

SWIR For Target Detection, Recognition, And Identification

Shortwave infrared (SWIR) imaging gives warfighters a clearer picture of the battlefield and minimizes the risk of civilian casualties.

by James Kirschner

Modern warfare dictates the necessity of proper employment of weapon systems and full accountability of the operators employing them. Whether reading about the ongoing effort of Operation Enduring Freedom in Afghanistan, or the future efforts supporting the global war on terrorism (GWOT), civilian casualties is a topic that will dominate the headlines.

The fog of war can impede the positive identification (PID) process used to discriminate enemy targets from innocent civilians and/or friendly troops. Historically, the enemy has used false claims of civilian casualties to further their cause. A tool in combating these claims is the use of imaging platforms. These platforms not only identify enemy targets, but can also refute any weapon employments utilizing solid battle damage assessment (BDA) video footage.

The most important characteristic of any imaging system is its ability to detect, recognize, and achieve PID of a target at the longest range possible. PID enables the warfighter to precisely acquire enemy targets and engage them, while eliminating the risk to civilians and/or friendly troops, and minimizing collateral damage.

There are many types of imaging systems currently deployed, but the focus of this article is on uncooled shortwave infrared (SWIR) imagers. Uncooled SWIR cameras manufactured with indium gallium arsenide (InGaAs) sensors typically image in the 0.9 to 1.7 micron wavelength range.

While this is infrared light (invisible to the human eye), SWIR is mostly reflective in nature, producing imagery similar to visible light imagery. The SWIR wavelength range provides the ability to penetrate through fog, smoke, and atmospheric haze at long range (see *Figure 1*) and remains unaffected by thermal crossover. For these reasons, the warfighter is taking an in-depth look at SWIR.

Another feature unique to SWIR is the ability to image beacons and lasers used with night vision goggles (NVGs). This makes SWIR technology backward compatible to the current technology while also leaning forward to detect new eye-safe lasers and beacons in the field invisible to NVGs.

Recently, Goodrich ISR Systems (formerly Sensors Unlimited) of Princeton, NJ, successfully ran tests with its SU640HSX camera to identify the maximum distance achievable for detection, recognition, and PID of NATO-standard human-sized and vehicle-sized targets. Imagery was captured at distances from 100 m to 3.5 km using SWIR-specific lenses (ranging from 25 mm to 500

mm) during day, night, and thermal crossover conditions.

The SU640HSX is a mil-rugged InGaAs video camera with high sensitivity and an operating range of -40° to $+70^{\circ}\text{C}$. It provides real-time daylight to low-light imaging for persistent surveillance, laser detection, and penetration through fog, dust, smoke, and thermal crossover. The camera also employs on-board automatic gain control (AGC), proprietary dynamic-range enhancement technology, and built-in nonuniformity corrections (NUCs), allowing it to address the challenges of urban night imaging without blooming. The standard SU640HSX camera images from 0.9 to 1.7 microns, while the one used for the test utilized the NIR/SWIR option which is capable of imaging in the extended spectrum from 0.7 to 1.7 microns.

Both hostile and nonhostile scenarios were filmed at multiple ranges using multiple

SWIR lenses. A hostile scene was defined by the items each individual was carrying and their hostile "intent." For instance, an individual running with a long object (possible rocket-propelled grenade or RPG) on their shoulder does not automatically make them hostile. It



Figure 1: Visible image (left) and SWIR image (right) of the same scene. The SWIR image shows more detail under the same conditions.

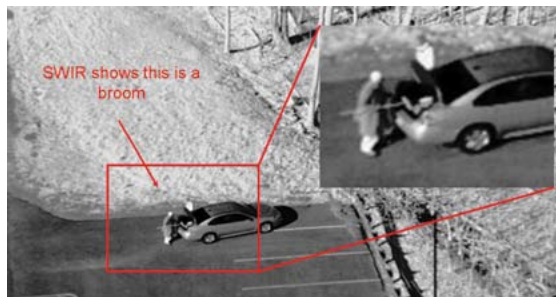


Figure 2: SWIR is used to differentiate between individuals with hostile or nonhostile intent.

is their actions and how they employ the object that determines how they are identified. As seen in *Figure 2*, the broom could be mistaken for a weapon. Here, the subject ran to the trunk, pulled out the broom, and began sweeping.

During the test, videos captured using multiple lenses for each range were analyzed to determine the activities taking place. If the subject was determined to be hostile, the raw data was extrapolated and plotted onto the appropriate graph (detect/recognize/PID) using focal length versus distance. A linear line was fit to the raw data (detection/recognition/PID) and an equation was generated. The graph yields a simplified model of the SU640HSX SWIR camera, giving the achievable detection/recognition/PID distance (in meters) for a known focal length. Conversely, a required focal length can be obtained if looking at a known distance (detection/recognition/PID).

Using this model, integration into an already fielded system can be made seamless. Incorporating a SWIR camera

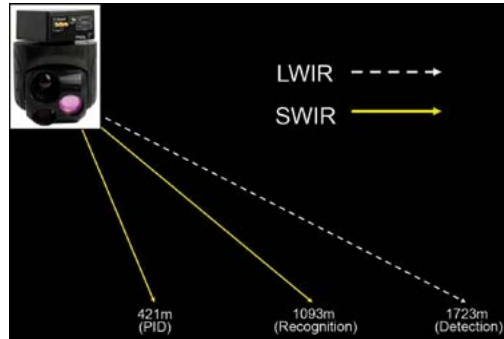


Figure 3: LWIR and SWIR sensors are integrated into a Cloud Cap TASE 300M gimbal. (Photo courtesy Cloud Cap Technology)

into a gimbal containing either a midwave infrared (MWIR) or long wave infrared (LWIR) camera could greatly extend detection ranges while utilizing SWIR's clear picture for recognition and PID (see *Figure 3*). This is an example where having detection, recognition, and identification ranges predefined for a known focal length is an extremely valuable tool.

It is vital to perfect the target PID process. By doing so, it provides the warfighter a cleaner picture of the battlefield and minimizes the possibility of civilian casualties and collateral damage. ■



Note: Many SWIR camera capabilities are considered sensitive. If you would like to learn more about SWIR for the military, you can register at www.swirconops.com.

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Visible image seen through smoke

SWIR image reveals details through smoke

SWIR and thermal image fusion

Fog obscures objects in the visible

SWIR clarity through fog

Sensors Unlimited - Goodrich ISR Systems brings a complete arsenal of mil-hardened shortwave infrared (SWIR) cameras to the field. These uncooled InGaAs cameras help image through smoke, dust, fog and haze, and aid in facial recognition – in daylight or starlight. Small and light, they are ideal for manned and unmanned ground, air, and maritime intelligence and surveillance. Our new high sensitivity 1280 x 1024, 1.3 Mpixel camera is ideal for UAS, UGS, hand-held, and mobile surveillance systems. Always the leader in SWIR vision.

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