Made to measure: integrations of large EO/IR sensor turrets are often tailored to the individual aircraft and operator, such as this left side pylon mount on an AS350. Image: GSS

Eyes in the sky

Aerial surveys conducted from helicopters play a crucial role in many areas, from surveying the powerlines and pipelines that underpin modern technological societies to environmental and agricultural monitoring and wildfire mapping. Peter Donaldson reviews the equipment solutions that make it all possible.

Helicopters serve as versatile platforms for a range of sensors such as electro-optical and infrared cameras, Light Detection and Ranging (LiDaR) systems and more.

Pilots and survey specialists work to optimise flight paths, ensuring safe, efficient data collection and transmission to customers in a lively and growing sector of helicopter operations.

Nick Ricciardi, VP of Sales and Marketing at Gyro-Stabilized Systems (GSS), reports a steady growth in demand for airborne sensors in the inspection and survey markets, as well as in law enforcement and the military – different market sectors with overlapping needs for high-resolution stabilised imagery in various wavebands.

GSS integrates multiple sensors into a range of stabilised platforms, including the four-axis U416 and the five-axis U512EX and U512EX Optical Gas Imaging (OGI) turrets.

Infrared camera specialist InfraTec produces airborne sensors that cover the thermal Long-Wave Infra-Red (LWIR) and Mid-Wave Infra-Red (MWIR) bands at wavelengths of 7.5 to 14 microns and 1.5 to 5.7 microns respectively, as well as the non-thermal Short Wave Infra-Red (SWIR) band at 0.9 to 1.7 microns.

Radiometric calibration of its LWIR and MWIR cameras enables them to take very accurate remote temperature and

Payload: the Galaxy T2000 LiDaR and camera solution delivers ultra high resolution 3D measurements on electric infrastructure, as well as nadir and oblique imagery. The data is used for as-built infrastructure mapping, together with close-up inspection of assets. Image: Network Mapping Group/Teledyne Geospatial Technology

radiance measurements, broadening their range of applications.

Teledyne Geospatial now owns Optech, which played a pioneering role in airborne LiDaR systems and currently offers the Galaxy family of airborne LiDaR packages.

"We've put LiDaR sensors in airborne vehicles for more than 40 years," says Malek Singer, Product Manager, Airborne. "There has been a long-term commitment to these sophisticated instruments."

Sensor progress

Singer recalls that around 20 years ago the technology was still largely experimental, and the market made up of early adopters with ambitions to explore potentially lucrative new applications.

The most ambitious, he adds, were the people who focused on utilities and wanted to use LiDaR to map power lines before the technology was proven.

Early heliborne LiDaR work focused on its use in obstacle detection and warning, and mapping the lines in detail meant narrowing the field of view and increasing the resolution, a task that the then Optech was given by an operator in Japan.

"The answer was 'challenge accepted' and it worked," Singer tells *RotorHub International*.

"Over the last 10 years, it has become an indispensable tool for many, many applications. The market is quite mature among governments and energy companies, particularly electric utilities who are either proactive about the health of their infrastructure and their services, or through regulation.

"Depending where you are in the world, many utilities are required to have an annual scan, for example, and to report on the most critical infrastructure."

In passive EO/IR sensors, meanwhile, Nick Ricciardi observes that technology is developing very rapidly.

"Improvements include longer focal length and high-resolution sensor integration including visible, near IR and IR," he says.

"New technology has also allowed us to produce smaller and lighter gimbals that help with flight costs and aircraft integration.

"We have also seen significant advancements with geo-spatially intelligent technology and augmented reality."

InfraTec notes that the company offers both relatively simple and robust light uncooled infrared and higher performance cooled cameras.

The microbolometer sensors at the heart of uncooled systems now feature sensor resolutions of 1,024 x 768 pixels, while the largest cooled-sensor MWIR cameras are based on larger sensing chips with dimensions of 1,920 x 1,536 pixels, which make these cameras full-HD infrared sensors.

With LiDaR sensors also, a major driver

> *"Just in this past year we've announced an onboard solution that makes it dramatically easier and more efficient for anyone to operate the system, not just an expert with a master's degree or a PhD."*

Malek Singer, Product Manager, Airborne, Teledyne Geospatial has been the desire to increase resolution, Teledyne Optech's Singer says.

"Some years ago, you would celebrate if you picked up a few measurements on wires and towers, and maybe a few of the trees nearby, but the technology has since really taken a 'hockey stick' progression."

LiDaRs generate "point clouds" in which each point represents information on the range and direction of the part of the object from which the laser light has been reflected. The denser the point cloud, the more information it provides about the object.

Today, Singer emphasises, point cloud density is sufficient to create very high resolution 3D images.

"It really is creating digital twins of these pieces of infrastructure," he says. "The expectation is quite high for how much density and resolution you pick up on a tower and conductors and insulators and the attachment points between wires and poles, etc."

Data fusion

Another major development in the use of information generated by sensors including LiDaRs and other EO/IR devices is data fusion, which has also made big advances over recent years.

"That is by fusing and co-processing of both the LiDaR output and the imagery from other sensors that come with it," says Singer.

"This allows systems to pick up even more meaning from colour imagery and non-thermal and thermal infrared imagery to help identify pieces of critical infrastructure that are near the end of their lives – indicated by overheating for example."

The other big development in LiDaR in particular is in ease of use, Singer notes, enabled by the application of computer processing power in the aircraft to make sense of the imagery.

"Just in this past year we've announced an onboard solution that makes it dramatically easier and more efficient for anyone to operate the system, not just an expert with a master's degree or a PhD," he says.

All set: a typical operator workstation for an aerial thermography installation. Advanced onboard processing speeds up fault location and identification tasks. Image: InfraTec

"And because the data is being processed and qualified in the air, you immediately know where the problems are. So when you land, you have to spend far less time, incur far less cost and lose far fewer weather windows because you know the nature of the issues and you can take action based on real-time data to mitigate the impact of a storm, for example."

These capabilities are incorporated into Teledyne Optech's Galaxy Onboard system, which is an edge computer that processes LiDaR data in real time and at full resolution, which Singer says is an industry first.

This, he notes, is a capability that has been in the works for a decade and a half or more and that was first realised in a commercial product in 2023.

As well as processing the data in real time, the Galaxy Onboard computer also qualifies the data to give the operator a sense of confidence in its reliability.

"For utilities, the value of the real-time data, which is a real-time LiDaR point cloud, is that you can run a quick analysis immediately when you land," says Singer.

"This means that if you have time-sensitive needs, such as locating points on a powerline that have been damaged by a storm, perhaps where wires have been snapped, you can do this very quickly and easily.

"What matters in that kind of situation is time, not the millimetric accuracy that is usually expected. That has been a big innovation for us."

Augmented video

Nick Ricciardi at GSS reports that the recently introduced U series utility inspection systems are being adopted at a higher rate than the company has ever seen before.

These are systems with between one and five sensors, which can include Optical Gas Imaging (OGI), for example.

Ricciardi points out that regulatory authorities in many countries have enacted legislation requiring continuous inspection of gas pipelines to look for methane leaks.

GSS integrates an MWIR camera that images such leaks and can be mated with a 4K visible light camera and a geolocation capability that attaches precise latitude and longitude co-ordinates to every leak detected.

The company also applies augmented reality to live airborne video, including maps, graphics, asset tags and points of interest.

Ricciardi says: "The U416 enables operators to offer a wide variety of services including powerline and pipeline inspection, gas leak detection, right of way mapping, disaster recovery planning, agriculture monitoring and more."

GSS has also integrated artificial intelligence (AI) that can potentially extract more information from the imagery than the human eye can.

In the utility context this can, for example, be a machine-learning application in which a model is trained to identify faults in powerline or pipeline infrastructure.

When planning the use of GSS's equipment from a helicopter, Ricciardi emphasises versatility.

"Our systems can either be mounted in the morning for a single-day mission, or highly integrated into the aircraft for a more permanent installation," he says.

"While some GSS systems put AR overlays onto live video that can help pilots with navigation, the majority of them are isolated as to not impact the other aircraft systems.

"GSS's heritage is in the film production market where a director of photography may rent a helicopter for the day, rig in the morning, fly the mission and de-rig in the evening. This ease and flexibility is built into all of our systems."

Continuous zoom

InfraTec's latest sensor intended for airborne applications is the ImageIR 6300 Z, a camera with a motorised 7.5 power zoom lens as standard.

The company emphasises that the camera's "unique" radiometrically calibrated continuous zoom lens is the first device of its kind.

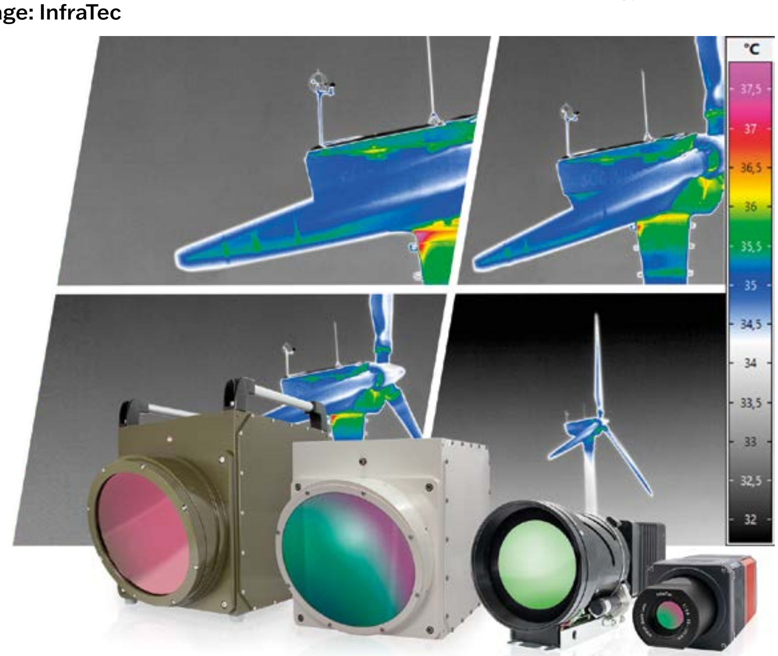
The camera's compact dimensions and total weight of 2 kg allow it to fit into small gimbals, suiting it for operation from small helicopters and even UAVs, while new interface options allow remote and wireless operation and video downlinking.

The company typically teams with integrators who offer three- and four-axis stabilised gimbals. Those integrators either use InfraTec's thermography software that controls both the camera and data acquisition or they design their own user interface with the help of a dedicated InfraTec software development kit.

LiDaR installations can be somewhat more involved. Teledyne Optech's Singer is most familiar with installations for the Airbus AS350 and Bell 206 and 407.

For both Bell helicopters, he says, there is a means of attaching a mounting bracket to the belly of the aircraft, a solution that is covered by a Supplemental Type Certificate (STC). This bracket supports the pod that contains the LiDaR, along with oblique cameras,

When integrated into airborne platforms, InfraTec's range of radiometrically calibrated cameras can be used to assess the condition of renewable energy infrastructure. Image: InfraTec



"native" cameras and GNSS equipment.

Inside the cabin, the LiDaR system operator have their own displays through which they run the mission, Singer says.

For the AS350, the installation is similar, but instead of a belly bracket there is a pole that extends all the way to the nose and positions the 0.03 to 0.25 m pod ahead of the helicopter.

Installation practicalities

Ricciardi at GSS emphasises that the practical challenges involved in attaching a sensor to a helicopter centre on weight and balance and certification, with basic considerations such as whether the camera operator should sit in the front or the back requiring careful thought

Real-time processing: the Optech Galaxy series LiDaR. This equipment can be installed in the cabin with an aperture in the floor, or packaged in an external pod. Image: Teledyne Geospatial Optech

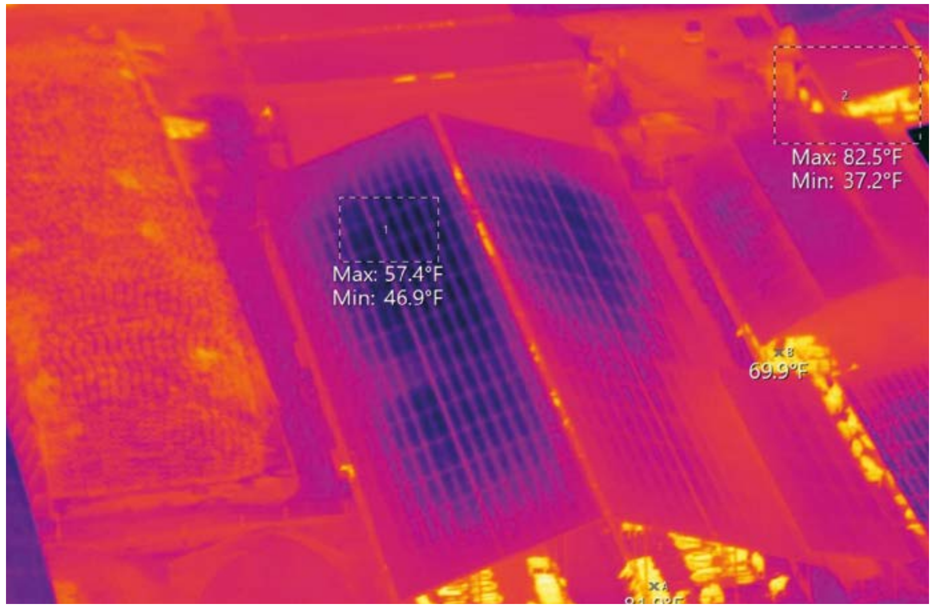
and attention to the aircraft's centre of gravity limits, for example.

"Not all aircraft have a mount certified for a camera system," he notes. "STCed mounts from Meeker and Dart Aviation are often used. However, not every rotory-wing aircraft has an approved mount capable of holding a 50lb+ camera system."

The biggest challenge comes from vibration and shock, InfraTec notes, so the company builds its systems to withstand at least 25 g of shock during operation.

Singer acknowledges the above issues, but focuses on cost, productivity and the problems involved in operating over non-flat terrain.

"Let me unpack this quickly," he says. "Cost is higher compared with fixed-wing aircraft, and cost and productivity go together.



Right, thermographic images like this have many uses – including identifying where buildings are losing heat and identifying faults in solar panels. Image: GSS

"New technology has also allowed us to produce smaller and lighter gimbals that help with flight costs and aircraft integration."

Nick Ricciardi, VP of Sales and Marketing, Gyro-Stabilized Systems

"Even if most helicopters are expected to fly quite high – I'm talking thousands of metres – in my experience I have never seen a helicopter being operated at more than a few hundred metres.

"So that naturally limits productivity because flying lower means that a smaller area is captured by the sensors. So that's a challenge for those wanting to cover larger areas faster."

Where helicopters have a real advantage, however, is in corridor mapping, which requires much more "tactical" traversing of irregular features on the ground, such as when following a pipeline for example.

Singer expresses admiration for pilots who take on this kind of flight close to the ground, particularly in mountainous terrain.

"That's not an easy thing to do," he says. "In my experience working with customers, you get operators who love doing this and have the right pilots for the job. And we have others who do not want to fly mountainous routes with elevation changes of 700 to 1,000 m, as they don't want to deal with those inclines and declines."

Singer points out that Teledyne Optech provides help with this problem through a combination of flight management software and dynamic compensation of the LiDaR system's field of view.

"We put the responsibility of compensating terrain on the scanner through patented technology called SwathTRAK, rather than having the pilot fly up and down hills," he says.

Good prospects

Offered with all Galaxy LiDaRs, SwathTRAK automatically and dynamically adjusts the scanner's field of view to keep a constant swath width over the ground, regardless of the varying vertical distance between the aircraft and the surface, eliminating gaps and unwanted overlaps in coverage.

The Galaxy T2000, for example, is designed as an all-terrain sensor optimised for landscape level surveys and pipeline/powerline corridor that demand high point cloud density.

Operating at altitudes between 150 m and 6,500 m above ground level, it offers horizontal accuracy of 1/10,000 of the altitude, and an elevation accuracy of 0.03-0.25 m throughout its altitude range.

The system's swath width is adjustable between 10 per cent and 115 per cent of the aircraft's altitude above the ground. The system weighs less than 34 kg.

Ostensibly, advances in UAV technology could eventually displace manned aircraft, whether rotary- or fixed-wing, particularly when machines with longer ranges are permitted to fly Beyond Visual Line of Sight (BVLOS) missions.

However, Singer does not see this as something to worry about just yet.

"They absolutely have a real place in the industry," he says. "If you have a farm, a small construction site or a quarry, it is quite effective to put up a drone that can fly for 20 minutes or less and come back home with data.

"There are areas or linear extents that naturally justify using a helicopter rather than a drone, and then there are those that naturally require a fixed-wing airplane rather than a helicopter.

"It is a good time in our industry, now that people have various tools to get the job done at various price points and turnaround times.

"Helicopter operation is not going anywhere – there will continue to be thousands upon thousands of linear kilometres that can only be surveyed effectively with helicopters.

"You can see from sensor development from manufacturers such as ourselves that this is a key part of our roadmap. We are keen about building products that are natively made for helicopters." ■