Controp Precision Technologies provides a number of EO/IR payloads suitable to helicopters, notably the iSky range, a version of which is pictured here. (Photo: Controp Precision Technologies)

EO/IR payloads: Looking sharp

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EO/IR sensors are advancing in several directions, becoming more effective while maintaining the lowest SWaP demands, according to industry representatives. Shephard *takes a closer look at recent developments, from augmented reality and shortwave IR to AI and advanced image processing.*

There have been three major areas of EO/IR progress in recent years, according to a Raytheon spokesperson. The first one involves reduced size. Raytheon is developing new focal-plane (or staring) arrays that are more capable, compact and lightweight than previous systems.

'EO/IR technology has [become] smaller without sacrificing capability. That's critically important on helicopters where space is at a premium, even more so than on fixed-wing vehicles. The sensors available today are significantly smaller and lighter-weight than those of just a few years ago,' the spokesperson explained.

Secondly, EO/IR sensors can now see further and with greater clarity. 'Just like high-definition [HD] television revolutionised how we watch TV, HD has also transformed how we are providing critical data to armed forces around the world,' the spokesperson said. On the same point, they confirmed that Raytheon is now applying advanced algorithms to enhance positive identification, 'which is critical in an increasingly complex battlespace. These algorithms are also a valuable tool for improving tracking and detection overall.'

Finally, EO/IR sensors are growing more reliable. 'What used to take us dozens of parts to create now only takes a handful. We're making the systems more efficient and more easily maintained, which increases their availability to the warfighter,' the spokesperson told *Shephard*.

Raytheon provides EO/IR sensors for the USAF Special Operations Command's V-22 Osprey, the US Army 160th Special Operations Aviation Regiment's MH-47G and MH-60M and the USN's Seahawk aircraft, among other platforms.

Data fusion

EO/IR is particularly important for assisting pilots in DVEs. Raytheon is blending different wavelengths of light captured through a single sensor, such as its Multi-Spectral Targeting System (MTS), to deliver a clearer view to pilots. Blending images from different bands – often referred to as 'colours' in the industry – takes advantage of the strengths of each camera while mitigating the limitations of relying on a single camera to capture only one band.

'We are fusing sensor data with map and terrain data to create virtual views of the environment,' the spokesperson explained. 'Combining modalities and using new processing techniques is helping us solve the DVE problem.'

The MTS is a sensor turret that sees in IR and the visible spectrum and delivers detailed intelligence in HD, full-motion video, according to Raytheon. There is a range of sensors in the family. Over 4,000 examples have so far been delivered to US and international armed forces, and 44 variants of the system have been integrated on over 20 fixed-wing, rotary-wing and UAS platforms, including the MH-60 Black Hawk. Over 4 million hours have been flown with MTS sensors, with more than 90% in operational combat.

Raytheon is currently developing a Modular Open Systems Architecture to enable universal adaptability and configurability for all rotary-wing aircraft, the spokesperson told *Shephard*. The company believes that the US Army's development of an FVL digital backbone will go a long way in defining common interfaces. 'That kind of flexibility will enable many different sensors to "plug and play" in future rotary-wing aircraft,' said the spokesperson.

Controp Precision Technologies also provides a number of EO/IR payloads suitable to helicopters, notably the iSky-20HD, iSky-30HD and iSky-50HD. The company has pursued a number of developments in recent years, said Controp's marketing director Nir Bar Natan, who pointed in particular to the integration of augmented reality, which allows information to be overlaid on real-time video on a screen. Bar Natan told *Shephard* that this initially came from the company's work for the law enforcement sector and meant that the OEM had to focus on improving the inertial navigation systems used in the payloads. Virtually all sensors today are HD, he added. This is certainly true for day cameras, but is also moving to the night domain, with Controp offering HD thermal capability on the iSky-50HD.

Bar Natan highlighted the growing popularity of shortwave IR (SWIR), which is particularly effective at penetrating fog and haze and similar impediments, making it a useful tool in DVEs. 'It enables the pilot to have better vision of where he or she is supposed to land or where they are flying,' he said.

Elbit Systems' BriteNite can integrate EO/IR sensors like Spectro. (Photo: Elbit Systems)

Bar Natan pointed to a number of areas of technological improvement in recent years. He noted that there has been a growing trend to integrate the payloads with mission computers, which contain many of the algorithms and other technology needed for the sensor to operate effectively. There have also been numerous improvements to the sensors themselves, as well as the use of wider FOVs, 'which are also important for DVE situations', he added.

According to Bar Natan, Controp is particularly focused on the further development of AI. This is especially useful as the sensors provide greater amounts of data in HD, which is often displayed on a very small screen, making it difficult for human operators to locate or track targets. 'You don't get the right resolution because the camera has much better resolution than the display,' he said. In this type of scenario, it is important that the computer behind the camera is able to analyse the image in HD and be able to point the operator to activity that he or she may not see. 'I think the future is artificial intelligence, with the computer analysing the information and able to give the operator much more information than they have right now,' Bar Natan said.

Developing solutions for DVEs is a key driver of the technology, said Itzik Huber, senior director of marketing and business development for international helicopters and C-130 solutions at Elbit Systems. 'This has been the benchmark for pilots all over the world for the past few years,' he told *Shephard*.

Elbit produces a number of EO/IR systems with applications in the helicopter space, notably the Spectro XR 38cm payload. Huber highlighted the importance of a wide FOV, notably in BriteNite, an airborne sensor featuring 11 integral sensors, which can also integrate EO/IR sensors like Spectro. 'This is a big change, the development of computing capability that provides one smooth picture from multiple sensors,' he noted.

SWaP challenges

Another major provider of EO/IR systems is FLIR Systems, notably through its Star Safire range. The company has had some recent successes in the rotary-wing space. For example, it announced in December 2018 that the Star Safire 380-HDc surveillance sensor had been selected by Boeing for the USAF's UH-1N Huey replacement contract.

The initial deal will see FLIR provide sensors for the first four MH-139 helicopters (which are derived from Leonardo's AW139 platform), with the potential to cover 84 aircraft. The deal is valued at more than $40 million. In a previous interview with *Shephard*, Adam DeAngelis, director of marketing for FLIR Surveillance, pointed to a range of activities that the sensors are deployed to support, such as CSAR, medevac and surveillance.

DeAngelis said that helicopters present a unique challenge for the systems, as they are naturally limited in terms of the amount of weight they can carry. ‘That’s especially true for mission helicopters that are getting more armour and search and rescue gear or military equipment, or more flight equipment being integrated onto the aircraft as new technologies emerge,’ he told *Shephard*. ‘All of this is a good thing, but weight starts to become an issue.’

On the SWaP theme, DeAngelis outlined FLIR's work on the Star Safire 380-HDc and 380-HLDc, which were designed as compact models, weighing about 40% less than the standard variants. The platforms have a significant portion of the range capability of the standard versions (about three quarters) and retain long-range HD telescope sensors and the laser designator in the case of the HLDc. ‘We kept the design principles. We implemented an HD, IR and EO sensor that is three-quarters of the range capability, and we kept in a long-range HD telescope sensor that has the same capability as the 380. This size, weight, power and cost advantage allows the user to work within restricted weight requirements and budgets without significantly sacrificing the always crucial performance component,’ DeAngelis noted.

He emphasised the need to keep costs down, particularly for operators with limited funding. ‘In some places, the price is really sensitive and [customers] do want a lower-cost system without sacrificing the performance,’ DeAngelis commented. ‘In those places, we’re seeing huge demand for the HDc and the HLDc.’

He added that there is only so much that can be done with regards to optics, because they are restricted when it comes to size. ‘Technology is rapidly evolving, which means that we can make more capable systems at a smaller size, with smaller electronic components, for example,’ he explained. ‘But when it comes to optics, there’s still only so much you can do, because you have physics involved. While we can make the systems smaller – and that will be the trend – you still have to keep them a certain size to be able to see a certain distance and maintain the resolutions needed.’

Still, DeAngelis expects more intelligence to be brought to the systems, with more automation helping the operators to make decisions. Eventually, ‘we probably won’t need a person in the loop’, he said. ‘That is a long way away, but in the foreseeable future I do see some level of intelligence being introduced to the systems themselves’.

The quantity of information the operator needs to process would be limited, with certain tasks carried out automatically. ‘I think that’s really where the technology is going to go in the next few years,’ DeAngelis highlighted.

FLIR Systems' Star Safire 380-HDc surveillance sensor has been selected by Boeing for the USAF’s UH-1N replacement contract. (Photo: FLIR Systems)

Enhanced performance

Improved sensors and image enhancement capabilities are providing better and longer-range observation in DVEs, according to Yitzhak Bendavid, senior manager of the optronics directorate at IAI's Tamam division, which produces a range of EO/IR payloads, notably the POP range. The company’s POP Ultra aims to exploit these benefits, Bendavid said, providing long observation ranges in a compact, lightweight envelope.

Recent years have seen higher-resolution HD imagery becoming available in EO/IR cameras, he noted, also pointing to the use of laser designators, laser pointers, rangefinders and SWIR imagery. Additionally, Bendavid said that the use of microelectromechanical systems (MEMS) ‘enables us to incorporate compact gyroscopes for stabilisation and navigation, providing line-of-sight pointing and geolocating capabilities’.

He added that the availability of compact, low-power computing incorporating graphics processing units (GPUs) allows for advanced image processing and image enhancements, such as image sharpening and colour enhancement, increasing the operational effectiveness of reconnaissance missions.

Furthermore, Internet Protocol connectivity allows for compressed video to be made available from the payload, while stronger computing power is improving tracking capabilities and adding features such as video motion detection to even the smallest payloads.

According to Bendavid, Tamam aims to ‘provide high-quality imagery, accurate sighting and high reliability in very challenging environments for both the helicopter and the gun’. The company has developed the Hand Control Grip Set to allow operators and pilots to operate the payloads effectively in the challenging helicopter environment, he added. The OEM sees significant business potential in the helicopter upgrade market, particularly for its 20cm and 38cm payloads.

Bendavid said that Tamam expects to see further technological progress in advanced image processing, computing, MEMS and other areas. '"Old-fashioned" technologies like materials science, motors and motion control continue to offer more capabilities that translate into more capabilities for EO/IR payloads,' he noted. 'We expect to continue providing larger observation ranges, more sensors and more automatic capabilities in smaller sizes, lower weights and at a lower cost.'

Processing power

Image and video processing are a crucial element of EO/IR systems, with a number of companies focusing on this side of the technology. Mercury Systems is a manufacturer of sensor processing subsystems for the defence and aerospace industries, including rotary-wing platforms.

The company develops the processing capability behind sensors, including EO/IR systems, said Shaun McQuaid, director of product management at Mercury Systems. This work covers a range of subsystems that process incoming data and translate it into actionable information.

The company's newest release is the EnsembleSeries HDS6605 blade server, which comes with hardware-enabled support for AI applications. 'This next-generation compute capability delivers enhanced performance and power optimised for modern AI applications, which enable our customers to take data centre processing capability all the way to the tactical edge,' said Joe Plunkett, Mercury's senior director and general manager for sensor processing solutions.

McQuaid told *Shephard* that the technology has advanced in several ways in recent years. This is particularly true of the graphics processing side, with the company now using more GPUs than in previous years. 'GPU technology has been a mainstay obviously for graphics processing for a long time, and there's been a lot of work done to take advantage of those processors and to use them for image processing for these kinds of EO/IR applications,' he explained.

Mercury Systems' newest release is the EnsembleSeries HDS6605 blade server. (Photo: Mercury Systems)

This is being driven by a number of industry trends, he said, which are now becoming more accessible for rotary-wing applications. The first is the ‘explosion in processing in the EO/IR space for automated cars’, he noted, with autonomous driving in the automotive industry ‘really making waves as far as image processing is concerned and providing a source of industry volume that’s driving key subsegments of the graphics processing market’.

Graphics processors for autonomous cars need to be able to survive in rugged environments, much like their equivalents in the helicopter sector, according to McQuaid. They have to endure for a relatively long amount of time without becoming obsolete, in order to support the lifecycle of the vehicles. This harmonises well with the types of EO/IR markets that Mercury is pursuing, including rotary-wing platforms.

‘I think that's a trend that has really benefited us and allowed us to really start to deploy more of these graphics processing solutions into our box-level processing solutions,’ McQuaid added, a reference to the company’s solutions more often being delivered and configured as pre-integrated subsystems.

Additionally, McQuaid highlighted that the technology has moved to an open systems approach, allowing it to be refreshed more quickly. By using open standards now prevalent in defence, the systems can leverage developments in commercial technology and refresh at a much faster rate. The combination of innovations in the automotive space with such open standards ‘is really driving acceleration in the capability, particularly in EO/IR’, McQuaid emphasised.

Smarter solutions

Mercury also works on unmanned systems, a market that McQuaid believes is informing the development of EO/IR systems on the rotary-wing side and manned aircraft more generally. He pointed in particular to work on AI ‘driving the ability to identify objects or people just by looking at the imagery data’. The unmanned space has obvious requirements in this dimension, to avoid stationary objects, for example. These are now being tied back to manned platforms, providing pilots and crew with higher-quality information and data ‘and presenting them with a better, 360° picture of the world around them’.

The idea is that by leveraging these kinds of AI algorithms directly onto the platform, it is now possible to place the processing power into the payload itself, ‘using these algorithms in real time – that puts a lot more capability into the hands of the operators of that manned equipment’. The requirement to assist pilots in DVEs is also being felt on the processing side, ‘driving a set of processing requirements that are continually growing more and more stringent’, said McQuaid.

Sensor fusion is demanding greater connections between processing elements, 'so that they can make intelligent decisions about which sensor is providing the best kind of integrated picture or what fusion of sensors provides the best integrated picture in that degraded environment'. According to McQuaid, Mercury is focused on combining data flows in the most intelligent ways possible, 'so that you have the processing resources at the tactical edge to deliver that kind of solution'.

John Bratton, product marketing director at Mercury Systems, said that EO/IR sensors and other payloads are also being used in more ways: for example, focusing on ensuring that rotors are operating as they should be. This creates new demand for the processing side as well, he added.

The development of processing capability is impacted by SWaP demands, 'whether we have the room to do some of the larger classes of server or whether we have to employ something a bit smaller', noted McQuaid. The company aims to take the same type of server architectures found in the data centres of Silicon Valley technology giants and package them in a way that makes them deployable in the highly rugged types of environments that helicopters experience.

Being able to conduct processing on board the platform via cloud capabilities gives operators many more options, McQuaid added. For platforms that are more SWaP-constrained, it is possible to use smaller architectures. 'That's what's driving the different solutions in our space – the power and space available on the platform,' he said. 'How much can we fit into the space, and what open standards form factor makes the most sense for long-term upgradability?'

Bratton said that the company expects to see more computing power in the sensors going forward. 'Platforms are getting smarter,' he explained. 'We take it for granted that a sensor will look at a picture and figure it out, but there's an awful lot of processing and machine learning that goes into it,' he continued. 'If we look at our roadmap going forward, we see more processing, more SWaP efficient [solutions] that must be trusted and flight safety certified.' Mercury is investing in overcoming these challenges in various ways, as it seeks to put more computing power onto platforms.