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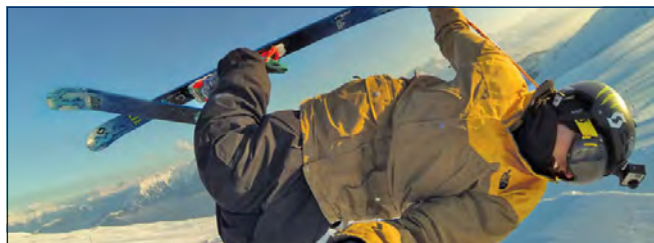


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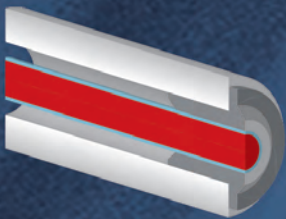


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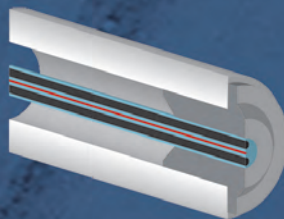


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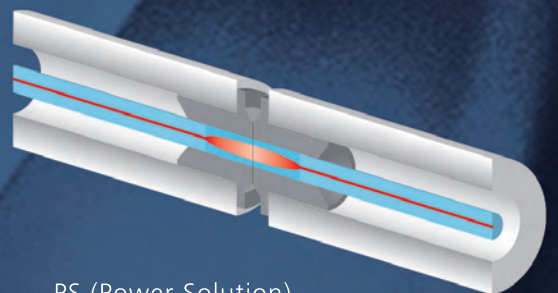
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LGS Innovations completes lidar development with DARPA

Breakthrough will improve DoD LIDAR systems' ability to detect and identify objects of interest.

US technology R&D company LGS Innovations has announced the successful completion of a two-year Laser Radar Technology project in partnership with the Strategic Technology Office within the US military research agency DARPA (Defense Advanced Research Projects Agency). LGS works in many photonics-related sectors such as wireless communications, RF spectrum analysis, cybersecurity, optical communications, and mobile broadband.

hone in and provide additional insight on the selected object.

LIDAR-based technologies have been used in military operations such as those in Afghanistan due to their ability to provide 3-D imagery from aerial platforms that is quicker to produce, more accurate, at higher resolution, and able to cover wider areas of terrain than other sensing and mapping tools.

"This breakthrough required developing a laser with the ability to produce a wide range of optical waveforms, and the ability

to meet all of these waveform agility requirements has ever been made before."

Kevin Kelly, Chief Executive Officer at LGS Innovations, added, "We are on bleeding edge of photonics research, which has a wide range of mission critical applications from LIDAR imaging and missile defense to free-space optical communication and more."

Further infrared R&D project

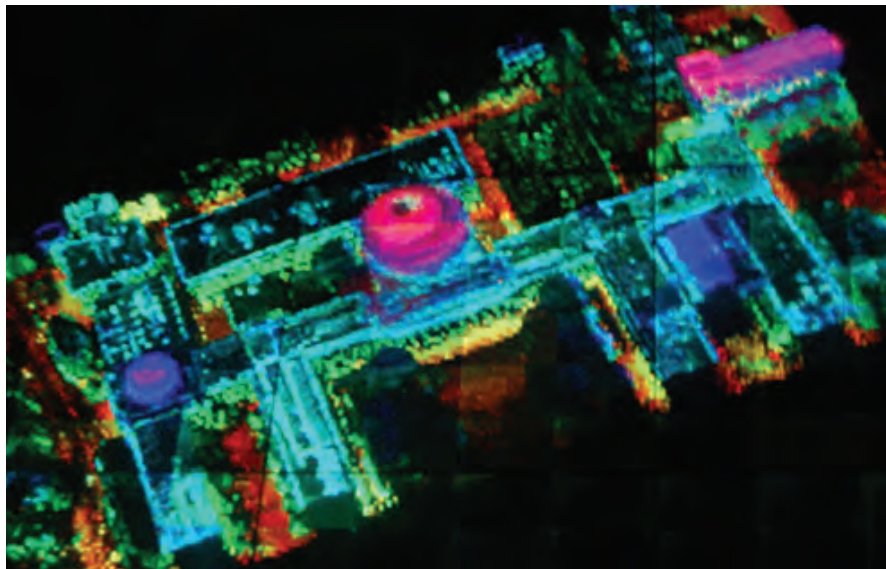
LGS Innovations has also announced (March 1) that it has won a four-year, \$11.2 million contract to develop and construct infrared-based technology for the U.S. Air Force to detect trace chemicals from diverse surfaces.

The US Defense Department announced Tuesday that LGS aims to help the Air Force develop a standoff sensor equipped with an active IR spectroscopy technology for the detection and identification of chemical residues at a range of up to 30 meters.

The contract stated: "LGS Innovations has been awarded an \$11.2 million contract to develop a portable system for real-time standoff detection and identification of trace chemical residues on surfaces using active infrared spectroscopy at a 30 meter range. Work is expected to be complete by October, 2020."

Following the competitive tender win, LGS's applied research and technology division will perform the contract work in its Florham Park, NJ, headquarters.

<http://optics.org/news/7/3/2>



Liar experience: Leveraging past DARPA developments in laser-based versions of RADAR, the High-Altitude LIDAR Operations Experiment (HALOE) provided unprecedented access to high-resolution 3D geospatial data.

The LRT program supports the development of detector arrays and laser transmitter technologies that could improve the ability for a LIDAR system to switch between settings geared to detect objects of interest and settings geared to

to change waveforms in real-time while operating at full power," said Stephan Wielandy, Chief Scientist for Photonics Applications for LGS Innovations' Advanced Research and Technology division. "To our knowledge, no laser with the ability

Flir to focus on high-growth markets

Fourth-quarter and full-year revenues rise in line with company expectations, with room for improvement.

Flir Systems, developer of thermal imaging and vision systems, saw a slight increase in revenues for the fourth quarter of 2015 and a similar increase in full-year figures, according to its latest financial results.

Quarterly revenues reached \$437.6 million, up by one percent from the equivalent quarter of 2014. Net income slipped slightly from \$72.8 million to \$70.2 million for the same periods.

For the full year 2015, the company's revenues rose by two percent to \$1,557 million. Net income rose by a more significant amount, from \$200.3 million in 2014 to \$241.7 million last year.

"The fourth quarter largely met our expectations," commented CEO Andy Teich to analysts. "Profits and cash flow came in strong, despite our modest top line growth. Backlog rose to the best levels since 2008, when military combat operations were higher than they are today. For 2016, we intend to grow in our existing and new markets through continued product innovation, operational discipline, strategic marketing, and opportunistic use of our capital."

Performance across the company's business areas was varied. Revenues rose in the Security and Detection segments, but dipped elsewhere. The Surveillance segment reported quarterly revenues down by five percent year-on-year to \$150.7 million, with the Instruments business falling by a similar percentage to \$98.6 million for the Q4 period.

Teich commented that Flir's Instruments and Maritime sectors were both the weakest areas, following the pattern reported at the end of the third quarter.



Credit: Flir Systems.

The Flir Vue is designed to make thermal imaging an affordable proposition for commercial unmanned aerial systems.

"Instruments was actually flat or up slightly on a currency-adjusted basis in Q4, but European and Latin American markets were soft from a bookings and revenue perspective," he said.

Even so, Teich pointed to the rising percentage of Instruments-sector products incorporating the company's Lepton sensors - now accounting for more than 60 percent of total unit volumes in the fourth quarter - as a positive development.

Amit Singhi, Flir CFO, told analysts that currency effects were the major cause of revenue decline; on a constant currency basis, the company's overall year-on-year revenues would have increased by three percent. He also pointed out that restructuring expenses had totaled \$300,000 for the quarter and \$1.4 million for the year.

Going forward, Teich commented that the company's plans involved shifting sales and marketing resources away from slow-growth markets and focusing on higher-growth areas instead. He also pointed to the Lepton platform as a source of good market traction for the future.

Daylight flights

During the fourth quarter, Flir acquired DVTEL, a New Jersey-based developer of surveillance software and hardware. The deal is intended to strengthen Flir Security's presence in the enterprise portion of the security market, according to Teich.

"What's important about DVTEL for us is that it fills a gap in our Security business, and builds on our strategy of providing a total system solution," he said. "DVTEL do have hardware products, but for us it's really more of a software play."

Another significant sector for the company is the Unmanned Aerial Systems (UAS) market, which it currently addresses with its FLIR Vue thermal imaging system and other products.

"We have been the major player in the military space for some time, but we are all watching the explosion occurring in the commercial side," commented Jeffrey Frank, Flir's Global Product Strategy VP.

"Late in 2015, we created two vectors into that market. One was the creation of a product line having appropriate capabilities and price points that we think that will help us gain inroads into the commercial space. The other was a strategic collaboration with unmanned aerial vehicle manufacturer DJI. We see a tremendous amount of opportunity coming out of this."

As Frank pointed out, regulatory issues around nighttime UAS use are in the process of being straightened out, but there are already a series of daytime applications that could deliver significant business opportunities.

"Things like agriculture, building inspection, search and rescue, fire fighting; all of these things have strong value," he said. "Thermal imaging brings a strong value proposition to these spaces, so we are optimistic about where this is going to lead."

<http://optics.org/news/7/2/21>

ZYGO Infrared Metrology

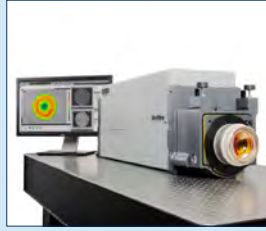
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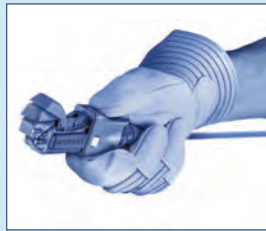
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Smallest SWIR camera targets cost-sensitive volume markets

Xenics new Bobcat-320 is ready to conquer cost-sensitive volume markets where performance in the SWIR – 900 to 1700 nm wavelength matters.

The camera is well suited for various applications such as laser beam analysis, sorting, recycling and semiconductor failure analysis.

The XSW-320 OEM counterpart is perfectly adapted for homeland security system integration.

The unit is available in 3 different configurations: a basic 100Hz version, an advanced 400Hz version and a 400Hz version for gated imaging.

www.xenics.com/en/camera/bobcat-320



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Autonomous vehicles get a push from lidar advances

Ford, Mercedes and Volvo are among the major car firms with vehicles featuring smarter, miniaturized optical sensors.

In recent years, light detection and ranging (lidar) systems have emerged as one of the central enabling technologies in the development of autonomous - or self-driving - vehicles.

an optical phased array transmitter, which is capable of guiding steady pulses of light by shifting the phase of a laser pulse as it is projected through the array.

Each of these pulses is transmitted in around



Photo: Volvo Cars.

Volvo's "Drive Me" trial of autonomous vehicles in 2017 will rely on data captured by Velodyne's 64-laser lidar system. Volvo's engineers have developed software that interprets the lidar data to identify objects such as other vehicles, lane markings, pedestrians and cyclists, which can then be checked against the car's readings and actions.

Analogous to radar but relying on infrared light instead of radio waves, the technique is now widely seen as a crucial requirement for the next-generation of autonomous vehicles – giving them the ability to react to potentially hazardous situations, prevent accidents and protect drivers, pedestrians and other road users.

Solid-state system

Several companies are now heavily engaged in the test and development of mounted lidar technology for use in both autonomous vehicles and so-called advanced driver assistance systems (ADAS). Among the players in the emerging sector is Quanergy, an automotive lidar and "smart sensing" start-up based in Sunnyvale, California.

At this year's CES (Consumer Electronics Show) in Las Vegas, the company launched its S3 LiDAR, which it claims creates a long-range 3D view of a self-driving car's environment in real-time - and the ability to recognise objects in its surrounding area.

Shown integrated within the body of a Mercedes-Benz GLE450 AMG Coupe at CES, the S3 is a compact, solid-state lidar system with no moving parts. Instead, it employs

a microsecond - in the process helping the S3 to gather in the region of one million points of data every second. Quanergy claims that the system will soon be available in production volume at a price of \$250 or less, and in Las Vegas the technology also featured in live demonstrations by Quanergy investor Delphi and Nvidia, on board a Volvo XC90 and Mercedes SUV, respectively.

Retro reflectors

Quanergy wasn't the only Californian company showing off new lidar systems at CES this year. Another one of the early



Quanergy Systems
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Quanergy at CES 2016
8:42 AM - 8 Jan 2016

1 2

Follow

front runners in the sector its Silicon Valley neighbor Velodyne LiDAR. Velodyne is better known for high-end audio equipment

including headphones and sub-woofers, but has more recently developed an innovative and compact lidar kit – claimed to be similar in size to an ice hockey puck - that is being tested by the Ford Motor Company on its developmental self-driving cars.

As Wayne Seto, product line manager at Velodyne LiDAR, explains, the compact "Puck" design uses time-of-flight (ToF) methodology combined with reflectivity measurements to both precisely calculate the distance to nearby objects and potential hazards at high speed and to determine what kind of objects they are.

"All of the Velodyne LiDAR sensors operate with ToF methodology and generate 3D distance measurements," he said. "Now the sensors also measure the reflectivity or intensity of the object as well so it can distinguish between black and white objects as well as retro reflectors."

"Retro-reflectors are items that have high intensity or reflectivity, such as bike reflectors - and folks who wear safety vests in construction areas or cross walk guides," Seto explained. "Lower intensity retro-reflectors include some lane markings on roads and highways. These markings have some retro-reflectors mixed into the paint when it is applied to the road. Traffic signs are also retro-reflectors along with license plates on vehicles here in the US."

Velodyne's sensors feature integrated 8-bit resolution, used in a process that Seto describes as 'calibrated reflectivity'. In this scheme, zero represents the color black, while 99 represents white and numbers between 100 and 255 represent the various retro reflectors.

Output power

The Velodyne system features 903 nm laser emitters and avalanche photodiode detectors, with optics designed to support vertical fields of view ranging from 20° to 40°.

While all these optical components are standard, off-the-shelf, devices from third-party suppliers, Seto says that where the company's sensors distinguish themselves from their competitors is with the amount of data they generate. He says that this provides "a wealth of information to enable the software in autonomous cars to make the best and right decisions".

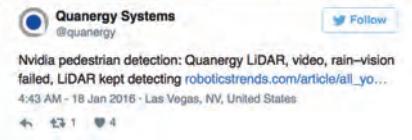
He added: "Velodyne LiDAR sensors provide not only distance measurements, but also reflectivity values, and since it can 'see' 360° it provides a surround view of the entire environment so there are no blind spots."

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Autonomous vehicles get a push from lidar advances

Looking ahead, Seto predicts that there will be a number of key innovations and developments in the design and use of laser and optics technology for autonomous vehicle lidar systems in the coming years.



“Over time, laser diode and detector suppliers will continue to develop better products and Velodyne LiDAR will make use of those products when they become available,” he

said. “We will also look for lasers with greater optical output power so they can support longer ranges and more sensitive detectors.

“Obviously one big thing is that when our volumes increase we believe that the economies of scale will translate to more cost-effective components that we will use in our systems.”

Quanergy reveals Sensata deal

Meanwhile Quanergy, identified by Fast Company earlier this year as one of the top-ten most innovative companies in the automotive sector thanks to its 11-ounce S3 lidar, has just signed a strategic partnership with sensing industry giant Sensata Technologies, formerly the Texas Instruments sensors and controls division and a company boasting strong commercial relationships across the automotive industry.

Sensata and Quanergy will become exclusive partners for component-level solid-state lidar sensors in the transportation market, announced the two firms, with Netherlands-based Sensata CEO Martha Sullivan saying:

“This partnership is a pragmatic way to extend our sensing capabilities into advanced driver assistance applications, one

of the fastest-growing areas of transportation sensing. According to industry experts, the lidar market is expected to develop into a billion dollar market opportunity by 2020.”

Quanergy CEO Louay Eldada added: “We know that by teaming up with Sensata we’ll stand to benefit from Sensata’s new product launch and manufacturing expertise, deep customer relationships and global presence as the leading independent sensor supplier. Together, we are well positioned to become the leading provider of lidar sensors to the transportation markets.”

That deal, combined with the advances at both Quanergy and Velodyne, suggests that lidar is on the verge of becoming a far more commonplace technology in the automotive industry – first in ADAS applications, but perhaps more significantly as one of the key enablers of what is expected by many to be the autonomous vehicle revolution.

About the Author

Andrew Williams is a freelance journalist based in Cardiff, UK.

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SPIDER technology offers route to lighter, compact telescopes

Lockheed Martin and UC Davis collaboration shrinks interferometry approach to fit on photonic circuits.

The size and weight of advanced astronomical telescopes pose a constant challenge to engineers aiming to launch them into Earth orbit, so any routes to improve matters without compromising on performance is potentially attractive.

A collaboration between the University of California, Davis, and Lockheed Martin is currently developing a novel optical design of telescope that should be much lighter in weight and smaller in size than competing approaches, making it easier to launch and position.

Rather than employ conventional optics and mirrors, it uses instead a large number of tiny individual lenses focusing the collected light onto silicon-chip photonic integrated circuits (PICs), of a type developed by Ben Yoo and his group at UC Davis. Combining the light from pairs of lenses produces interference fringes, which the PICs use to reconstruct a digital image of what the telescope sees.

Christened SPIDER - Segmented Planar Imaging Detector for Electro-optical Reconnaissance - the concept takes its cue from existing astronomical interferometry principles, but shrinks things down drastically by employing thousands of tiny lenses to feed sets of PICs.

"A nanophotonics waveguide array in a PIC maps the collected photons onto detectors that measure amplitude and phase at a pupil plane, and image reconstruction algorithms are used to compute an image from measured complex visibilities," said Alan Duncan of Lockheed Martin. "Each 'blade' of PICs samples a linear swath in the spatial frequency domain, with multiple PIC blades arranged in a disk geometry offset in azimuthal angle."



Credit: Lockheed Martin

Using the SPIDER concept in place of traditional large lenses and mirrors could lead to a new class of telescope.

Among other advantages, this concept should produce a high-resolution result even while maintaining a thin disk of PICs, and do so without the same complex alignment requirements of large lenses and mirrors.

Although imaging interferometer arrays currently exist at multiple sites, including CHARA at Mount Wilson in California, and NPOI at Lowell Observatory, Arizona, these instruments employ a small number of interferometer channels with very long baselines and vacuum delay lines to interfere the light. They take advantage of the earth's rotation to slowly collect enough data for a uniformly sampled spatial frequency domain, and use that to form an image.

"SPIDER forms images in a similar way, but contains many individual interferometer channels on a much more compact scale, which collects all the required data simultaneously," said Duncan.

Next-generation PICs

The key enabling technology is the capability to fabricate very high density waveguide arrays in photonic integrated circuits - one of the Yoo group's areas of expertise.

For SPIDER, UC Davis fabricated a PIC able to collect interference fringes and form images in three bands of wavelengths. Behind each lens are multiple waveguides gathering light from a wide field of view, and each pair of waveguides at a given band of wavelengths will form the crucial interference fringes used to reconstruct an image.

At present, the density of waveguides and the depth that the waveguide layers can be written into the PIC substrates imposes one potential barrier on the concept, limiting the field of view - and hence image size - to small values. But enhanced

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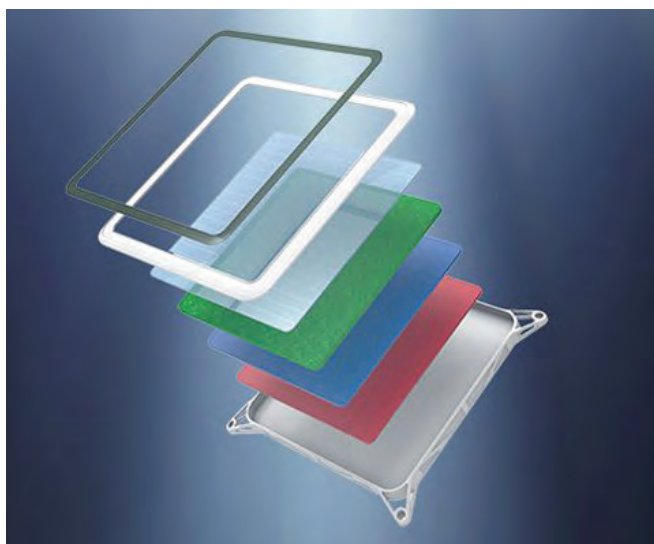
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SPIDER technology offers route to lighter, compact telescopes

fabrication technologies are emerging and expected to mature rapidly, allowing higher field-of-view imaging sensors to become viable.

While the SPIDER prototype today employs fewer than 100 waveguides, Yoo expects that future generations of PICs will feature highly functional and densely integrated systems. Those circuits could be manufactured using three-dimensional laser inscription, in which an ultrafast source writes waveguides of any desired shape within a solid piece of glass.

And the prototype has already demonstrated the potential benefits of the SPIDER concept, given that the cost of imaging payloads in space is strongly driven by the dimensions and scope of their optics. Although astrophysics applications that require large collecting apertures to image distant point-like objects may not benefit greatly from a SPIDER approach, earth-observation (EO) systems could be a different story.



Waveguides direct light onto photonic integrated circuits, allowing SPIDER to employ an interferometry approach on a compact scale.

"SPIDER can significantly reduce the size, weight and power requirements of a telescope, by factors of between ten and 100, alongside similar reductions in fabrication, integration and test schedules," commented Duncan. "The result will be substantially lower-cost imaging sensors, particularly for EO space applications or orbiting planetary missions in our solar system."

Non-astronomical applications could also open up, with Lockheed Martin envisaging SPIDER systems playing a role in automotive security systems, or military reconnaissance and targeting instruments.

"The development timeline is critically dependent on the PIC fabrications technology, which is being driven by commercial applications for very low power chips, primarily for mobile CPUs and larger server-farm applications," said Duncan. "We expect to be able to fabricate competitive imaging sensors in five to ten years."

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Credit: Lockheed Martin.



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Flir sensor powers first thermal imaging smart phone

On show at the MWC, Flir's Lepton thermal microcamera module is embedded in rugged Cat Phone.

Flir Systems has announced that Bullitt Group, a manufacturer of ruggedized smart phones, is to integrate Flir's Lepton microcamera in the new Cat S60 phone, creating what the partners are calling "the world's first thermal imaging Smartphone".

The Cat S60 Smartphone, part of the range of ruggedized Cat Phones handsets, is the latest consumer product to feature Flir's thermal imaging technology and was unveiled at the Mobile World Congress 2016 in Barcelona, Spain.



Cat S60 phone: said to be "the world's first thermal imaging Smartphone".

Leveraging Flir's Lepton core, claimed to be the world's smallest and cheapest microbolometer-based thermal imaging camera, the Android-based Cat S60 Smartphone is said to expand the capabilities of a Smartphone. Flir says, "With the ability to visualize heat that is invisible to the naked eye, the Cat S60 allows users to measure surface temperature from a distance, detect heat loss around doors and windows, spot moisture and missing insulation, making it the ideal Smartphone for building professionals, electricians, and first responders."

Visible-thermal embossing

The Cat S60 also exploits Flir's patented MSX technology, which can emboss details from visible imagery onto thermal images, offering users more detailed and higher quality thermal imagery.



Based on Flir's Lepton core, the microbolometer-based thermal imaging camera.

"We're excited to partner with Bullitt to create the world's first Smartphone with integrated thermal imaging," said Andy Teich, President and CEO of Flir. "We have achieved significant reductions in size, weight, power, and cost of thermal cameras and the Cat S60 represents yet another application for our technology."

Peter Stephens, CEO Bullitt Group, a global licensee for Caterpillar, said, "We are excited for thermal technology to now be in the hands of Cat phones' customers, who have the opportunity to discover the myriad of daily time and efficiency use cases it will present for them."

The partners say the Cat S60 is "ideal for builders, electricians, emergency services, utility workers, among others. Its thermal camera has applications in detecting heat loss around windows, spotting moisture and identifying overheating appliances, for example."

The phone is a ruggedized Smartphone, featuring a Corning Gorilla Glass 4 touchscreen. It also exceeds military specifications and is designed to withstand drops onto concrete from up to 1.8m. It is also waterproof to depths of up to 5m for one hour, meaning it can be used as a reliable underwater camera.

Graphene showcase at MWC

Also appearing at the Mobile World Congress in Barcelona, the Graphene Flagship, the EU's largest research initiative has been hosting the inaugural Graphene Pavilion. This exhibit showcased the latest graphene-based innovations from both academia and industry with numerous prototypes and demonstrations.



The Graphene Flagship stand at MWC.

The Graphene Pavilion, jointly operated by the Graphene Flagship, ICFO and mobile industry association GSMA included live demos and prototypes of many different properties and applications.

These innovations included a wearable fitness sensor that collected heart beats from visitors (presented by ICFO), printable touch sensors (presented by the University of Cambridge and Novalia), a working graphene super-capacitor (presented by Manchester University), flexible displays (presented by FlexEnable), a supercapacitor charger for smartphones (presented by Zap&Go) and a number of different flexible NFC antennas, sensors and ultra-fast photo receivers.

A notable attraction on the Flagship stand was that delegates had the opportunity to make their own graphene sample, while visiting some of the leading players in the field. These included Aixtron, AMO, Avanzare, BGT Materials, FlexEnable, GNext, Graphenea, Libre SRL, nVision and Zap&Go, alongside academic institutes such as University of Cambridge, Chalmers University of Technology, University of Manchester, ICFO, Catalan Institute of Nanoscience and Nanotechnology, National Research Council, Institute of Electronic Materials Technology and the Italian Institute of Technology.

<http://optics.org/news/7/2/32>

UK develops 'Hyperion' laser-based aircraft tracking system

EPSRC-funded UK partnership development, which could aid disaster relief efforts, starts field tests.

A ground-breaking tracking system called Hyperion, which is based on eye-safe lasers could enable aircraft, unmanned aerial vehicles (UAVs) and even orbiting satellites to transmit vital data to ground stations more securely, quickly and efficiently.

of aircraft, UAVs and satellites are being deployed the sky for a variety of applications from agriculture and land surveying through to disaster relief, security and military; the bandwidth offered by laser frequencies – the conventional RF spectrum is over-allocated meaning it cannot support the desired high data rates cannot easily; and safety – 1550nm

How it works

This optical system aims a laser with a wavelength of 1550nm up from the ground towards the target aircraft, which is equipped with a specially designed reflector that captures the beam, modifies it with the data to be transmitted and then sends it back to the ground where it can be decoded and read.

With its optimized aircraft tracking capability and secure high-speed data link, Hyperion offers key advantages over RF communications which are potentially vulnerable to interception and jamming and rely on an increasingly crowded part of the electromagnetic spectrum. Unless alternatives are developed that can supplement radio communications, it simply will not be possible to cope with the huge volumes of data that need to be transmitted from the skies in years to come.

Professor Dominic O'Brien, who has led the Oxford team, said: "Hyperion has the potential to enable extremely lightweight, low-power data terminals for UAVs, allowing flight-time to be extended, or smaller aircraft with enhanced capabilities."

Yoann Thueux, Research Team Leader at Airbus Group Innovations, added: "Hyperion has clear potential to develop into a technology solution addressing the requirements of UAV operators, who need real-time access to increasing amounts of

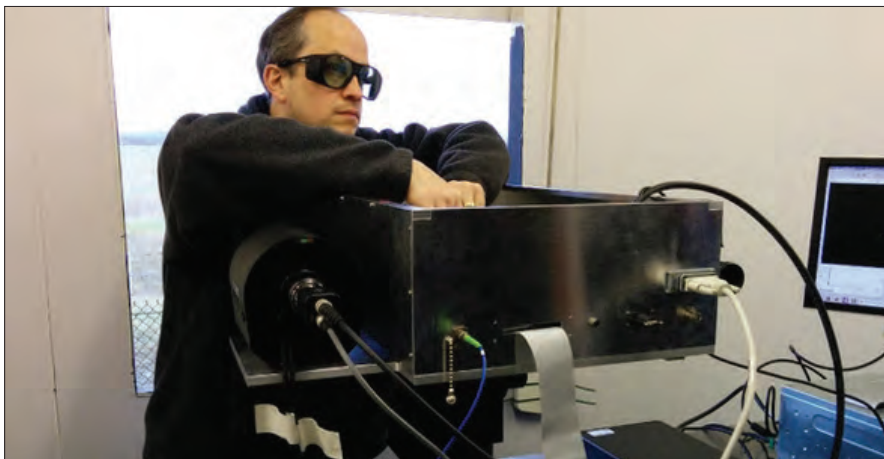


Image: Hyperion project website.

Hyperion's optical system transmits a 1550nm signal towards the target aircraft, which is equipped with a specially designed reflector that captures the beam, modifies it with the data to be transmitted and then sends it back to the ground where it can be decoded and read.

The £325,000, 2.5 year research program to develop Hyperion was completed in mid-2015, with field testing of the component systems now ongoing. The developers say they are confident that with further development, the Hyperion system could be introduced into commercial use as early as 2019.

The development of Hyperion has been pioneered by a joint team through the UK Government's Innovate HITEA program, including the University of Oxford with funding from the Engineering and Physical Sciences Research Council and Airbus Group Innovations with Innovate UK support. A proof-of-concept system has now been successfully tested in-flight. The range of the system is currently 1km but work to extend this range is underway.

The developers say that the Hyperion system offers major benefits compared with traditional radio frequency data transmission systems currently relied on in the UAV sector. Hyperion could, for example, allow UAVs engaged in disaster monitoring, surveying, search and rescue and other humanitarian missions to send detailed images more rapidly back to the ground for analysis.

The project managers say the main motivations behind this project are: the growing market – increasing numbers

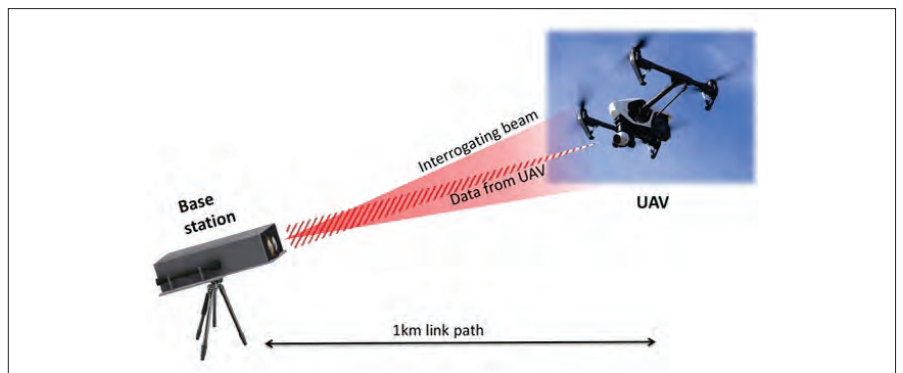


Image: Hyperion project website.

Hyperion could enable aircraft to rapidly transmit vital data to ground stations.

light does not focus on the human retina so this wavelength can be used in an eye-safe manner.

It could also enable airliners of the future to offload huge amounts of technical and performance data gathered by sophisticated on-board sensors to ground crews during final approach to an airport, speeding up maintenance procedures and cutting turn-round times.

Professor Philip Nelson, Chief Executive of EPSRC said: "This EPSRC-funded research is leading to exciting developments in aerospace and communications. It will potentially make aircraft and unmanned vehicles better connected and more resilient to outside interference."

mission data for surveillance, agriculture and disaster relief. It could also address the needs of the space sector, by allowing data download from microsatellites in low Earth orbit."

John Laughlin, Aerospace Program Lead at Innovate UK says "High bandwidth rapid transfer of aircraft data allows more efficient operation, new services and safer travel. Collaborations such as these between industry and academia to develop new disruptive solutions to existing challenges are essential to the success of the UK aerospace sector."

<http://optics.org/news/7/3/15>

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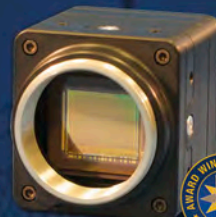
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