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Several defense contractors were asked about multi-spectral imaging. This roundup article answers the question: *What does multi-spectral imaging have to offer the modern warfighter?*

Multi-Spectral Imaging Industry Roundtable

Kevin P. Gibbons, Program Manager
Government Products Group, Deposition Sciences Inc. (DSI)

A significant aspect of the modern war-fighter's function has become information management. Today's sensors and communications capabilities can inundate a soldier or pilot. Multi-spectral imaging is a key technology used to provide the warfighter with the information he needs to perform his mission, in a clear, efficient and intuitive manner. At its most basic level, multi-spectral imaging is simply capturing and processing an image at multiple wavelengths (colors). In simple terms, this means more data is available to analyze a situation. Instead of a monochrome image, a soldier can see a full-color view, or cycle between different colors to highlight features that might otherwise be camouflaged. A helicopter pilot or remote analyst can view images in both the visible and infrared spectra to see through bad weather and smoke, or at night. A sensor can analyze heat signatures at several different temperatures simultaneously to more accurately identify the source and to defeat single-wavelength jammers such as flares or lasers. All these instances are examples of extracting and managing data to get the most useful information most efficiently.

Thin film coatings play a vital role in multi-spectral imaging. Discrete bandpass filters can be deposited on planar substrates which can be bonded together to make multi-spectral filter mosaic assemblies placed in front of a sensor. To reduce size and weight, multiple filters can be deposited on a single surface via traditional semiconductor photolithography techniques. To further reduce size and weight, the multi-spectral filters can be deposited directly on the active sensor devices. These advances allow for miniaturization, which enables multi-spectral imaging in helmet—or eyeglass-mounted sensors, weapons scopes, small, remote vehicles and satellites.

Deposition Science Inc. provides highly durable, optical thin film coatings for a wide variety of applications, including multi-spectral imaging for military/defense and industrial tasks. For more information, please visit www.depsci.com.

David Dennis
Business Development Manager
ISR Systems
Sensors Unlimited - UTC Aerospace Systems

For quite some time, Sensors Unlimited - UTC Aerospace Systems' SWIR and near-infrared (NIR)/SWIR cameras have been the heart and lungs of many hyperspectral imagers (HSI). HSI is essentially the process of chopping up the camera response into several slices, and looking at very narrow pieces of spectrum within the camera's response. Over the years, much of the hyperspectral work that has been done has identified several different areas of interest within the SWIR and NIR/SWIR regions.

We've been fortunate enough to participate in the development of multi-spectral imaging technology. We were teamed with a company called Pixelteq (previously Ocean Thin Films). Pixelteq's expertise is very specialized optical filter technology. They have been able to develop Bayer pattern filters at the pixel level. Once our customers have identified the unique bands they are most interested in, Pixelteq then creates a custom filter that focuses the camera on the unique bands of interest. The filter is then bonded to the camera FPA through an active alignment process. This process is called hybridization. This process creates a color SWIR image, which allows the user to identify/detect very specific spectral lines.

Unfortunately, many of the DoD applications for multi-spectral imaging are sensitive, so I can't share specific applications. What I can tell you is that this technology is game changing and provides never-before-seen, enhanced situational awareness for the warfighter. We continue to work with Pixelteq and our integration partners to develop higher resolution and smaller pixel pitch multi-spectral imagers. These imagers have a relatively small SWaP, and can be integrated in airborne, land-based, shipboard and dismounted soldier systems. Multi-spectral imaging has also shown promising results for medical, agricultural and manufacturing markets. The future for multi-spectral imaging is very exciting.

Dave Fish
Vice President Technology
Pixelteq

The key is providing warfighters effective imaging tools to make the best decisions quicker—delivering richer data, displayed intuitively in real time. Multi-spectral imaging enhances contrast to

see beyond our human vision. Using targeted spectral bands across the visible and infrared can improve target acquisition, tracking and stand off chemical detection.

Today's multi-spectral cameras deliver live processed images that highlight key features in specific scenarios. In the same way color cameras use red, green and blue pixels, multi-spectral cameras have pixels at specific targeted wavelengths, combining three to nine bands of visible and infrared "color." Even when part of that light is invisible to our human eye, multi-spectral cameras can assign false color so the warfighter "sees" colorized images that the brain processes quickly and logically. Going beyond the visible range, this approach is applied to a variety of sensors—including the near infrared with conventional silicon, and indium-gallium-arsenide sensors to reach into the short wave infrared, or SWIR, band.

Multi-spectral SWIR has some interesting applications in low light, covert, detection and authentication applications. SWIR light is invisible, but it's also reflective—so it behaves a lot like visible light, bouncing off objects with similar shadows and contrast … and the images appear more natural to us. A conventional SWIR camera is monochrome, imaging shades of gray, but a multi-spectral SWIR camera can deliver a colorized image that helps uncover more spectral detail across the visible and infrared. Multi-spectral cameras also go more places now. The latest technology integrates custom mosaic filter arrays on sensors—a robust, passive approach that creates multi-spectral cameras in the same size, weight and power footprint as a monochrome camera. So this reduced payload means a broader range of missions—from handheld and unattended platforms, to smaller UAVs with longer range and duration.

Tim Cronin
Director
Strategy & Business Development, Surveillance and Targeting Systems
Raytheon Space and Airborne Systems

During the past decade, warfighters have developed an insatiable appetite for multi-spectral, full-motion video (FMV) imaging fueled by the exponential growth of intelligence, surveillance and reconnaissance platforms.

The reason is simple—FMV imaging provides complete and accurate situation awareness, which is critical to the safety and success of a mission.

Furthermore, multi-spectral imaging provides situation awareness under all types of environmental conditions. For example, Raytheon's Multi-spectral Targeting System (MTS) products use up to six different cameras operating in multiple spectral bands allowing warfighters to select the optimum camera spectrum for the conditions.

Visible and near infrared (IR) cameras (0.4-0.9 µm) provide the highest resolution for daytime detection, recognition and identification. Short-wave IR cameras (0.9-1.7 µm) are good for haze penetration and in low light conditions, day or night. Mid-wave IR cameras (3.3-5.1 µm) are ideal for airborne imaging at night and in tropical or maritime environments. Long-wave IR cameras (7.5- 10.5 µm) penetrate smoke, dust, clouds and other obscurants.

Each spectrum provides unique benefits under different conditions, and having access to these different bands allows warfighters to tailor a single multi-spectral FMV imaging system to the mission.

Raytheon is proud to provide our warfighters with the finest multi-spectral, full motion video imaging sensors, augmented by targeting, in the world. Raytheon's MTS systems have successfully completed more than 2.5 million flight hours, providing our warfighters with a decisive edge over their enemies. MTS systems are in constant use around the world, logging almost 50,000 flight hours per month supporting missions that reduce threats, protect borders and save warfighters' lives.

Frank Vallese
President
Sofradir EC Inc.

At Sofradir EC Inc., we recognize the role of multi-spectral imaging systems in improving visibility through battlefield obscurants (such as fog, smoke and dust) as well as discerning camouflaged and low-visibility objects in a cluttered background. As such, we offer three classes of infrared imaging solutions that are useful for these multi-spectral applications.

First, because of the versatility of mercury cadmium telluride detector materials, we offer a full range of infrared detectors and engines in several distinct spectral ranges, including SWIR (visible to 2.5 mm), MWIR (3-5 mm), LWIR (8-10 mm) and VLWIR (8-12 mm). We recently introduced our new MiTIE line of SWaP engines, including a LW video graphics array engine and high definition MW engine ideal for use in gimbals and pan-tilt-zoom surveillance systems. In addition, we offer tiny uncooled thermal imaging cores for portable SWaP applications that, when coupled with image intensifiers, provide better visibility for soldiers wearing night vision goggles.

Second, we also produce dual-band imagers based on a single detector array that simultaneously detects infrared radiation in two distinct spectral bands. For example, Altair MLW is a video graphics array imager designed for use in third generation tactical IR systems to detect in both MWIR and LWIR, delivering the benefits of imaging in both spectral bands. A dual-band MW/MW system is also available exploiting the optical characteristics of certain battlefield signatures to improve visibility.

Finally, Sofradir EC also produces infrared detectors for hyperspectral imaging systems to collect image data simultaneously in hundreds of narrow, adjacent spectral bands making it possible to derive spectral information for each observed location. Our Saturn and Neptune Integrated Detector/Dewar/Cooler Assemblies are based on a 1000-by-256 and 500-by-256 format (pixel pitch of 30 mm) array, respectively, to image in the SWIR spectral range (0.9-2.5 mm) or optionally with extension to visible spectrum (0.4-2.5 mm).

Cees Draiijer
Senior Program Manager
IR Applications Teledyne Dalsa

Modern warfare is mainly about achieving a more detailed situational awareness of the battlefield than your opponent. Translated for the imaging domain, this means gaining as much information as possible from a captured scene and providing it to a fighter in a format that enables them to take action. Multi-spectral imaging provides more scenery information just by the fact that the images are captured over various wavelengths and can be compared with a relative or an absolute standard.

The additional information can result in stand-off and early detection of threats, which has a tremendous strategic advantage for the modern warfighter, especially in this era of doing more with less. An interesting example is the detection of man-made objects in a natural environment like camouflage. Although camouflage is designed to blend with landscape by utilizing color and patterns to create a cover for man-made objects barely visible to the human eye, multi-spectral imaging can basically detect whether materials have been used that are not consistent with the natural scene (e.g., a fabric).

Obviously camouflage technique will continue to evolve, but its detection will always be challenged by multi-spectral imaging modalities. An equally important aspect is how the additional detail is brought to the attention of the warfighter, so that the “awareness” is effectively achieved. This is not an easy task. By definition, detailed spectral information is more difficult to comprehend and can result in misinterpretation because of the very large amount of information being conveyed.

A high level of image processing capability combined with smart detection-overlay imagery and high resolution display technologies will take care of this issue and then we can truly claim that more detailed situational awareness has been realized to the benefit of the modern warfighter

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John MacEachin
Technical Director Persistence Surveillance
BAE Systems

Multi-spectral imaging provides a new level of security for the modern warfighter. Today's military engagements require the warfighter to be highly connected to available intelligence in near real time. By blending low light and the infrared spectrum, soldiers are presented a picture that provides a high level of detail, perception and striking cues to important elements of a scene. The fusion of information provided by multi-spectral imaging can help identify the presence of a variety of materials—for example, items used to create bombs or other chemicals. Many of the wavebands used in multi-spectral imaging can recognize gases or see that the ground was recently unsettled and potentially hiding danger from view. This is all vital situational data for our troops.

It's also important to note that this imaging technology is available day or night and in all weather so that the warfighter has even more timely information—and information that is impervious to the elements. At BAE Systems, we want to provide the modern soldier the most advanced situational awareness at all times. Remote sensing comes in many forms, and that's why we've developed a family of systems to serve many needs. BAE Systems' Digitally Fused Sensor System, with its multi-spectral camera and fusion engine, provides multiple modes of imagery, and weighing in at just 144 grams, it's sized to fit on the smallest UAVs. For larger battle space requirements, BAE Systems developed the Spectral Infrared Imaging Technology Testbed to provide troops with near real-time detection and identification.

Whatever the situation, it's about knowing what you're up against. We want our men and women in uniform to return home safely—and with multi-spectral imaging, our troops have the tools to help them do just that.

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