environments. Patrols can use these devices to coordinate their actions and provide significant tactical advantages. However, 'lessons learned' reviews have identified the problems created by this technology. As mentioned, image intensification equipment can suffer from wash-out effects when soldiers inadvertently focus on strong sources of illumination. In consequence, many units have reduced the number of search lights around their compounds. This can, in turn, exacerbate confrontations with the local population. Civilians will often panic and run when patrols loom out of the darkness using night vision equipment. Several armies now restrict the use of this technology in 'friendly areas' and have reverted to conventional illumination around the perimeter of their bases.

The latest (Sept 2008) edition of the US Army's Safety Magazine provides a further illustration of the operational issues that complicate the application of night vision technology. This contains an account of a 'near miss' involving a four-hour airfield security mission with two OH-58Ds using night goggles. The crews had successfully performed this duty many times before. However, on the night of the mishap one of the radios started to malfunction; emitting a series of loud squelch noises. The pilot filing the report could not understand his co-pilot or wing man. A few seconds after reaching mission airspeed and altitude, they flew over a well-lit area that 'washed out' their goggles. The pilot describes how he felt as though they were "manoeuvring into a classic accident situation" so he began to cancel the mission. The combined effects of the hissing from the radio and the washed-out goggles affected his situation awareness but amidst the confusion he heard a single word 'wires'. He immediately started a 500-foot-per-minute climb and a few moments later passed about 50 feet over a large set of wires. This example illustrates the complexity of interpreting operational experience using night vision technology. Most operational military accidents occur while using these devices. In simple statistical terms it can, therefore, be argued that night vision equipment contributes to the majority of operational military accidents. However, many hazardous missions could not be attempted without the assistance of these devices. In other words, they act as both an enabler and a risk factor in an increasing proportion of military operations.

It is important, therefore, that military organisations should not be seduced by the technological sophistication of new generations of night vision equipment. These systems provide significant tactical and operational benefits. However, they also increase the risks to many of those who operate them. The rapid deployment of night vision equipment to the Gulf, for example, has been implicated in a large numbers of incidents. Many soldiers received insufficient training to understand the limitations of their devices. In consequence, relatively inexpensive goggles and monocles led to significant costs and delays while vehicles ranging from battle tanks to tractors were retrieved and repaired. It seems unlikely that these operational problems will be eliminated with the increasing use of sensor fusion techniques. The application of this technology will increase rather than decrease the importance of situation awareness. Many of the proposed applications provide access to such a wider array of information that it will still be difficult for individual soldiers to see the 'wood for the trees'.