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VISION focus

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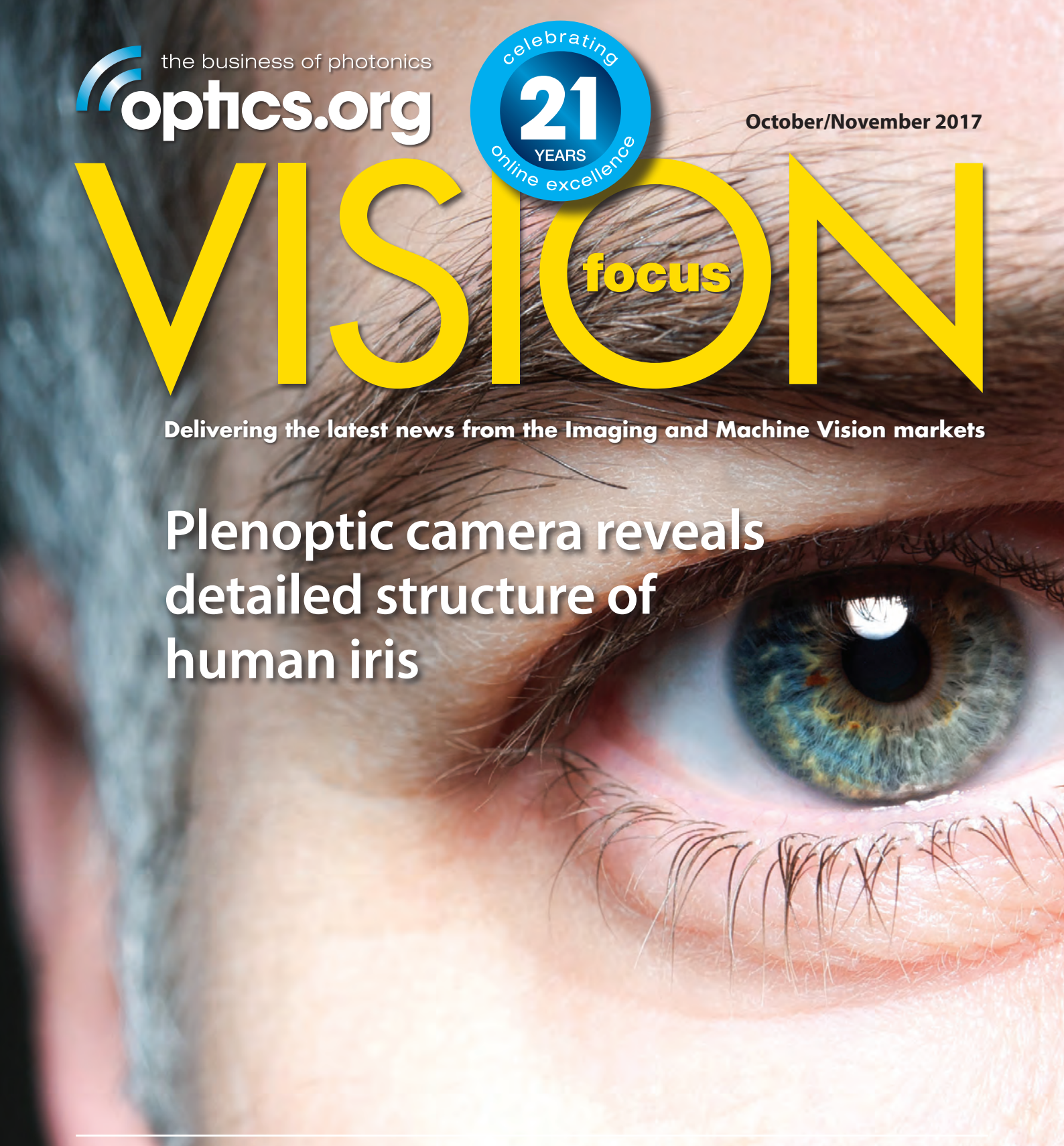
Plenoptic camera reveals detailed structure of human iris



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Eye-intelligence powers next-gen vision systems

Welcome to the latest issue of VISION Focus, the quarterly digital magazine that covers all aspects of vision and imaging, produced by the team that brings you optics.org. The editorial focus of this issue is on how embedded intelligence is boosting the performance of vision systems.

Considering this year's new Embedded Vision event *(positioned between the now biannual Vision Show in Stuttgart)*, it is not surprising that its focus is on the capabilities of hardware and software platforms to extend the reach of vision systems. While the performance of lenses, cameras, sensors and the usual range of vision systems components has clearly not reached any fundamental limit, there is an exciting new wave of capabilities based on innovation in software, intelligence and microelectronics.

Attendees to the new show and other interested parties can refer to this edition of Vision Focus online via optics.org. Here we round up some of the latest developments in embedded and software-empowered vision systems such as will be explored in Messe Stuttgart, between 12 - 13 October.

The problem of high-powered drones (UAVs) interfering with regular air traffic is growing. But now researchers in Switzerland have developed innovative algorithms that are capable of detecting and tracking small UAVs with the combination of a simple vision system and dedicated software *(page 7)*.

The highest specification (and highest cost) iPhone "X" features Face ID; is this a killer app for VCSEL mappers? Does this software empowered vision system justify the cost and ultimately will it protect the user's private data? *Find out on page 8*.

Time to wake up, sleepy drivers! The pairing of in-car optical sensors based on Jabil's optics with algorithmic awareness software from partner eyeSight will reduce auto accidents, claim the partners, *on page 10*.

In more conventional vision system applications, our cover story reveals how a plenoptic (light-field) camera system can reveal the detailed structure of human iris; the University of Michigan project offers a new route to identifying tumor precursors *(page4)*. Also concerning the "window of the soul", the University of Bonn is using adaptive optics to probe the human retina to better understand how color signals are conveyed on a cellular level *(page 16)*.

Besides all this we have astronomical, biological and financial features as well as new product information. And if you're attending Embedded Vision Europe, please send us your feedback.

Matthew Peach, Contributing Editor
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This Issue

Publication and Editorial Schedule 2018

January/February Issue 2018

- Bonus Distribution **SPIE BiOS, Photonics West, SPIE Medical Imaging**
- **Editorial Focus:** industrial applications, sensing, biomedical analysis and treatments.
- Published in advance of BiOS, 27th - 28th Jan, Photonics West, 30th Jan - 1st Feb, SPIE Medical Imaging, 10th-15th February 2018

April/May Issue 2018

- Bonus Distribution **SPIE Defense+Commercial Sensing**
- **Editorial Focus:** aerospace and defense applications, associated research and development
- Published in advance of DCS *(Defence & Commercial Sensing)*, 15th – 19th April 2018

June/July Issue 2018

- Bonus Distribution: **Astronomical Telescopes + Instrumentation**
- **Editorial Focus:** optical components, academic research, software applications.
- Published in advance of Astronomical Telescopes + Instrumentation, 12th – 14th June 2018

October/November Issue 2018

- Bonus Distribution: **Vision**
- **Editorial Focus:** opto-electronic systems, applications in sensing and manufacturing.
- Published in advance of Vision, 6th – 8th November 2018

Plenoptic camera reveals fine structure of human iris

University of Michigan project offers route to identifying tumor precursors.

The iris of the human eye can be affected by a number of medical conditions, and changes to its morphology provide an indication not just of disease in the local tissues but of broader systemic conditions as well.

Existing techniques for accurately imaging the structure of the iris include OCT and ultrasound, but the dynamic nature of the iris and natural movement of a patient's eye can affect the results they produce, and interfere with the generation of the 3D image information that clinicians would like.

The theory behind light-field cameras has long-established roots, but the configuration conceived in 2005 and subsequently commercialized by Lytro placed a micro-lens array in front of a conventional image sensor, to record the directional information as well as color and intensity. Real-world applications of the technology are now increasingly attractive in sectors such as machine vision, where its ability to enhance the optical capabilities of robots could be of value.

Source: Pexels/stock photo.

A plenoptic camera reveals the characteristic morphology of the iris in more detail than a standard camera can capture.

A project at the University of Michigan has developed a possible solution, by using a plenoptic or light-field camera to image 3D iris patterns in a single photograph. The work was published in Biomedical Optics Express.

Plenoptic cameras are able to capture not just the intensity of incoming light but also the angle from which it arrives. A "4D" image can then be recreated from the data, which among other useful properties can be refocused after being taken, something impossible in a conventional photograph.

At Michigan, the project team employed a camera from plenoptic suppliers Raytrix, and mounted it into a standard ophthalmology slit lamp. Human iris images were recorded at five frames per second, with an exposure time of 100 milliseconds, allowing a full sequence of 50 images for each eye to be generated in around ten seconds.

Early signs of melanoma

To test the system, it was first used to image the irides of healthy patients, exploiting the ability of plenoptic image data to be refocused in order to reveal the 3D topography of the iris and its characteristic fine structure of radial folds. Peaks and valleys with height differences of 20 to 80 microns were measured, according to the team's published paper.

The plenoptic platform may ultimately make its clinical impact by either monitoring the condition of patients suffering from iris melanoma - a tumor in the iris - or by helping to identify precursors to the condition before a tumor develops. In particular, clumps of pigment cells on the iris surface, called iris naevi, develop spontaneously and are usually benign, but are thought to be connected to the subsequent appearance of a tumor.

Plenoptic imaging of the region around an iris naevus in test subjects allowed the altered topography of the area to be accurately measured. The BOE paper notes that the relative heights of the peaks and valleys in the iris structure were different in the area of the iris naevus compared to the surroundings, presenting a relatively flat topography with small height differences of less than two microns.

Further work is now planned to enhance the platform's capabilities, including replacement of the slit lamp with a brighter short-pulsed illumination in order to reduce the exposure time, along with modifications to the computational algorithm used to generate the 3D data. But the value of a simple micro-plenoptic system designed to measure the 3D human iris topography has already become clear to the researchers.

"As iris naevi is the precursor of iris tumor, they need to be monitored frequently, and this imaging technique offers a simple promising way to realize this," the team commented. "The micro-plenoptic imaging system has great potential to be utilized for iris disease diagnosis and continuing, simple monitoring."

Tim Hayes, Contributing Editor, optics.org

http://optics.org/news/8/9/27

Image: EPFL.

A vision system installed directly onto drones could enhance safety in the skies.

Vision system identifies and tracks speeding drones

Researchers in Switzerland have developed algorithms that are capable of detecting and tracking small UAVs with simple vision system and dedicated software. *By Matthew Peach.*

Scientists at the École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland have shown that a vision system based on a simple camera supported by their novel algorithms can detect and track flying drones. The developers say that the lightweight, energy-efficient and inexpensive technology could also be installed directly onto the drones themselves to enhance safety in the skies, at a time when drones are increasingly seen as a danger to regular airplanes.

To address these concerns, EPFL researchers have developed algorithms capable of detecting and tracking small flying objects using a simple camera. The proof of concept was conducted as part of a PhD dissertation, and a real-time detection and collision avoidance system is now being developed in a project funded by the Swiss Commission for Technology and Innovation (CTI; kti.admin.ch).

Conventional collision avoidance systems operate actively: an airplane in flight calculates its position, altitude and course, and communicates this information to other aircraft using the same technology. Those aircraft can then evaluate the risk of a collision based on their own positioning data and, if necessary, alert the pilot. But this system is only effective as long as all aircraft are equipped with the same technology. In reality, drones often lack such systems, which are costly and heavy and consume more power.

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Vision system identifies and tracks speeding drones

Artificial intelligence, deep learning

A camera can thus be an effective, non-cooperative (i.e., not every aircraft must be equipped with it) addition to this defensive system, provided the camera can successfully detect a flying drone. Therein lay the obstacle that researchers at EPFL's Computer Vision Laboratory (CVLAB; cvlab.epfl.ch) sought to overcome. The biggest challenge for a moving camera is to spot another moving object. The researchers also needed to find a way to teach the vision system to recognize all sorts of drones.

Supporting the EPFL development is the thesis from Artem Rozantsev, a PhD student, who demonstrated that these practical challenges can be overcome. The first step is using artificial intelligence and deep learning to teach a camera system to recognize drones.

Rozantsev's method combines information on both appearance (types of drones, position, etc.) and motion (movement in the camera's field of view), because neither on its own was capable of achieving sufficiently reliable detection. He therefore proposed a machine-learning technique that operates on spatio-temporal cubes of image intensities where individual patches are aligned using a regression-based motion stabilization algorithm.

Real-time performance

But the recognition algorithm on its own is not enough. To train a detector to recognize all types of drones in all kinds of positions, it has to have observed and logged as many as possible. Rozantsev found that the existing database of drone images is limited. So he filled in the gaps by generating realistic synthetic images.

The generated images, which are based only on a small set of real examples and a coarse 3D model of the object, are used together with the real examples to train the detector. A key ingredient to this method is that the generated images are as close as possible to the real ones – not in terms of image quality, but according to the key features used by the machine-learning algorithm.

Consequently the EPFL researchers have developed a reliable algorithm capable of detecting a drone using a lightweight camera similar to those found in smartphones. The aim of the project, now financed by the CTI, is to train a detector using an even larger data set to improve its real-time performance and accuracy. EPFL's CVLAB researchers are working on this in collaboration with FLARM Technology AG, a developer of affordable collision avoidance technology for civil aviation. The first commercial models are expected to be released sometime in 2018.

Artificial eyes let drones see in the dark

Researchers at the University of Zurich, Switzerland, have taught drones how to fly using an eye-inspired camera, opening the door to them performing fast, agile maneuvers and flying in low-light environments. Possible applications could include supporting rescue teams with search missions at dusk or dawn.

To fly safely, drones need to know their precise position and orientation in space at all times. While commercial drones solve this problem using GPS, this only works outdoors, and is not very reliable, especially in urban environments. Furthermore, the conventional cameras mounted on drones work only when there is sufficient light, and the drone's speed has to be limited otherwise the resulting image is motion-blurred and cannot be used by computer vision algorithms. To solve this problem, professional drones use sensors that are elaborate, expensive, and bulky, such as laser scanners.

A group of researchers from the University of Zurich and the Swiss research consortium NCCR Robotics has developed an innovative alternative approach, enabling drones to fly in a wide range of conditions using an eye-inspired camera that can easily cope with high-speed motion. It can even see in the dark much more effectively than the conventional cameras currently used by all commercial drones.

Photo: UZ / NCCR Robotics

University of Zurich and NCCR Robotics have developed a novel vision system enabling drones to fly in challenging conditions.

"This research is the first of its kind in the fields of artificial intelligence and robotics, and will soon enable drones to fly autonomously and faster than ever, including in low-light environments," said Prof. Davide Scaramuzza, Director of the Robotics and Perception Group at UZH. He and his team have already taught drones to use their onboard cameras to infer their position and orientation in space.

Event cameras, which were invented at UZH together with ETH Zurich, do not need to capture full light on the entire bio-inspired retina in order to have a clear picture. Unlike their conventional counterparts, they only report changes in brightness for each pixel, ensuring perfectly sharp vision even during fast motion or in low-light environments. The UZH researchers have also designed new software able to efficiently process the output from such cameras, harnessing this to enable autonomous flight at higher speeds and in lower light than currently possible with commercial drones.

"There is still a lot of work to be done before these drones can be deployed in the real world since the event camera used for our research is an early prototype. We have yet to prove that our software also works reliably outdoors," says PhD Student Henri Rebecq. And Professor Scaramuzza adds: "We think this is achievable, however, and our recent work has already demonstrated that combining a standard camera with an event-based camera improves the accuracy and reliability of the system."

www.ifi.uzh.ch/en.html

Face ID: a killer app for VCSEL mappers?

At $999, the launch price of the much-anticipated iPhone 'X' is eye-wateringly high – even for an Apple device.

It seems reasonable to think that part of the reason for the high cost relates to the new 'Face ID' owner recognition system, which will map the face of the phone's owner to unlock the device and allow them to use banking, shopping, and other applications requiring secure access.

The Face ID functionality doesn't work in the way that most people would expect – it isn't just about recognizing facial features in the traditional sense of machine vision. Thanks to an array of tiny infrared-emitting lasers, the user's face is contour-mapped. What Apple refers to as the "TrueDepth" camera is in fact more like a surface profiling instrument than a camera.

So how exactly does that Face ID system work? As ever with Apple, not a huge amount of detail is available. What we do know is that it is based around a two-dimensional array of lasers, optics to project the array pattern of some 30,000 invisible dots, sensors to collect both the reflected pattern and an infrared image, and an on-chip neural engine to compare mapped faces to the stored model of the phone's user.

Apple claims that it will provide a 20-fold improvement in security compared with fingerprint identification. "The probability that a random person in the population could look at your iPhone X and unlock it using Face ID is approximately 1 in 1,000,000, versus 1 in 50,000 for Touch ID," it announced – notwithstanding users who have twin siblings, or are below the age of 13.

Photo: Apple.

One of the major innovations in the iPhone X is Apple's new "Face ID" security feature. It uses the combination of an infrared image and a 30,000-dot laser-projected array to create a 3D contour map of a user's face. The company says that there is only a one in a million chance of security being breached.

The lasers in those sensor arrays are crucial to the system's functionality. And they aren't just any old lasers - they're vertical-cavity surface-emitting lasers (VCSELs). While they have been widely used in consumer electronics applications before, including optical mice and Blackberry (remember them?) navigation sensors, VCSELs are manufactured by a relatively select band of photonics companies, only some of which have the kind of volume production capacity, expertise and reliability demanded for iPhone deployment. Despite its ultra-premium price, one analyst has suggested that pre-order demand for the iPhone X could top 50 million units.

At the moment, it looks like the key Apple supplier is Lumentum (the photonics hardware half of the company previously known as JDS Uniphase). According to AppleInsider, some industry analysts have pencilled in a $200 million pay-day for Lumentum as a direct result of iPhone X requirements.

But it's been far from plain sailing with Face ID. Following a rare and embarrassing tech-failure during the iPhone X launch event, it has since been reported that there is a shortage of key components. The Wall Street Journal reported late September that Apple has code-named the key elements of the TrueDepth hardware "Romeo" and "Juliet", and that Romeo is proving more time-consuming to assemble than Juliet.

It may or may not be connected, but Finisar, one of the few major existing VCSEL producers, had been expecting to ramp its production for the 3D sensor application by now. However, its long-time CEO Jerry Rawls, due to retire next year, recently told investors that there had been a delay in the production ramp because an unexpected change to its VCSEL production process was required. It is not certain whether Finisar is supplying Apple, but such a request is always a danger when dealing with a customer as fickle as the Cupertino tech behemoth.

Meanwhile, more VCSEL makers are joining the fray, notably US-based II-VI and Austria-headquartered ams. Both have embarked on construction projects to scale up production to the kind of levels demanded by either Apple or the other smartphone OEMs who will no doubt look to provide their own versions of Face ID.

Also in the supply mix now is Philips Photonics, the VCSEL-producing subsidiary of the Dutch conglomerate based in Ulm, Germany. Now able to produce the devices in a largely automated process and on a 4-inch gallium arsenide wafer platform – perhaps larger in the future – it is set to ramp production in early 2018.

Mike Hatcher, Editor, optics.org

Jabil developing in-car optical sensors to warn sleepy drivers

Combination of Jabil's optics and algorithmic awareness software from partner eyeSight will reduce accidents, claims US firm.

US-based contract manufacturer Jabil is joining forces with Israeli machine vision company eyeSight Technologies to develop in-car sensors designed to monitor drivers for signs of awareness and distraction.

Said to combine Jabil's "automotive-grade" optics capabilities with eyeSight's computer vision and deep learning software, the partnership is ultimately intended to reduce the number of car accidents caused by human error.

Image: Business Wire.

Based on a combination of time-of-flight and infrared sensors, the technology developed by eyeSight and Jabil will be able to monitor drivers for signs of fatigue, such as blinking rate, head position, and eyelid droop.

Using a combination of infrared and time-of-flight sensors, the envisaged system will be able to identify drivers by facial recognition, gender, and age, while monitoring attentiveness to the road by assessing their head pose, posture, and mood, as well as tracking eyelid movements associated with falling asleep at the wheel.

Sleep-related road deaths

According to the UK's Department for Transport, around one in every five accidents on major roads are sleep-related, and are more likely to result in death or serious injury than other causes.

The UK's Royal Society for the Prevention of Accidents adds: "These types of crashes are about 50 per cent more likely to result in death or serious injury as they tend to be high-speed impacts, because a driver who has fallen asleep cannot brake or swerve to avoid or reduce the impact."

Lisa Bahash, a senior VP within Jabil's automotive group, said: "Jabil's partnership with eyeSight Technologies supports automakers working to reduce accidents involving driver distraction. The accuracy, intelligence and efficiency of the system we're developing will enable automakers to implement in-car sensing systems across all vehicle types."

eyesight, which sells embedded machine vision technology across a variety of markets including virtual and augmented reality and consumer electronics, has developed ways to assess different aspects of a driver's behavior, including their gaze and gestures.

That includes tracking the movement of eyelids, irises, and head position – where a tilt is likely to indicate fatigue.

Innoviz lidar connection

eyeSight and Jabil say that the combined hardware and software system under development will offer "sub-pixel" accuracy, enabling higher-resolution driver monitoring than has been possible thus far. "The accuracy of the camera modules, together with intelligent software, allows the system to be smaller, resulting in reduced weight and footprint," they add.

The system is also intended to support gesture control of electronic in-car systems.

Jabil is also working closely with Innoviz Technologies, another Israeli startup targeting the automotive industry, this time with lidar technology for autonomous vehicles that promise to do away with human error entirely, by letting robots do the driving.

Innoviz raised $9 million in series A venture funding almost exactly a year ago, and earlier this year it entered into a manufacturing agreement with Jabil to produce solid-state lidar modules intended for research and testing activity in the autonomous driving space.

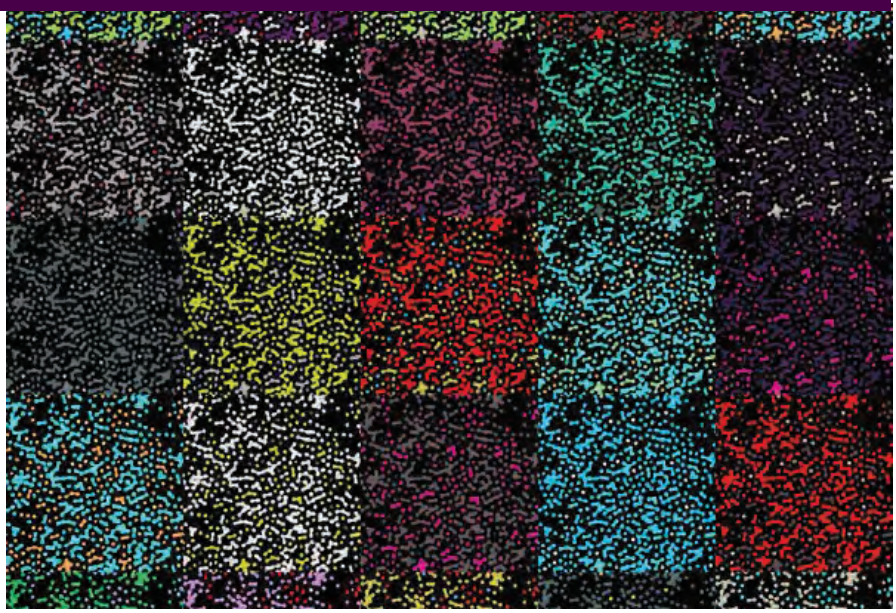
Mass production of initial devices is expected in early 2018, followed by sampling of a high-definition version a year later.

Mike Hatcher, Editor, optics.org

http://optics.org/news/8/8/30

University of Bonn probes human retina behavior

Adaptive optics helps reveal how color signals are conveyed on a cellular level.



Credit: William S. Tuten/Wolf M. Harmening

Researchers at the University of Bonn and the University of California analyzed the sensitivity of receptor cells in the human retina.

The workings of the human retina and the manner in which it responds to incoming illumination are understood in broad principle, but several aspects of the detailed processes underway remain to be fully investigated.

A project from the University Eye Hospital Bonn, University of California, Berkeley, and University of Alabama at Birmingham has now completed a study of how the topography of individual wavelength-sensitive cells shapes perceptual sensitivity, a step towards understanding how color signals are conveyed at the cellular level. The work is published in the Journal of Neuroscience.

The project employed adaptive optics scanning laser ophthalmology (AOSLO), a technique in which a laser is scanned in horizontal and vertical directions across an area of the retina while adaptive optics remove aberrations from the optical pathways caused by astigmatism, movement, or other origins.

Using the ophthalmoscope to both examine and stimulate individual photoreceptor cells in living subjects, the project investigated how human color vision emerges from the three independent receptor types known to operate within the retina.

Adaptive optics

"We demonstrate how the precise topography of the long (L), middle (M), and short (S) wavelength-sensitive cones in the parafovea region of the retina shapes perceptual sensitivity," said the team in its published paper. "We used adaptive optics microstimulation to measure psychophysical detection thresholds from individual cones whose spectral types had been classified independently by absorptance imaging."

The AOSLO platform allowed the generation of three independent narrow-band input channels for illuminating the retina: one in the infrared at 842 nanometers for retinal imaging and wavefront sensing, and two stimulation channels in the green and red visible spectrum, at 543 and 710 nanometers respectively.

Cell by cell analysis

Having initially mapped the pattern of L, M and S cones in the retina by measuring each cell's absorption of different wavelengths, the project was then able to determine the detection threshold for each cone, by steadily lowering the intensity of the stimulation light.

"This is important because we could use the sensitivity of each cell to determine how overall perception is governed by the contribution of individual cones," commented Wolf Harmening of University Eye Hospital Bonn.

This led to a potentially significant finding about the way in which an individual cell's sensitivity depended on the immediate neighboring cells. It seems that the brain does not receive raw data from individual photoreceptors, but rather a retinal signal already subject to a degree of pre-processing depending on the environment of the receptor.

"If a cone sensitive to red light is surrounded by cells that are more sensitive to green, this cone is more likely to behave like a green cone," explained Harmening. "Spatial and color information of individual cones is modulated in the complex network of the retina, with lateral information spreading between receptors through what are known as horizontal cells."

While the full implications of this discovery remain to be investigated, the project has already proven the benefit of cellular-level investigations such as the one facilitated by AOSLO. Conventional tests of vision use stimuli that necessarily activate hundreds to thousands of photoreceptor cells at the same time, but cellular-scale retinal computation has important implications for basic and clinical research.

"What's new is that we can now study vision on the most elementary level, cell-by-cell," said Harmening. "When the basis of vision is understood better, we open avenues for new diagnoses and treatments in case of retinal disease. The novel single-cell approach offers access to new findings in ophthalmology."

Tim Hayes, Contributing Editor, optics.org

http://optics.org/news/8/9/13

Radiant Vision Systems

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New JAI 2.35 megapixel GO camera with USB3 Vision interface

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https://navitar.com/products/imaging-optics/resolv4k-zoom-system/

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Photo Credit: (NASA/Carla Thomas)

The solar corona, only visible during a total eclipse, is seen here as a 'crown' of white flares emerging from the sun's surface on Monday, August 21, 2017. This image was captured aboard a NASA Gulfstream III aircraft flying 25,000 feet above the Oregon coast. Aboard a different Gulfstream jet, flying 50,000 feet above Kentucky, was the NSF-funded team attempting to capture the corona's infrared emissions for the first time. The appearance of red spots, called Bailey's beads, in this photo occurs when sunlight shines through the craters and valleys of the lunar surface.

Infrared camera captures new view of solar corona

Flight of 'AIR-Spec' imager on adapted Gulfstream jet during eclipse totality expected to improve understanding of solar wind phenomena.

An infrared camera designed specifically for viewing the sun's corona was able to capture data on board a Gulfstream jet during yesterday's solar eclipse.

The camera, based around an indium antimonide (InSb) focal plane to access coronal emission lines in the mid-infrared spectral region, was designed by the Santa Barbara-based Heico subsidiary IRCameras.

It formed a critical part of the Airborne Infrared Spectrometer (AIR-Spec), built by a collaboration involving scientists and engineers from the Smithsonian Astrophysical Observatory (SAO) and the US National Center for Atmospheric Research (NCAR) High-Altitude Observatory (HAO).

Above the water vapor

Flying over Kentucky at close to 50,000 feet to avoid most of the absorbing interference caused by atmospheric water vapor, AIR-Spec also featured an elaborate image stabilization system to counteract the effect of flying at 450 knots. The adapted jet "chased" the eclipse, extending the period of totality experienced on board to four minutes and providing more time to capture data.

"For the first time, AIR-Spec allowed measurements of the solar corona in the infrared spectrum, thereby increasing our understanding of various phenomena including solar wind and plasma heating and acceleration," reported IRCameras.

It is hoped that the images and data captured by the AIR-Spec instrument will shed some light on many of the mysteries of the solar corona – like why it seems to be hotter than the sun itself, the nature of giant plasma eruptions, and the connection with magnetic effects.

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Infrared camera captures new view of solar corona

The InSb sensor that forms the focal plane array is able to detect photons in the 1-5.3 µm wavelength range, covering coronal emission lines that should yield a better insight into the workings of the sun.

"Although high-resolution, high-sensitivity coronal imaging spectroscopy has never been performed between 1.4 and 4 µm, this spectral region has great potential for coronal plasma diagnostics, for coronal hole spectroscopy, and as a path finder for observations of coronal magnetic fields," explained the team in an abstract describing the project posted on the National Science Foundation (NSF) web site.

"The 2017 eclipse provides a unique opportunity to survey these lines, and AIR-Spec observations can help provide guidance for future ground-based infrared observations."

Photo: Heico/Businesswire.

Built to order by Heico subsidiary IRCameras, this is the infrared camera used to observe the August 21 eclipse corona on board the airborne High Altitude Observatory.

Gyroscope stabilization

Reporting their progress during last year's SPIE Astronomical Telescopes and Instrumentation conference held in Edinburgh, UK, the team said that AIR-Spec was groundbreaking in two respects: "it will image infrared coronal emission lines that have never been measured, and it will bring high-resolution imaging to GV HIAPER (NCAR's Gulfstream airplane that has been adapted for environmental research)."

As well as the image stabilization system, the AIR-Spec design takes advantage of a sapphire window in the jet, and uses a Cassegrain telescope in combination with a camera fold mirror, bandpass filters and a grating that directs the infrared light onto the 1280 x 1024 pixel InSb sensor.

The image stabilization system is based around a fast-steering mirror, which switches position according to the feedback received from a 3-axis fiber-optic gyroscope, directing the coronal light onto the telescope and into a slit-jaw camera.

Just how successful yesterday's mission was remains to be seen, but completion of the development program means that NCAR now has a stable instrument that is certified and available for other teams to fly on the Gulfstream for future research missions – for example the 2019 total solar eclipse that will traverse the southern Pacific.

The initial response seems to be positive, with Heico's CEO Laurans Mendelson and the company's "co-president" Victor Mendelson, jointly stating: "Heico congratulates the entire AIR-Spec team on the mission's success and their leading-edge research. We also congratulate the entire IRCameras team for their role in the mission."

Mike Hatcher, Editor, optics.org

http://optics.org/news/8/8/36

Hyperspectral imaging firm SPECIM wins €3.5M funding

Investment by Bocap intended to double Finnish firm's sales to €20 million.

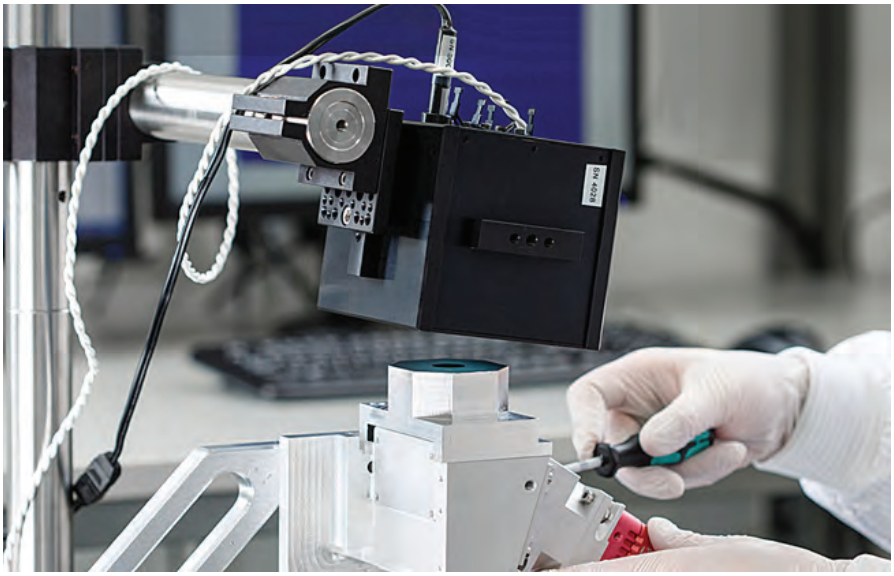
Specim – Spectral Imaging Ltd. – has secured new investment of €3.5 million from Bocap SME Achievers Fund II Ky, with the aim of doubling its current €10 million revenue by 2020.

Specim is a pioneer in hyperspectral imaging technology and developing related products. Its cameras are widely used in industrial, environmental and security applications, such as in drill core scanning and for producing mineral maps, in agriculture to screen the crops for disease, and they are key components in the latest waste-sorting robotics. Specim's products also help to authenticate artworks, detect explosives, and in forensic investigation.

Since 2015, Specim has invested about €6M in developing a new generation of cameras and it will complete the rollout of a new product family by the end of 2017. The cameras are said to offer hyperspectral imaging technology for industrial OEM-clients. Specim plans to invest the latest funding in further strengthening its position in the global markets.

"I am proud to say that Specim will be investing nearly as much in sales and marketing as in R&D. With this latest move we will take full commercial advantage of our superior knowledge, the entire R&D investment, and the new camera family," said Specim's Chairman Risto Kalske, who has already brought several high-tech companies into rapid growth.

During Specim's 22 years of existence, its clientele and customer solutions have all seen significant change besides the rapid development of the technology. The originally large items of research equipment, typically weighing tens of kilos and offering challenging usability, have been transformed into more compact, portable instruments now weighing less than one kilo and with high-specifcation data-processing capabilities.



New investment of €3.5 million from Finnish investor Bocap.

Transformation of hyperspectral

Timo Hyvärinen, one of the founders, commented, "I have every reason to believe that with miniaturization, hyperspectral imaging will become a part of people's everyday lives. Usability will undergo a revolution, and soon mobile equipment can easily be brought to the measurement sites for real-time use. Collecting samples, transporting them to the lab for analysis, and experiencing delays in getting the results will become history."

Bocap's partner, Vilma Torstila,commented that she is very excited about this opportunity. "Specim combines superior technological knowledge with the ability to commercialize it to meet sophisticated and ever-demanding customer needs. We are happy to enhance Specim's commercial success, and accelerate future growth via this investment."

SPECIM has so far delivered more than 5,000 HS systems worldwide and the company claims that its core technology team "has the world's longest continuous track record in hyperspectral imaging". The company is headquartered in Oulu, Finland and currently employs 60 professionals.

Bocap is an independent private equity company founded in 2012 and dedicated to established, entrepreneur-led, high growth SMEs. It is a forerunner in Finland for its concept and role as an active minority investor, by which Bocap champions its portfolio companies into successful growth. Bocap is funded by mainly Nordic institutional investors such as life and pension insurance companies, foundations, pension funds and selected private investors.

Matthew Peach, Contributing Editor, optics.org

http://optics.org/news/8/8/40

Image: SpecIm.

SPECIM has so far delivered more than 5,000 HS systems worldwide.

Hyperspectral imaging could boost IVF success

Australian study on cow embryos suggests that the photonics technology could improve in vitro fertilization (IVF) outcomes in both animals and humans.

Researchers at Australia's Centre of Excellence for Nanoscale BioPhotonics (CNBP) say that hyperspectral imaging could improve in vitro fertilization (IVF) success rates, by providing a more objective assessment of the health of early-stage embryos.

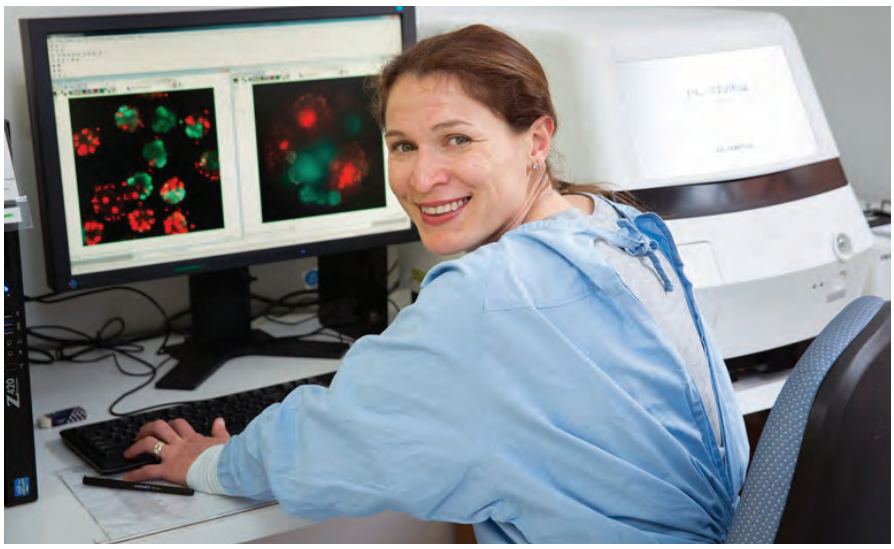


Photo: CNBP.

CNBP's Mel Sutton-MacDowall and colleagues believe that hyperspectral imaging for embryo selection could improve IVF outcomes for both human and livestock applications.

Members of the team from the University of Adelaide and Macquarie University have tested the application on cattle embryos, working alongside Sydney biophotonics and informatics company Quantitative, whose engineers have developed a hyperspectral system.

Reporting their findings in the journal Human Reproduction, lead author Mel Sutton-McDowall and colleagues said that the approach had the potential to significantly benefit the IVF industry of the future, improving assisted reproduction outcomes for women.

Sutton-McDowall explains that the hyperspectral approach shows up differences in the metabolism and chemical make-up of embryos before they've been implanted, potentially giving clinicians an objective indication of which embryos it would be best to select for the IVF process.

"Pre-implantation screening of embryos generally takes place under a normal optical microscope," says the University of Adelaide researcher. "Although it's quite easy to discern poor embryos (due to differences in uniformity), it is far harder for the clinician to determine objectively, the viability of the other embryos."

Measuring metabolism

Being able to measure embryo metabolism is viewed by many researchers as one of the most important factors determining whether a particular IVF program will be successful. However, Sutton-McDowall says that, at the moment, fertility specialists take a largely subjective approach in deciding which embryos should be used.

"The challenge is how to choose the single healthiest embryo out of this group to maximize the chances of pregnancy," she said.

In the latest work, differences in metabolic characteristics between embryos exposed to two different oxygen concentrations (20% and 7%) could not be detected with traditional fluorophore and two-channel autofluorescence imaging, whereas the hyperspectral technique was able to spot the difference.

"The benefit of hyperspectral imaging is that it can capture information-rich content of inspected objects. It analyzes every pixel in an image for its light intensity at differing wavelengths," said Sutton-McDowall.

"This lets us drill down and analyze the hyperspectral signature of each individual embryo, looking for known or anomalous characteristics. It lets us discriminate between embryos, but also measure metabolic differences within individual embryos. We predict that embryos that have cells with homogeneous (uniform) metabolic profiles are the healthier ones."

Livestock applications

Although the approach has only been used on cattle so far, Sutton-McDowall believes there is a great deal of promise for human applications.

"It offers benefits of being a non-invasive imaging approach that provides real-time information to the clinician," she said.

And while the development of specialized hyperspectral imaging equipment for use in IVF clinics remains several years off, Sutton-McDowall expects to see a surge of interest from those clinics in technologies that are better able to predict embryo development outcomes.

"I think we'll see this innovative approach commercialized fairly quickly," she predicted. "IVF is a costly and complex treatment. Any new method that can help improve the odds of women successfully having babies is of benefit to both clinicians and their patients."

The potential for animal applications should not be underestimated either, with Sutton-McDowall anticipating future commercial opportunities in the livestock and farming sectors.

"Many beef and dairy producers include advanced reproductive technology programs as a regular part of their farming practice," she said. "Identifying and breeding from elite animals improves herd quality and maximizes productivity.

"If we can enhance the IVF process and improve pregnancy outcomes, farmers will see better animals with healthier genetics and more desirable traits. I see a lot of potential for our imaging technology in this economically important area too."

Mike Hatcher, Editor, optics.org

http://optics.org/news/8/8/43

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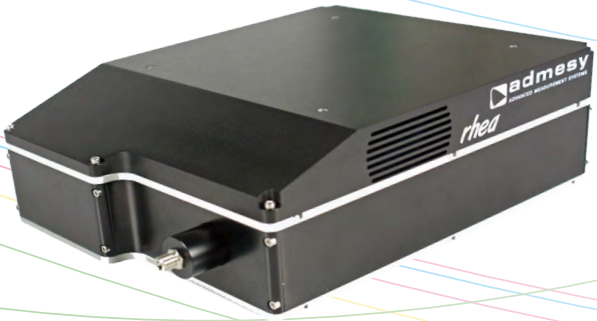

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