NUSTL
NATIONAL URBAN SECURITY TECHNOLOGY LABORATORY

SAVER TechNote

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NIGHT VISION TECHNOLOGIES

Night vision technologies provide enhanced vision, sensing, and awareness for first responders operating in low or no light conditions.
AEL reference numbers: 030E-02-TILA, "Optics, Thermal Imaging and/or Light Amplification" and 04MD-01 LAMP, "Equipment, Light Amplification."

Overview

Night vision devices amplify the available visible light and detect wavelengths in primarily the infrared region of the electromagnetic spectrum, making them effective in low or no light environments. They operate in the visible spectrum and the near to longwave infrared regions of the electromagnetic spectrum (see Figure 1). Night vision technologies fall into three broad categories: image intensification, active illumination, and thermal imaging. Integrated night vision systems (INVS) combine image outputs from two or more night vision technologies into one composite image, thus taking advantage of the strengths of each type.

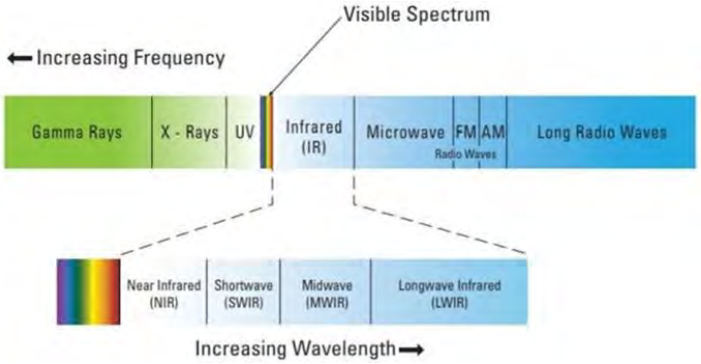

Figure 1. Electromagnetic Spectrum *(Image courtesy of FLIR Systems, Inc.)*

In different configurations and applications, night vision technologies may be useful to law enforcement, fire departments, and emergency medical services. The devices can enhance sight to assist in evidence collection, surveillance, border patrol, navigating smoke-filled environments, and search and rescue.

Image Intensification

Also known as image enhancement, image intensification (I^2) increases the intensity of available light and captures some near-infrared radiation to provide an image. Using an optical lens to capture available light, I^2 greatly amplifies that light before it strikes a green or white phosphorescent screen and glows. The amplification uses photomultiplier tubes that direct photons to a photocathode; the photocathode releases electrons to the phosphorescent screen. White screens produce images in grayscale, which may be easier for the human eye to interpret. I^2 technology is generally categorized into generations established by the U.S. Army's Night Vision Lab: Generation (or Gen) 0-4. (Gen 4 is also referred to as Gen 3+.) The higher the generation number, the more advanced the technology. I^2 systems are the most widely available type of night vision technology on the market.

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to help emergency responders improve their procurement decisions.

Located within the Science and Technology Directorate (S&T), the National Urban Security Technology Laboratory (NUSTL) manages the SAVER Program and conducts objective operational assessments of commercial equipment and systems relevant to the emergency responder community.

The SAVER Program gathers and reports information about equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

SAVER publications focus on answering two main questions: "What equipment is available? and How does it perform?

SAVER knowledge products are created for the nation's first responders and made available to help them make operational and procurement decisions.

For more information on this and other technologies, contact NUSTL by e mail at NUSTL@hq.dhs.gov or visit the SAVER website: www.dhs.gov/science and technology/SAVER.

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Active Illumination

Active illumination couples I^2 technology with an active source of illumination in the near infrared (NIR) or shortwave infrared (SWIR) band. This allows images to be produced when no light is present. Illumination sources include incandescent, light emitting diode (LED), and laser. The resulting images are typically higher resolution than other night vision technologies. While active illumination devices also integrate I^2 technology, their use of additional (not just available) illumination means the light source may reveal the user's position. This technology is not preferred for covert or stealth operations. [1]

Thermal Imaging

Thermal imaging shows the temperature difference between objects in the foreground (target) from objects in the background. Thermal imagers detect thermal radiation and do not need a source of illumination. They can produce images in daylight or night and can see through rain, light fog, and smoke. They cannot see through transparent solids like glass, because the transparent material does not transmit the IR spectrum that thermal imaging requires.

Figure 2. GEN 3 NVG (Left)/Thermal Imaging Camera (Right)
(Image courtesy of FLIR Systems, Inc.)

The two main types of thermal imaging devices are cooled and un-cooled. Uncooled thermal imagers can distinguish temperature differences of 2-3° C and operate at room temperature. They are completely quiet, activate immediately, and have a built-in battery.

Uncooled systems, with their smaller form factor and lower cost, are more common than cooled systems, which are more sensitive. Cooled thermal imaging devices use sensors with temperatures cryogenically lowered to below -196.15° C in order to achieve excellent resolution and sensitivity. They can detect as small as a 0.1° C difference from more than 300 meters away—sensitive enough to determine if a person at that distance is holding a gun. [2]

Integrated Night Vision Systems

Integrated night vision systems (INVS) leverage the strengths of different types of night vision technologies by fusing inputs to provide a combined image output. INVS are also called "fused night vision" and "enhanced night vision" systems. INVS use one of two methods to combine sensor images: the optical method and the digital method.

Optical INVS can operate by overlaying the image from one sensor onto another or by providing the wearer with two different sensor images and relying on the brain's ability to fuse the images into one. Digital INVS use digital signal processing to combine sensor images. This requires additional power, however, greatly increasing the size, weight, and cost of the digital devices.

User Considerations

Night vision technology devices vary in form factor to include goggles, binoculars, monoculars, scopes, and cameras. They can also be operated on different platforms such as fixed site, vehicular-, or aircraft-mounted; individuals can use handheld, head-, or helmet-mounted systems. A particular first responder operation or application should be a guide to device requirements such as resolution, range, no light or low light functionality, sensitivity, and size. [2]

References

[1] J. Tyson, "How Night Vision Works" 27 April 2001," 27 April 2001. [Online URL].

[2] DHS S&T SAVER, "Handbook of Night Vision Technologies," 2013. [Online URL].