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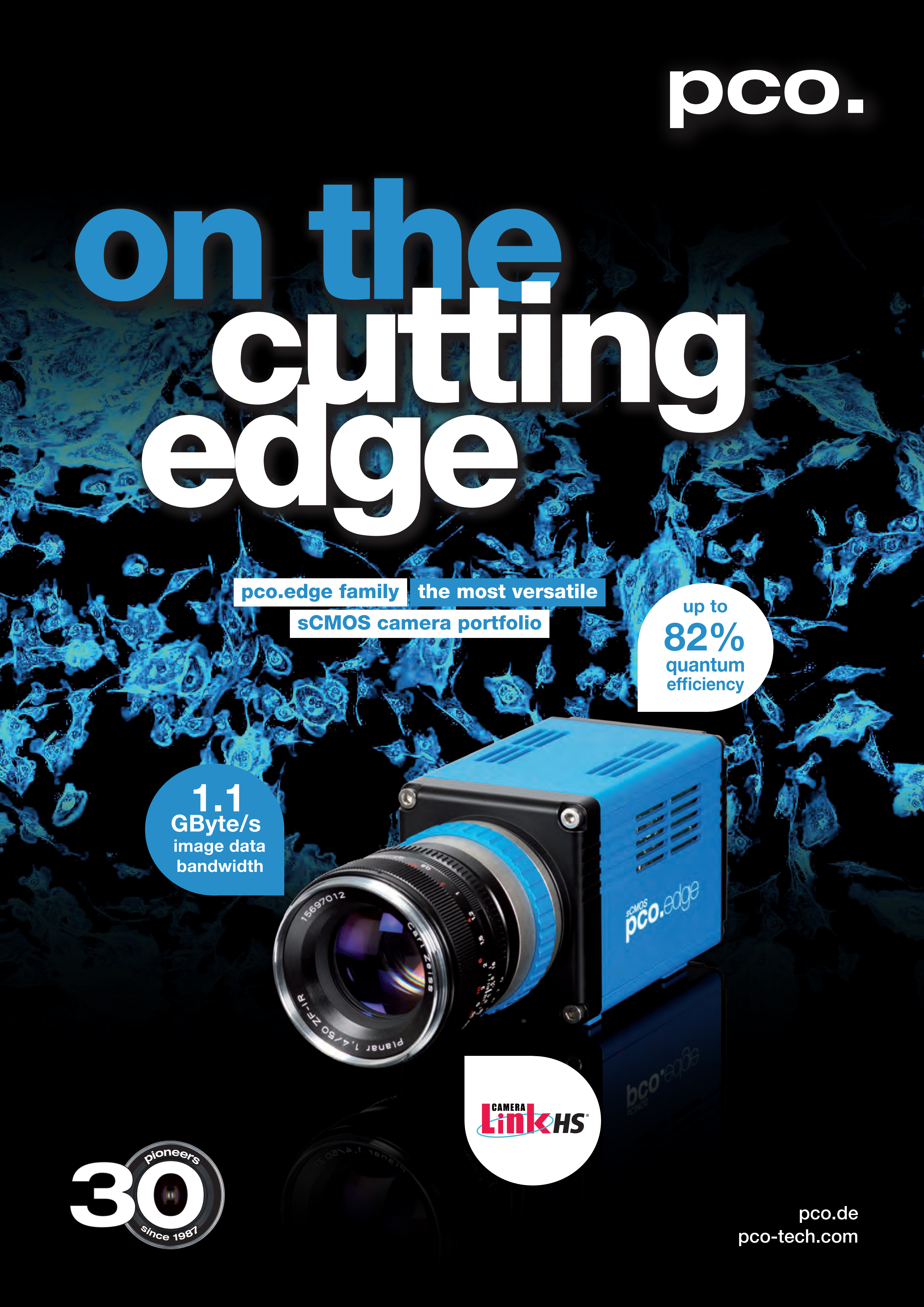
VISION focus

Delivering the latest news from the Imaging and Machine Vision markets

JunoCam images delight and amaze astronomers

Image: NASA/JPL-Caltech/SwRI/MSSS/Betsy Asher Hall/Gervasio Robles.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Glad to be back in München!

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 centered on the LASER World of Photonics 2017 expo, the international trade fair for lasers, photonics components, systems and applications. The expo is open June 26th through 29th.

LASER returns to Munich after two years, during which time both the laser development and photonics-dependent industries have progressed substantially. In a recent survey of German laser industry, show host Messe München recognized the importance of the industry with a survey of players large and small.

"An outstanding scientific infrastructure has come into being in Europe and especially in Germany," commented Prof. Peter Loosen of the Fraunhofer Institute for Laser Technology, involved in the survey. "Science is providing manufacturing industry with effective and focused, application-oriented support with the introduction of photonics technologies."

Dr. Reinhard Pfeiffer, Deputy CEO, Messe München, added, "This year, we are expecting around 1300 exhibitors and more than 30,000 trade visitors from more than 70 countries. There will also be a packed conference program at various locations around the halls."

So this special issue of VISION Focus is dedicated to the LASER show and following is a taste of machine vision-related features that exemplify how vision and photonics systems are proving to be invaluable to research and manufacturing.

Materials researchers are using laser scanning confocal microscope to boost performance *(page 6)*. The Palo Alto-based Electric Power Research Institute improves throughput and accuracy of metallurgical studies with 3D Laser Scanning scope from Keyence.

Researchers in Finland, Germany and Israel help 'democratize' the broadband sensor technology *(page 12)*. In recent months, several organizations worldwide have made great progress in the development and application of miniaturized hyperspectral imaging and sensing hardware.

A new optical chip developed by Bielefeld University and the University of Tromsø , Norway, *(page 15)* could help platforms based around conventional microscopy achieve performance levels approaching those of super-resolution systems.

Finally, G2 Technologies, a test and measurement company, has developed a customizable, automated 3D inspection system *(page 18)*, which it says "can catch flaws that previous inspection systems would miss".

If you will be attending LASER please come and meet the optics.org team on Booth B2 142.

Matthew Peach, Contributing Editor
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This Issue

Publication and Editorial Schedule 2017/18

September/October Issue 2017

- **Editorial Focus:** opto-electronic systems, applications in sensing and manufacturing.

January/February Issue 2018

- Bonus Distribution **SPIE BiOS + Photonics West**
- **Editorial Focus:** industrial applications, sensing, biomedical analysis and treatments.
- Published in advance of BiOS, 29th Jan – 1st Feb 2018 and Photonics West, 30th Jan – 1st Feb 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

JunoCam images delight and amaze astronomers

Extraordinary new views of Jupiter's poles provided by sensors on board NASA craft.

NASA's Juno mission to Jupiter has returned a set of extraordinary images that shed new light on the giant gas planet – thanks in part to the optical, ultraviolet and infrared sensors on board the spacecraft.

Launched in August 2011, Juno arrived in the Jovian orbit almost exactly five years later, and has since flown to within 4200 km of the planet's vast, swirling, atmosphere.

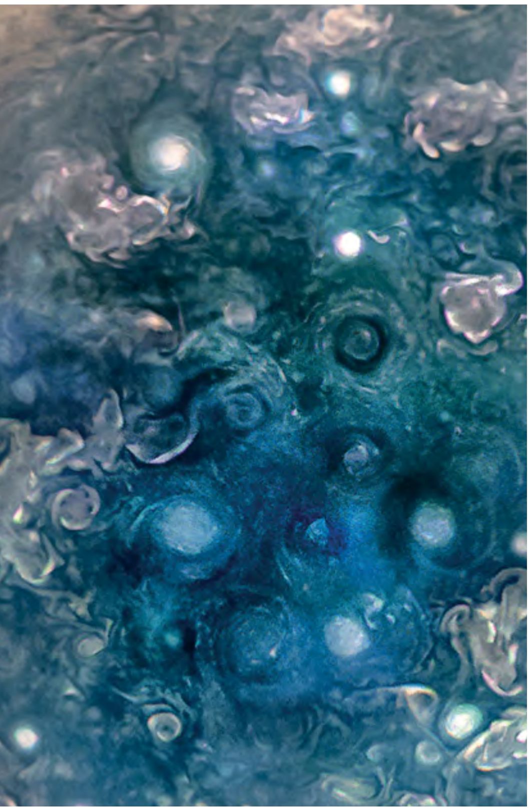


Image: NASA/JPL-Caltech/SwRI/MSSS/Betsy Asher Hall/Gervasio Robles.

Juno's red-green-blue-methane (890nm) filtered 'JunoCam' instrument captured this remarkable view of Jupiter's south pole. Taken from an altitude of 52,000 km, it shows giant cyclones measuring up to 1000 km in diameter. Multiple images taken with the JunoCam instrument on three separate orbits were combined to show all areas in daylight, enhanced color, and stereographic projection.

Data collected by JunoCam and other instruments, and now published in more than 40 different journal papers, was said to have thrown scientists – in baseball parlance – not just a "curveball", but "knuckleballs and sliders".

Rethinking Jupiter

"We knew, going in, that Jupiter would throw us some curves," said Scott Bolton, Juno principal investigator from the Southwest Research Institute (SwRI) in San Antonio, in a NASA release. "There is so much going on here that we didn't expect that we have had to take a step back and begin to rethink of this as a whole new Jupiter."

The space agency says that the assumption-challenging findings are largely provided by the JunoCam imagery, which have provided close-up views of Jupiter's poles for the very first time.

They show several enormous, swirling, storms – each larger than Earth – clustered together closely. "We're puzzled as to how they could be formed, how stable the configuration is, and why Jupiter's north pole doesn't look like the south pole," Bolton added.

Aside from JunoCam, the probe's payload of instruments includes ultraviolet and infrared imagers and spectrometers, as well as a six-wavelength microwave radiometer for atmospheric sounding. Several non-optical pieces of equipment are able to monitor charged particles, gravity, and Jupiter's huge magnetic field.

Based around CCD sensors provided by the US-headquartered company TrueSense Imaging (now ON Semiconductor), JunoCam is a visible-range camera with red, green and blue filters, plus a methane filter centered at 890 nm.

In an open-access overview paper published in the journal Science, the NASA science team and colleagues wrote: "The wealth of detail in these [JunoCam] images surpasses that of previous spacecraft because their trajectories were close to Jupiter's equatorial plane, whereas Juno's orbits were closer to the planet and oriented over the poles. Only Pioneer 11 had acquired non-oblique images over Jupiter's north pole, but at ten times the distance of Juno."

UV and IR spectrometers

While JunoCam has provided the most striking imagery, Juno's UV and IR imaging tools have also captured brand new, high-resolution views and spectra of the planet's northern and southern aurora, from directly above the respective poles.

"The IR aurora is thicker on the dusk side of the planet and thinner on the dawn side, as in UV," reports the NASA science team, adding that it was possible to discern effects related to Galileian moons Ganymede and Io.

"Although many of the observations have terrestrial analogs, it appears that different processes are at work in exciting the aurora and in communicating the ionosphere-magnetosphere interaction," they added.

Developed by the Italian National Institute for Astrophysics and funded by the Italian Space Agency, the Jovian Infrared Auroral Mapper (JIRAM) instrument captures aurora imagery at a wavelength of 3.4 µm – matching that of light emitted by excited hydrogen ions in the polar regions.

Methane in the atmosphere absorbs light at the same wavelength, darkening the atmosphere behind the auroras, NASA explains. In front of a darkened background, the auroras stand out even more brightly.

JIRAM is able to determine how water-containing clouds circulate below Jupiter's surface, revealing the amount of water in the clouds. Spectra measuring methane, water, ammonia and phosphine absorptions indicate the chemical make-up of the atmosphere.

Juno's Ultraviolet Imaging Spectrograph (UVS) is sensitive to both extreme and far-ultraviolet light, operating across a wavelength range of 68-210 nm. SwRI provided the instrument, with CSL/BELSPO in Belgium responsible for the scan mirror.

The good news for scientists is that they won't have to wait long before the next set of intriguing results are collected: Juno's orbit is scheduled to swing the craft close to Jupiter's atmosphere every 53 days, and the next pass will see its instruments pointed at the famed "red spot", on July 11.

Mike Hatcher, Contributing Editor

http://optics.org/news/8/5/51

Materials researchers use laser scanning confocal microscope to boost performance

Palo Alto-based Electric Power Research Institute improves throughput and accuracy of metallurgical studies with 3D Laser Scanning scope from Keyence.

Consumers and businesses in industrialized nations have come to expect low-cost, clean, and reliable electric power "24-7". Delivery of that power is often easier said than done, however.

The world's electrical grid is provided by a diverse array of technologies, from nuclear to carbon-based plants, hydroelectric dams, wind farms, geothermal sources, and increasingly solar cells placed on residential and business rooftops. Connecting these disparate sources is a challenging task, besides managing their outputs and safety issues while doing so.

Dr. John Shingledecker and colleagues at the Electric Power Research Institute (EPRI), a non-profit organization based in Palo Alto, CA with offshoots in Knoxville, TN and Charlotte, NC, EPRI. This member-funded organization, established in 1972, involves more than 1,000 electric utilities, government agencies, public and private firms, which contribute financial support, while representing approximately 90 percent of the electricity generated in the United States as well as 30 countries internationally.

"EPRI is an independent and collaborative R&D company, one that shares its findings with the public, the electric supply chain, and our international participants," commented Shingledecker in a recent interview with AIA – the world's largest machine vision association (formerly known as the Automated Imaging Association).

"Because of this, we are an important source of information for everyone in the industry, and help promote efficient and safe generation of electricity from fossil fuels, renewables, and nuclear power sources as well as its transmission and distribution, with a focus on end-use efficiency and overall effect on the environment."

Vision requirements

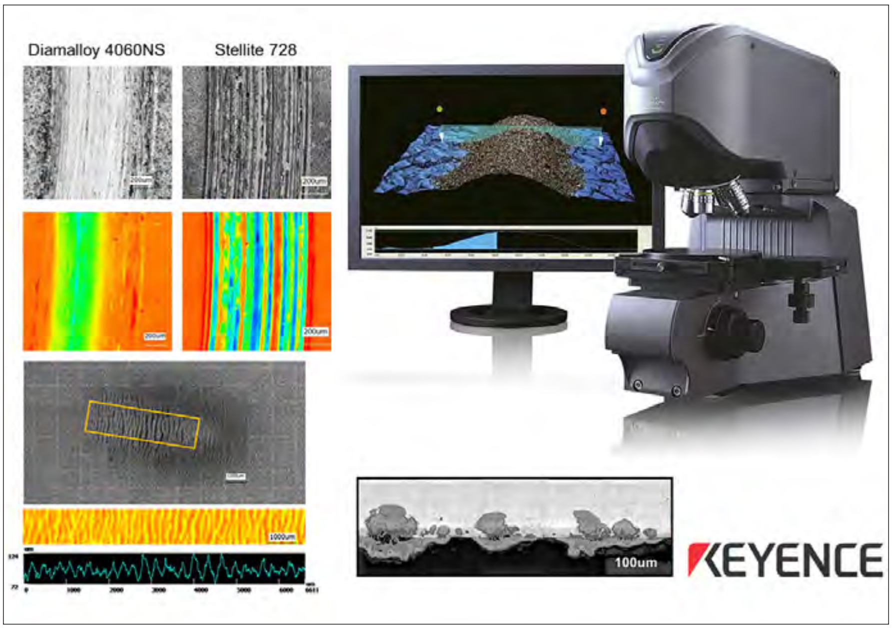
Electrical power sources require a variety of precision metal components, machinery and management systems to operate correctly and safely. However the metal parts become fatigued over time after repeated stress from the extreme pressures and temperatures of these power systems. So EPRI works to manage and help prevent fatigue in such systems.

The organization's material laboratory in Charlotte, NC, studies novel metallic alloys and other materials for emerging power applications. Legacy systems are also monitored; samples of metal tubing from utility boilers, for example, or the coatings of valve stems used in steam turbines, are collected and analyzed.

The primary tools used for such work have traditionally been optical microscopy, scanning electron microscopy (SEM), and contact profilometers. Yet despite their long track record, these instruments are often less than ideal.

Contact measuring techniques present the possibility of surface damage, particularly with soft metals or where scaling and oxidation exists, a common occurrence in steam-based power generation. Furthermore, details smaller than the stylus tip are impossible to measure.

Optical microscopes are generally limited to around 0.2 µm feature size and 1500 x magnification, and suffer lighting constraints. This is why SEM is often the tool of choice when very high magnification is needed, but this requires lengthy artifact preparation,



Keyence VK-X160K 3D Laser Scanning Confocal Microscope and examples of high-resolution analyses of various metals and alloys.

Photos: Keyence / EPRI.

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Materials researchers use laser scanning confocal microscope to boost performance

is limited in the amount of 3D depth information offered, and does not easily generate large area images.

To identify the root causes of material failures, or predict those failures years in the future, the team in Charlotte required a better tool. Shingledecker and his team assessed a range of equipment and vendors in the area of microscopy and metrology. After reviewing the available options, they selected a Keyence VK-X160K 3D Laser Scanning Confocal Microscope.

He commented, "Power plants are obviously quite large, and much of our research is done on commensurately large material samples; a welded structure, for example. Producing lots of images with the SEM and piecing them together can be difficult and time-consuming."

The VK-X microscope features a 408 nm wavelength semiconductor laser, motorized stage with 100mm x-y movements, and optics capable of 28,800 x magnification. Furthermore there is no need for specimen preparation before measurement, nor is a vacuum chamber required as with SEM.

The relatively simple operating procedure is to place the sample on the inspection stage and begin the measurements. Z-axis display resolution as high as 0.5 nm is possible, and 130 nm in the x and y axes. Images are displayed via a high-resolution CCD camera, displaying subtle differences in surface relief and large area metallurgical maps.

Some worked examples of this process include 3D analyses of hard-facing alloys used for erosion resistance in high-temperature valves. Laser microscopy of samples exposed to erosion tests in the laboratory and evaluated with the VK-X clearly showed surface perturbations that were indistinguishable using traditional 2D methods, resulting in reliable and quantifiable measurement of material erosion rates.

The VK-X offered similar results during analyses of the 30 µm-thick, nanostructured TiSiCN coating EPRI and a collaborating utility were evaluating in-service on a valve stems, clearly displaying the amount and depth of material loss during service.

As EPRI has discovered, images can be collected without the need for a vacuum. This means that technicians can take more samples, more quickly, boosting overall throughput of the lab. Shingledecker commented, "The end result is that our scientists can spend more time focusing on the results, as opposed to collecting them. That helps us toward our end goals of developing optimal welds and materials that can endure harsher conditions."

More information about EPRI's research can be seen at **www.epri.com.**

Author Matthew Peach is a contributing editor to optics.org

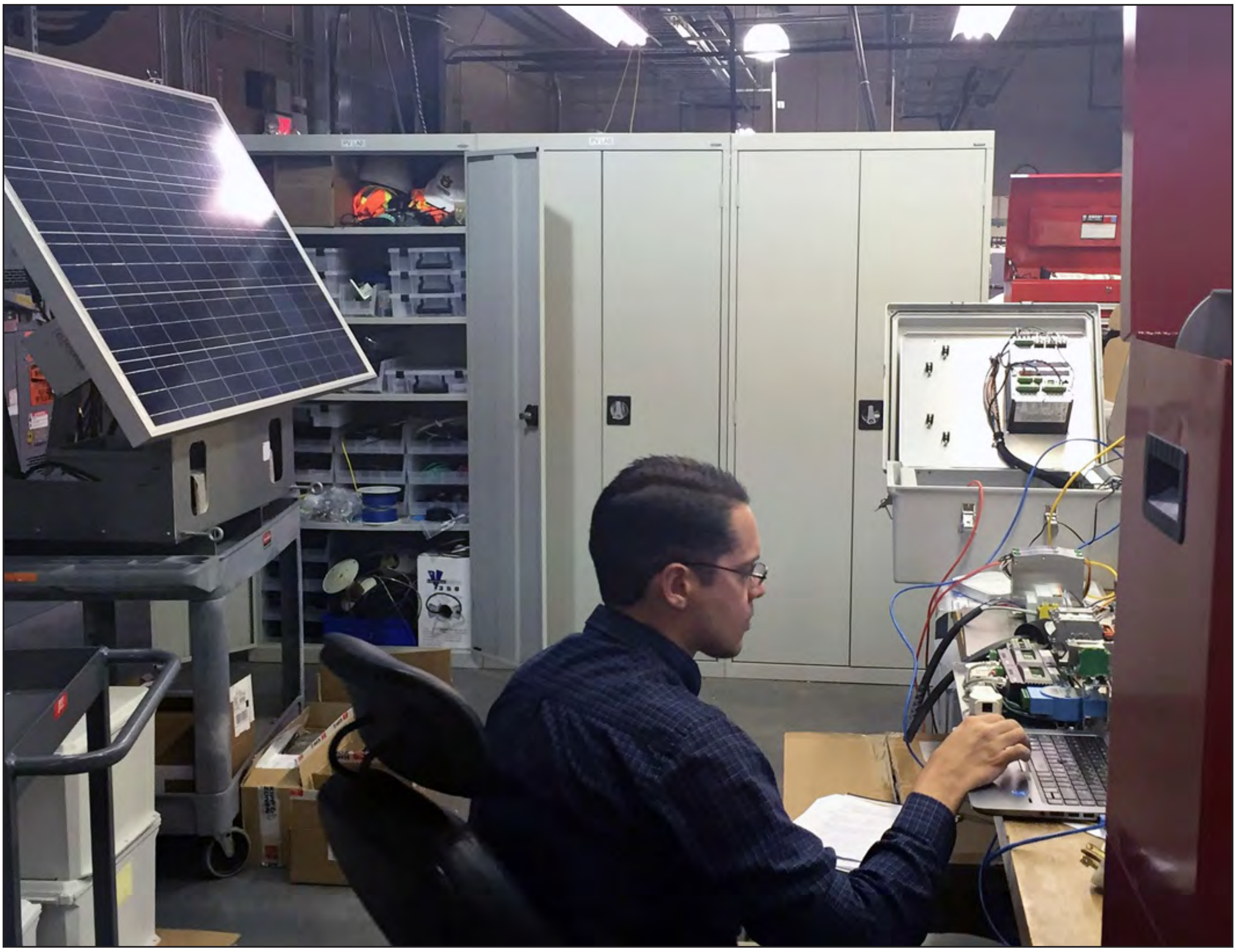


Photo: Ed Marcum / News Sentinel.

Materials research lab managed by the US Electric Power Research Institute (EPRI), in Knoxville, TN.

Photoacoustic imaging shows accurate tumor margins

Using ultraviolet wavelengths reveals cell architecture more rapidly than standard histology.

The importance of complete tumor removal during breast cancer surgery is highlighted by the significant number of patients who need to return for subsequent procedures, to excise parts of the tumor initially left behind.

At present, the gold-standard technique for assessing the cut margins of tissues and determining whether surgeons have removed all of a tumor involves post-operative analysis of the excised lump by microscopic examination and histology, which can take days to be completed.

An alternative histology procedure using frozen tissue samples has been under development as a route to producing results more rapidly, although the freezing procedure is difficult and large samples still take too long to analyze.

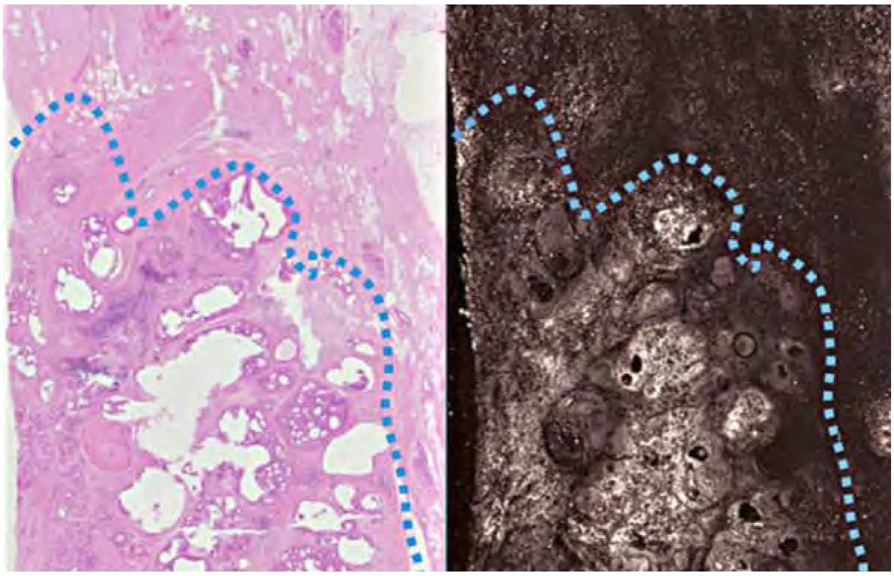
A project at Washington University in St Louis (WUSTL) and Caltech has now shown that a photoacoustic (PA) technique might offer a more rapid alternative. The results were published in Science Advances.

Photoacoustic microscopy using infra-red illumination to image internal organs and clusters of blood vessels is an active area of current research, but the new method employs ultraviolet illumination at 266 nanometers, exploiting the ability of the PA technique to image different targets with appropriate wavelengths.

In its paper, the team notes that the use of UV allows the cell nuclei to be highlighted, since the DNA and RNA in those nuclei absorb the 266 nm wavelength much more strongly than the surrounding biological components. Hence UV photoacoustic microscopy (UV-PAM) can provide the the same contrast as the hematoxylin labeling used in conventional histology, but without the need for labels - and crucially produce results in a shorter time.

Lihong Wang, a pioneer of PA techniques and co-author of the new study, said that using UV illumination to spot the margins of tumors was a further indication of what makes the technology so powerful.

"All molecules absorb light at some wavelength," he said. "Essentially, you can see any molecule, provided you have the ability to produce light of any wavelength. None of the other imaging technologies can do that."



Credit: Terence T.W. Wong.

UV-PAM (right) produces images as detailed and accurate as traditional methods (left), but in far less time.

Towards clinical use

The researchers tested the UV-PAM technique by scanning ex vivo slices of tumors removed from three breast cancer patients, and compared the images it created to conventionally stained specimens. According to the paper, the UV-PAM images matched the stained samples in all key features, revealing the key cell parameters such as growth pattern and size that can be used to differentiate normal tissue from a malignancy.

Although improvements to the scanning time and rate of image throughput will be needed before UV-PAM can realize its likely potential, these proof-of-concept results hold out the promise of using the technique in clinical workflows, and potentially for in vivo tissue analysis.

"In vivo intraoperative guidance would be a natural next step," said Rebecca Aft, a WUSTL professor of surgery and a co-senior author on the study, speaking to Optics.org.

"We envision that this device would allow us to evaluate surgical margins intra-operatively for any cancer cells, and to act on the results while we have the patient in the operating room. The main challenges to achieving this are timely evaluation of specimens, and refining the software to accommodate the many histological variations observed in breast tissue."

Other enhancements to the platform could include the incorporation of a system to physically mark the tissue at the margins of the tumor, as an indication to pathologists of the area to focus on when performing histological evaluation.

Aft echoed Lihong Wang's comment about the range of wavelengths that could be of use in a PA platform. It may be that visible, rather than UV, wavelengths could be be used to image particular proteins called cytochromes which absorb in the visible range, opening another possible route to obtaining histology-like image information in an in vivo scenario.

"One day we think we will be able to take a specimen straight from the patient, put it into a machine in the operating room and know in minutes whether we have got all the tumor out or not," Aft said. "That is the goal."

About the Author

Tim Hayes is a contributor to optics.org.

http://optics.org/news/8/5/45

Sensors that mimic the human retina promise improved machine vision

UK project investigates neuromorphic vision sensing for cameras and robots.

A three-year project funded by the UK Engineering and Physical Sciences Research Council (EPSRC) aims to investigate the topic of machine-to-machine communications for neuromorphic vision sensing data, in which sensors mimic the action of biological vision systems.

Titled the Internet of Silicon Retinas, or IOSIRE, the project's £1.3 million has been divided among three project streams, involving Kingston University, King's College London, and UCL, alongside industry partners.

At Kingston University, a group led by Maria Martini will research innovative ways to process and transmit information secured through neuromorphic sensors.

"Conventional camera technology captures video in a series of separate frames, which can be a waste of resources if there is more motion in some areas than in others," commented Martini, whose group will receive £280,000 of the ESPRC funding. "Where you have a really dynamic scene, you end up with fast-moving sections not being captured accurately due to frame-rate and processing power restrictions, and too much data being used to represent areas that remain static."

DVS sensors send only information relating to the local pixel-level changes caused by movement in a scene, and so consume less power.

The goal is to examine how data from artificial vision systems inspired by the human eye can be captured, compressed and transmitted between machines at a fraction of the current energy cost. The project will commence in June 2017.

Neuromorphic sensors aim to deal with this problem by sampling different parts of a scene at different rates. The principle behind silicon retinas - also termed dynamic vision sensors (DVS) - involves transmitting only the local pixel-level changes caused by movement in a scene, and transmitting them at the time they occur.

The result is a stream of events at microsecond resolution, said to be equivalent to or better than conventional high-speed vision sensors running at thousands of frames per second, but with significant reductions in the power required.

Cloud-based analytics

"This energy saving opens up a world of new possibilities for surveillance and other uses, from robots and drones to the next generation of retinal implants," Martini said. "They could be implemented in small devices where people cannot go, and where it is not possible to recharge the batteries required."

At King's College London, a group led by Mohammad Shikh-Bahaei in the Centre for Telecommunications Research has been awarded £560,000 to explore a novel and advanced technology for layered representation and transmission of silicon retina data over the Internet of Things (IoT) for cloud-based analytics.

The third leg of the IOSIRE project will see researchers at UCL's department of electronic and electrical engineering under Yiannis Andreopoulos receive £550,000 to meet the challenge of how to represent and compact the captured neuromorphic vision streams of data, in order to allow for the most efficient transmission and processing by a cloud-based back-end processing system.

Industrial partners in the project include Samsung, Ericsson and Thales, who are interested in exploring how such sensors could be incorporated into the next generation of smart devices and used in future machine to machine communications. iniLabs, a spin-off of the University of Zurich and ETH Zurich which promotes neuromorphic engineering for a range of applications, is also a IOSIRE partner.

Tim Hayes is a contributor to optics.org.

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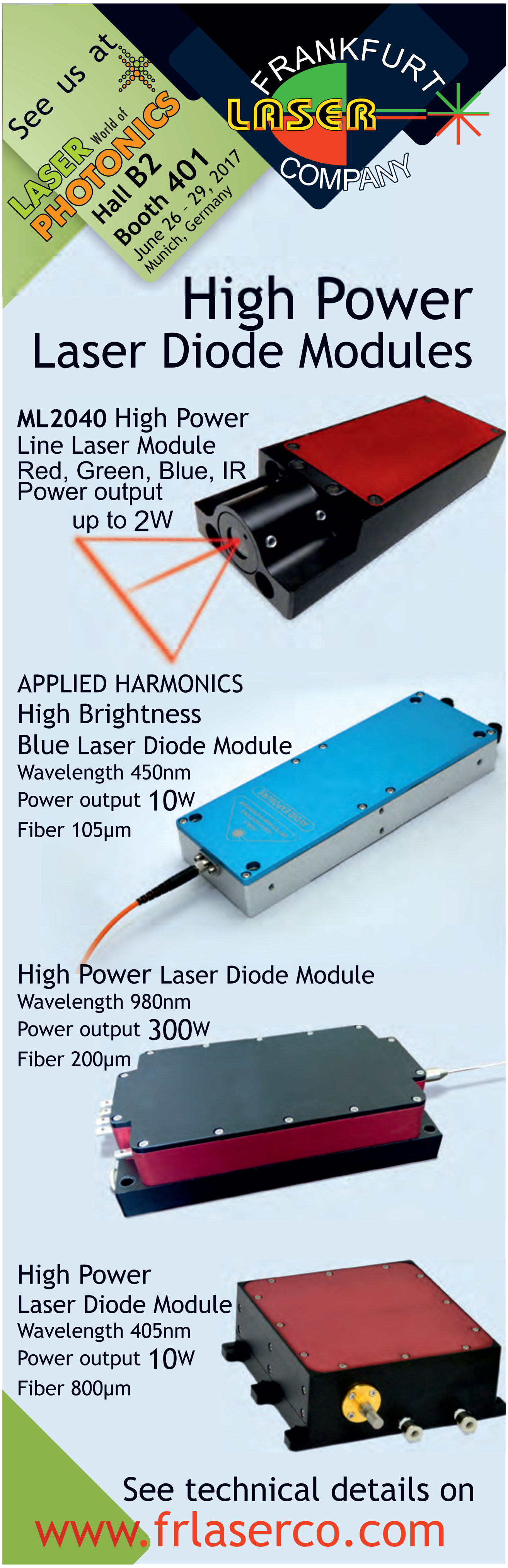

Radiant Vision Systems

VIS-I Automated Visual Inspection Station

The VIS-I is a fully-integrated inspection station that attaches to production lines to perform in-line automated inspection with greater accuracy and repeatability than human inspectors or traditional machine vision systems. Using photometry-based CCD imagers *(engineered for light measurement)*, the VIS-I offers the highest resolution and dynamic range available for detecting the most subtle, low-contrast defects in complex assemblies.

- High Resolution: Up to 29 megapixels
- Superior Dynamic Range: Up to 73.4 dB *(single exposure, per pixel)*
- Fully-integrated: Photometry-based camera, bright field lighting, programmable inspection software

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JAI A/S

New JAI 2.35 megapixel GO camera with USB3 Vision interface

The GO-2400-USB is a new 2.35 megapixel model in JAI's GO-2400 family of small and affordable industrial cameras.

It features USB3 Vision interface and the low noise and high image quality of the Sony PregiusTM IMX174 CMOS sensor. With 80G shock ratings, 10G vibration, MTBF greater than 200,000 hours – they have much greater reliability than other small "entry-level" cameras.

- 2.35 megapixels (1936 x 1216)
- Sony PregiusTM IMX174 CMOS imager (1/1.2")
- Global shutter
- 159 fps at full resolution
- 5.86-micron square pixels

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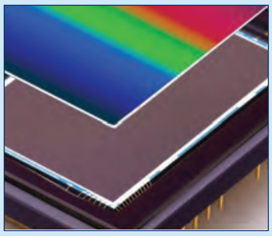
- Short measurement time
- High suppression of stray light
- Excellent signal to background ratio



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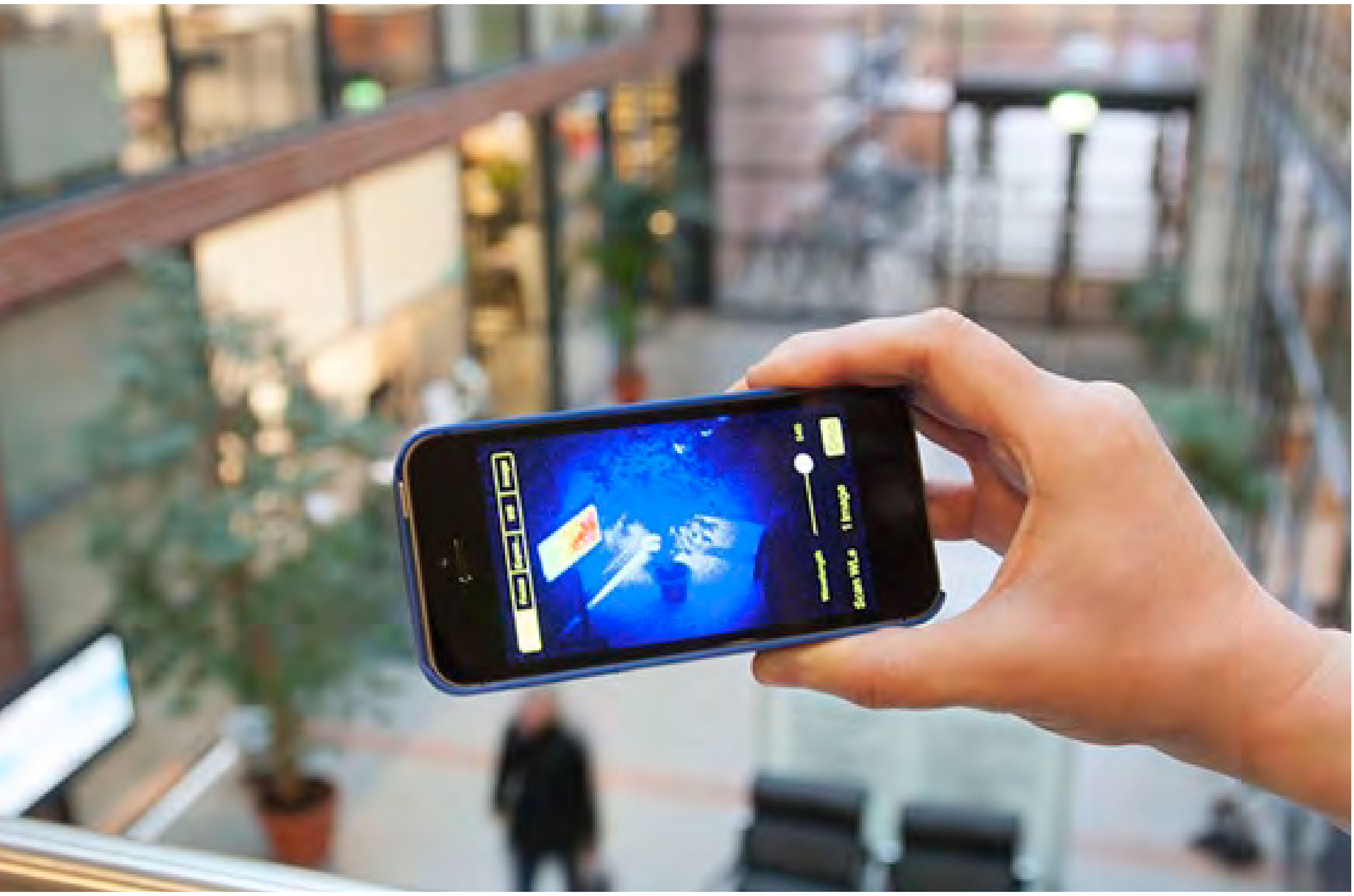

Photo: VTT.

Integrating miniaturized optical components within smart phones to generate hyperspectral images is a major research area right now, with applications in medicine, agriculture, industry and elsewhere anticipated.

Hyperspectral developers target smart phone applications

Researchers in Finland, Germany and Israel help 'democratize' the broadband sensor technology.

By Andrew Williams

In recent months, a number of organisations around the world have made great strides in the development and application of miniaturized hyperspectral imaging and sensing hardware.

One of the stand-out developments comes from the VTT Technical Research Centre of Finland, whose team claimed late last year that they had created the world's first hyperspectral mobile device by converting an iPhone camera into a new kind of optical sensor.

Over recent years, the VTT group has developed various types of novel hyperspectral imagers for applications ranging from skin-cancer detection to drone-based environmental monitoring and light-weight imagers for CubeSat space applications - all based around Fabry-Pérot interferometer tunable optical filters (FPIs).

Food quality sensing

According to research team leader Anna Rissanen, staff at VTT have also recently developed a new breed of MEMS-based FPIs that can be produced at high volumes and low cost - making them suitably cheap for use in smart phones.

"We wanted to show that with MEMS FPI technology it's possible to turn a regular iPhone into a hyperspectral imager," says Rissanen.

Based on their past work with more conventional hyperspectral imaging hardware, the VTT team believes that the new technology could be suitable for a variety of different applications depending on the wavelength range - but has already singled out food quality sensing and health monitoring as the likely key sectors.

"The whole potential of the technology can only come out once the hyperspectral data becomes available for application algorithm developers, which is the key to finding novel ways to interpret our surroundings," Rissanen told optics.org.

Although confidentiality agreements dictate that she is not currently able to share detailed information about the ongoing

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Hyperspectral developers target smart phone applications

commercialization of the MEMS-based hyperspectral imagers, Rissanen does reveal that VTT is aiming to engage with different types of companies, supply chains and end-user needs to find different potential paths for commercialization.

The Technical Research Centre has certainly made solid progress in establishing partnerships with a wide range of established companies and startups in recent years - including Senop Oy (formerly Rikola), which worked with VTT to commercialize hyperspectral imagers for drone applications, and Revenio, which is currently commercializing a hyperspectral camera for skin cancer diagnostics.

Reaktor Space Labs is also actively involved in joint efforts to bring hyperspectral imagers to the CubeSat market.

"As a research institute, VTT does not sell products so our aim is to work with company partners for the commercial development of new camera prototypes," added Rissanen. "The markets and applications will be defined by those partners."


Photo: Amir Lehr/Unispectral.

The MEMS component that provides hyperspectral imagery in Unispectral's smartphone-compatible technology. The Israeli startup recently closed a $7.5M round of series A venture funding.

Pesticide scanner

Another initiative focusing on smart phone-integrated hyperspectral imaging for the food monitoring and safety is the new HawkSpex app under development at Fraunhofer IFF in Germany, which can be used to scan apples for pesticide residues.

An initial laboratory-based version of the app has already been successfully trialled at IFF - with a commercial launch currently slated for late 2017.

Elsewhere, the Israeli start-up Unispectral - established in March 2016 after a research project aimed at developing the technology at Tel Aviv University by co-founders Ariel Raz and David Mendlovic - is also working on a novel hyperspectral digital camera.

As well as being built into smartphones, the company believes that the new technology could be used for a number of applications in the burgeoning field of computer and machine vision.

"The majority of the captured images today are stored, shared and presented to humans - and the imaging technology is aimed at mimicking our eyes," explains Amir Lehr, 'chief business officer' at Unispectral. "Looking forward, we believe that a hefty proportion of captured images will instead serve a computer for analysis and decision-making."

Most modern cameras today mimic the human eye, which registers light between 400 and 670 nm, by splitting light into red, green and blue pixels arranged as a Bayer Pattern - while a typical CMOS image sensor

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Hyperspectral developers target smart phone applications

is sensitive into the near-infrared, up to around 1000 nm.

According to Lehr, more flexibility in the wavelengths captured within and beyond the visible spectrum holds out the potential to enhance human-visible images in low-light and other situations.

Tunable wavelengths

This flexibility, achieved by building a tunable wavelength optical filter as a MEMS device implementing a Fabry-Perot interferometer, means that the Unispectral team can displace two parallel optical surfaces to precisely select the frequency of transmitted light.

"The filter design and the optical surface coatings set the filter transmission curves," says Lehr. "The filter is integrated into the camera lens structure and displaces - or is added to - the Bayer RBG filter pattern."

A driver and a set of algorithms manage

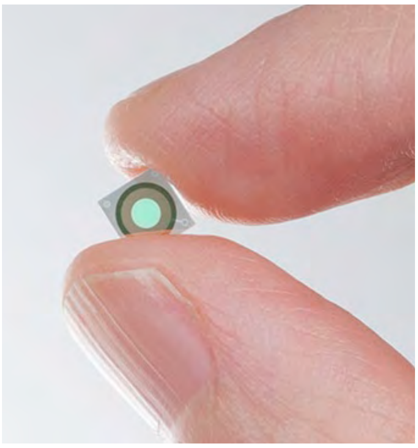


Photo: VTT.

The Fabry-Pérot interferometer tunable optical filter that sits at the heart of the VTT research team's hyperspectral hardware. The group is working with several commercial entities looking to develop applications.

the camera and the filter according to the particular application requirements, and when combining this solution with a conventional CMOS image sensors, delivers hyperspectral imagery across 400-1000 nm. "A combination with different image sensors would yield a different wavelength range," he points out.

The development appears to be catching some attention. Following a $7.5 million Series A funding round led by Jerusalem Venture Partners (JVP) and involving Robert Bosch Venture Capital, the Samsung Catalyst Fund and the Tel Aviv University Technology Innovation Momentum Fund just over a year ago, Unispectral has already identified several potential commercial applications.

Sectors expected to benefit from what Lehr describes as the 'democratization' of hyperspectral sensing include pharmaceuticals, precision agriculture, and food intelligence.

"We believe that wellbeing food-related applications, in business-to-business and business-to-consumer markets would also be early adopters of this emerging capacity," Lehr says.

Although coy about sharing any more specific details at this stage, he claims that the company is currently engaged with several "leading global companies" to drive the new capacities inherent in the technology to the market.

"We are targeting multiple hosting platforms and aim to deploy the solution starting at 2018 and expand thereafter," he told optics.org.

About the Author
Andrew Williams is a freelance writer based in Cardiff, UK.

http://optics.org/news/8/4/28

Photonic chip brings super-resolution potential to conventional microscopy platforms

Bielefeld University and University of Tromsø project enables chip-based localization microscopy. *By Tim Hayes*

A new optical chip developed by Bielefeld University and the University of Tromsø - The Arctic University of Norway (UiT) could help platforms based around conventional microscopy achieve performance levels approaching those of super-resolution systems, offering an alternative to the complexity and expense of most current nanoscopy techniques.

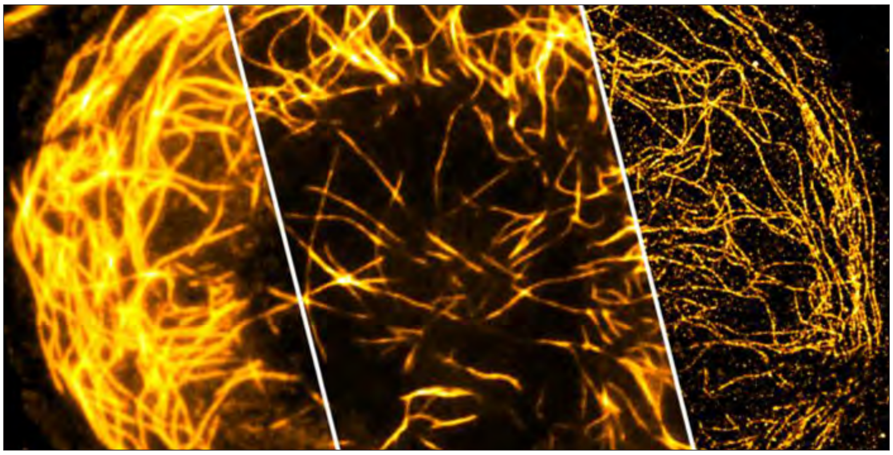
The chip's developers believe that it could ultimately allow a much broader use of nanoscopy, both in scientific research and other, more everyday, applications.

"A new chip-based super-resolution technique is a paradigm shift in microscopy," commented Mark Schüttpelz of Bielefeld University. The research was published in Nature Photonics.

According to the project team, the breakthrough centers on a reversal of the normal architecture for current nanoscopy methods. These usually employ a complex microscope for imaging and a simple glass slide to hold the sample, but the new technique uses a complex - although mass-producible - optical chip to both host the sample and provide a waveguide for the illumination source, while a standard low-cost microscope acquires the super-resolution images.

The waveguides themselves are designed and constructed so as to create an evanescent field strong enough for both single-molecule switching and fluorescence excitation, enabling single-molecule localization microscopy to be carried out on the chip itself.

The chip can also be employed for a different super-resolution approach termed optical fluctuation imaging, a post-processing method for deriving super-resolved images from recorded series of independently fluctuating fluorescent emitters. This technique uses multi-mode interference patterns to induce spatial fluorescence intensity variations in a sample.



Credit: Bielefeld University/Robin Diekmann

Standard resolution (left) compared to (center, right) high resolution and super-resolution obtained with the chip-based technique.

Live-cell imaging

In use, the chip-based design separates the illumination and detection light paths, making total-internal-reflection fluorescence excitation possible over a large field-of-view. The team demonstrated a field-of-view of up to 0.5 x 0.5 mm in its Nature Photonics paper.

One application area where the chip could make a substantial impact is in the imaging of live cells and the study of biological systems. The project has already carried out multi-color chip-based nanoscopy of sinusoidal endothelial cells taken from the liver, aiming in particular to examine transcellular pores called fenestrae. Each fenestra typically has diameters ranging from 50 to 200 nanometers, making examination difficult without applying a super-resolution technique to the task.

"Whereas the images that can be obtained simultaneously with established nanoscopy techniques range from only parts of cells up to just a few cells, the use of photonic chips now makes it possible to visualize more than 50 cells in one super-resolution image," commented the project team.

Efforts to reduce the complexity and associated cost of super-resolution techniques and bring them within reach of a wider spectrum of applications are now gathering pace. Recent examples include the DNA-PAINT technology developed by Ultivue, a reagent-based approach using short complementary DNA strands to allow single-molecule localization in fluorescence microscopy.

Elsewhere, scientific camera specialist Photometrics and Netherlands-based microscopy start-up Confocal.nl have collaborated on a system intended to balance low cost with useful sub-diffraction-limit resolution, for researchers wanting to use super-resolution techniques on limited resources. This technique is based on optical manipulation and also targeted towards live-cell applications, with wide field-of-view again a particular goal for that application.

http://optics.org/news/8/5/4

MIT Media Lab develops faster single-pixel camera

New design principles and optimized algorithms enhance the potential uses of lensless imaging systems.

Traditional imaging and microscopy techniques employ high-magnification objective lenses to map light from an object onto a suitable sensor plane, but methods to obtain high-quality images without the use of a lens are making steady progress.

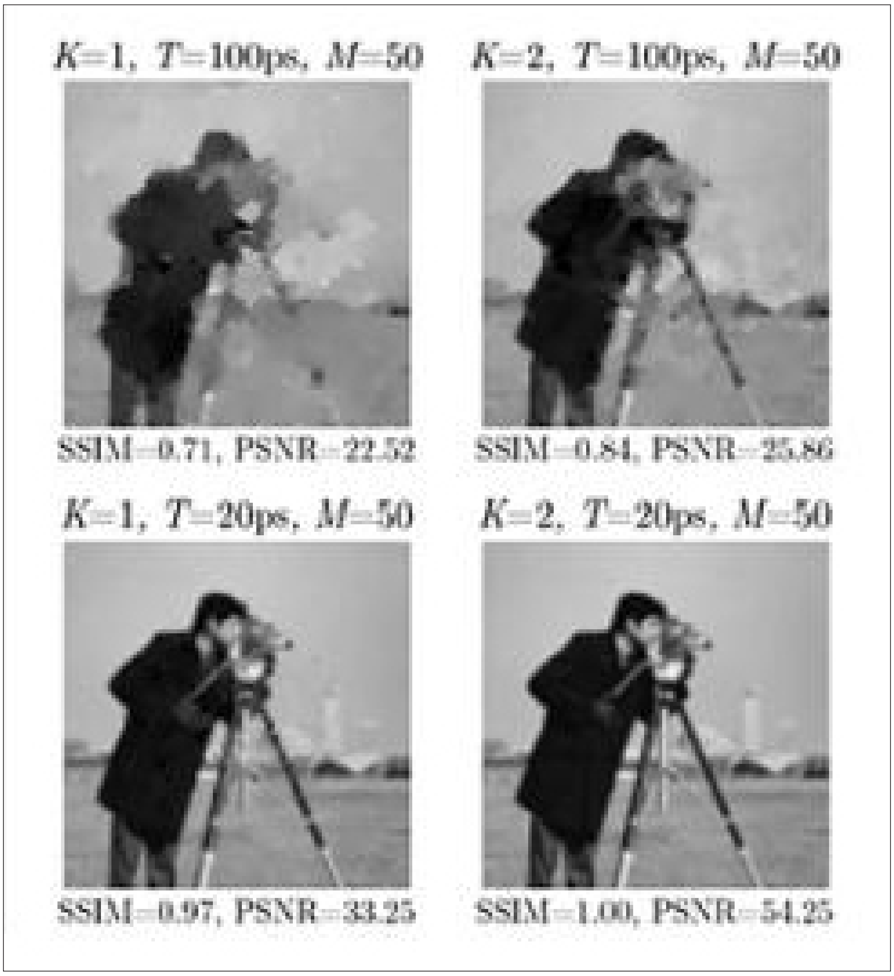
One reason for this has been advances in modern signal processing techniques, and the opportunity they provide to shift the emphasis in an imaging operation away from the optical hardware and onto the computational aspects instead.

A project in the Camera Culture Group at MIT Media Lab has now developed a method for lensless imaging that leverages both compressive sensing (CS) - one of the foundational numerical methods of computational imaging - and current breakthroughs in time-resolved optical sensing, a technology which is already key to several Group research projects.

The results show that efficient lensless imaging is possible with ultrafast measurement and CS, and point towards ways that novel imaging architectures could be put to use in situations where imaging with a lens is impossible.

"To the best of our knowledge this is the first combination of time-resolved sensing with a single-pixel camera used for detecting reflectivity - effectively, a photography application," commented Guy Satat of MIT.

"Single-pixel systems have been known and investigated for some years, while time-resolved sensing has been used for measuring reflectivity without CS, as well as in LIDAR to recover scene geometry. But we have now developed the missing piece of the puzzle, combining these approaches to recover the reflectivity and albedo of a scene."



Credit: MIT Media Lab, Camera Culture Group.

MIT Media Lab has developed ways to reduce the number of exposures needed for high-quality images in single-pixel systems, and created a design framework to assist engineers using other lensless imaging systems.

As reported in a paper for IEEE Transactions on Computational Imaging, the new approach ultimately made image acquisition using CS more efficient by a factor of 50. In lensless single-pixel camera systems - which rely on multiple measurements by the same sensor pixel under different illumination patterns, each controlled by a spatial light modulator so as to encode different information into each measurement - the findings could help to reduce the number of exposures typically involved from thousands down to dozens.

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MIT Media Lab develops faster single-pixel camera

Smarter modulations

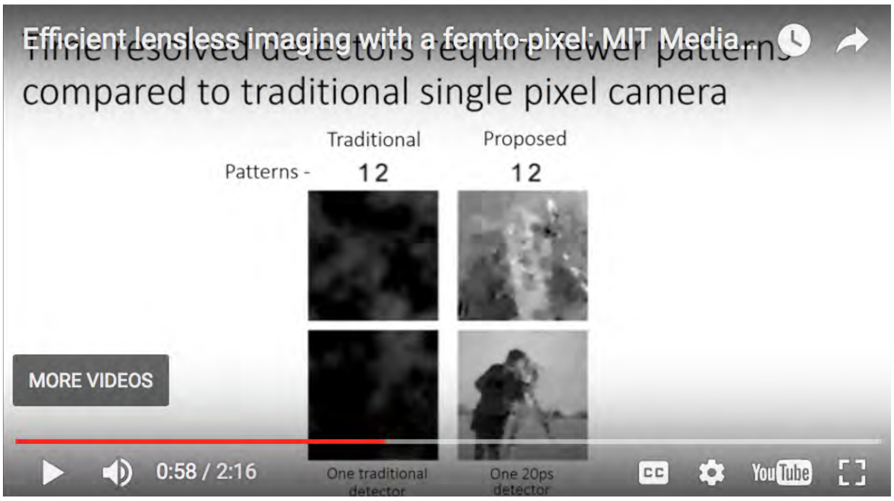
The MIT project investigated three distinct, but closely connected, fundamental issues in lensless imaging, starting with how to guide designers towards the best system architectures for lensless applications in general. A new design framework created by the Group provides a set of guidelines and decision tools to suggest how the available resources in a given scenario can be deployed to recover the best image using CS, and define when the CS approach is likely to be of most benefit.

This need not necessarily involve single-pixel sensing - one of the goals of the framework is to help define when a single-pixel system can be of most value and when it might not be - but the framework is intended to answer relevant design questions about the best positions for particular sensors, or lay out the conditions under which an improved time-resolution might be more beneficial than additional detectors.

A second project thread was to examine the role of time-resolved signals, and clarify how an improved temporal resolution can reduce the number of individual modulated signals needed to build up a high quality image. The third area of investigation related to the optimization of those individual patterns of modulated light, and ways to squeeze more information out of each one.

Compressive sensing

"Compressive sensing allows you to modulate the light in a smarter way," said Satat. "Without it, you have to do a large number of measurements to obtain a high-resolution image, which takes time. The geometry of the system will significantly affect the time-resolved measurements, since points closer to the detector are going to be measured first while points further away will be measured later. Modulating the



MIT Media Lab video

light allows you to accommodate this effect and obtain more information per measurement, and so potentially need fewer modulation patterns to obtain a full result."

Optics in challenging environments

Time-resolved sensing and femto-photography have already played a part in several projects in the Camera Culture Group under its leader Ramesh Raskar, an indication of the diverse practical uses that can arise from precise optical time-of-flight measurements.

Notable breakthroughs have included the use of time-resolved sensing to effectively image through scattering media by collecting and assessing all of the photons emerging after scattering events, rather than attempting to sift the most useful ones from the group. Another line of research studied ways to measure the bidirectional reflectance distribution function (BRDF), a complex parameter related to the reflection of light from an object that is a vital element in the creation of realistic computer graphics and VR animations.

"To measure the BRDF completely is a challenge, and involves a moving illumination source," said Satat. "A Group project avoided these difficulties by using a streak camera to measure the BRDF without a moving light source, recognizing instead that time-of-flight and the angle of reflection are related, and allowing us to recover more information from the time-resolved signals."

Other Group projects have included terahertz time-gated spectral imaging for analysis of layered structures, likely to be valuable in industrial inspection but already deployed in an eye-catching proof-of-concept to read the pages of a closed book; and using an open-ended bundle of optical fibers to image locations that would be difficult for a conventional monolithic camera instrument to reach, effectively turning the fibers into a group of scattered individual pixels whose locations in space are not precisely defined.

And outside MIT, a recent indication of the potential value of lensless single-pixel camera systems has come from M Squared and the University of Glasgow, and the development of an instrument to directly image methane gas leaking from a ruptured pipeline in real-time.

"Some of the interesting uses for single-pixel systems are in exactly these kinds of places, in challenging environments where it is hard to build and maintain conventional optical instruments," commented Satat. "Our work in the Camera Culture Group aims to help this process by showing ways to augment any lensless or single-pixel system, and suggesting combinations of hardware and computational techniques that can not only enhance existing applications but also enable entirely new ones."

About the Author
Tim Hayes is a contributor to optics.org.

http://optics.org/news/8/4/41

G2 Technologies develops novel 3D inspection system

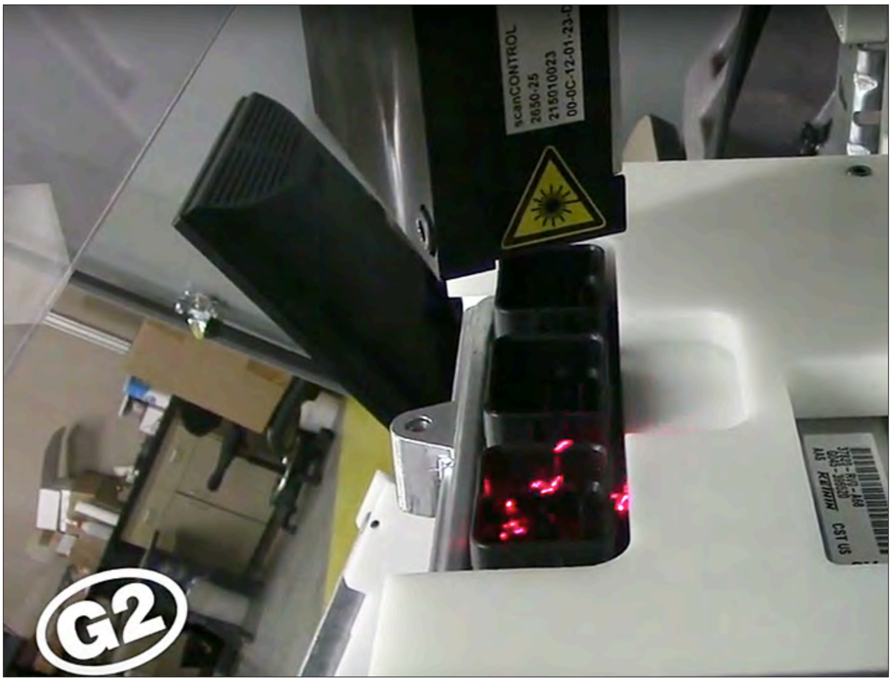
Could help reduce recalls for automotive, aerospace and other industries. *By Matthew Peach*

G2 Technologies, a test and measurement company with clients including Honda, 3M, BE Aerospace and NASCAR, has developed a customizable, automated 3D inspection system, which it says "can catch flaws that previous inspection systems would miss".

The system was developed in response to a client's need for faster, more accurate connector inspection; the global market for the connector industry is estimated to reach $80 billion by 2022, says the company.

With 3D inspection systems, manufacturers can now catch such faults before it's too late."

The new 3D system from G2 Technologies combines a machine-vision based, non-contact 3D inspection system, a cleaning station, and electrical test and engraving stations. It is built on a PXI platform from National Instruments, based in Austin, TX. It inspects a variety of connectors with pin counts up to 32.



The 3D inspection system from G2 Technologies combines a machine-vision based, non-contact 3D inspection system, a cleaning station, and electrical test and engraving stations.

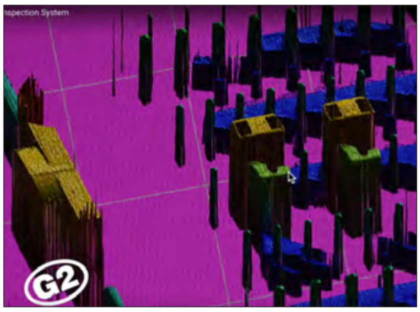
Craig Borsack, president of G2, commented, "So far, inspection of connectors has been limited to 2D assessment and checking by eye, so while an examiner can catch bent or missing pins, a faulty connector with a pin that is just too short to see is easily missed.

Borsack said that is hoping connector and other manufacturers will consider exploring the automated 3D systems for use in their manufacturing process. "It's a relatively small investment when you look at the potential savings it offers. Not only can this inspection system help protect a manufacturer from being sued for damages in a recall situation."

Tech-spec of the test process

The inspection system is installed after stitching, a process that accumulates contact pins and inserts them into molded connector housings. Stitched connectors enter on an input conveyor and pass under a Genie Nano M1920 GigE Vision camera from Teledyne DALSA.

An image of the connector is acquired with illumination provided by a DL 194 diffuse dome light from Advanced Illumination, which is then analyzed to verify that the correct part is present and in the proper orientation.



To achieve a complete 3D point cloud, the part is scanned from both directions, then the images are combined to mask out the shadows.

Parts that are properly aligned proceed to an orientation wheel that repositions the part board-side down, for the next station, which is board-side inspection. At this station, a scanCONTROL 2650-25 laser line profiler from Micro Epsilon scans the entire board side of the connector.

Next, connector-side inspection takes place. Due to cycle time requirements, and the need to scan the part from both directions, inspection of the mating side of the connector is performed at two stations by two additional laser line profilers.

Two scans are used because of the shadowing effects created by the connector shell when the part is scanned from one side. To get a complete 3D point cloud, the part is scanned from both directions, then the images are combined to mask out the shadows. The system scans from both sides and creates a plane based on a datum (feature) on the bottom of the mate side connector. This plane is used to measure true position and pin height of the contacts.

http://optics.org/news/8/5/21

Wireless camera system monitors babies' vital signs

Credit: Marc Delachaux/EPFL.

A contactless and wireless camera system developed by EPFL and CSEM continuously monitors premature babies' vital signs.

Swiss NewbornCare project aims to replace skin sensors, reducing false alarms and easing discomfort.

The heart rate and breathing of babies are normally monitored by sensors placed on the skin, but these can be both uncomfortable for the babies and prone to false alarms.

A camera system able to detect and measure a baby's vital signs without needing to be in contact with the skin has now been developed by the Swiss Federal Institute of Technology in Lausanne (EPFL), Neuchâtel-based research center CSEM and University Hospital Zurich (USZ). The project forms part of the broader Swiss federal research initiative Nano-Tera.

The system uses a camera to detect a baby's pulse, by watching the small changes in skin color which take place with each heartbeat. Meanwhile, the baby's breathing is monitored through movements in the baby's thorax and shoulders. The use of infrared cameras allow the monitoring operation to continue overnight, without disturbing the baby's sleep.

"Conventional skin sensors placed on a baby's chest are so sensitive that they generate false alarms nearly 90 percent of the time, mainly caused by the babies moving around," said Jean-Claude Fauchère of USZ's division of neonatology. "This is a source of discomfort for the babies, and a significant stress factor for nurses and a poor use of their time. It distracts them from managing real emergencies, and can affect quality of care."

The new project involved collaboration between researchers at CSEM and EPFL to develop cameras sensitive enough to detect minute changes in skin color, and also the design of computational algorithms able to process the collected data in real time. CSEM focused on assessing respiration, while EPFL worked on measuring the baby's heart rate.

EPFL video

Multi-modal approach

An initial study on a group of adults used a camera system to monitor an area of skin on the forehead. This proved that the algorithms were able to isolate an area of pixels and track it as the person moved, while using minor changes in the color of the pixels to determine the pulse. The trial also showed that the cameras produced practically the same results as conventional sensors, said the project team.

Preliminary tests will be run shortly on newborns at University Hospital Zurich, to confirm that results under real-world conditions also match data from conventional skin sensors.

The new monitoring system has been developed as part of NewbornCare, one of a number of research projects operated by the Swiss research program Nano-Tera. This federal initiative encompasses four strands of research identified as driving engineering and information technology in Switzerland for the next century: health, security, energy, and the environment.

The research under way in NewbornCare is intended to ultimately produce several novel technologies, including an innovative monitoring system hosted on smartphones or tablets for medical staff, and a computer-aided diagnostic tool to detect and classify cardiac events based on learning methods.

In particular, NewbornCare aims to combine the computer vision-based contactless measurement of heart and respiratory rates with a separate technology for monitoring arterial and brain-tissue oxygen saturation using near-IR optical sensors, expertise developed in an earlier Nano-Tera project called NeoSense.

A multi-modal approach combining the use of near-IR spectroscopy to measure oxygenation and a camera system to monitor heart and respiration could completely eliminate false-alarms in neonatal vital sign monitoring, according to the project team.

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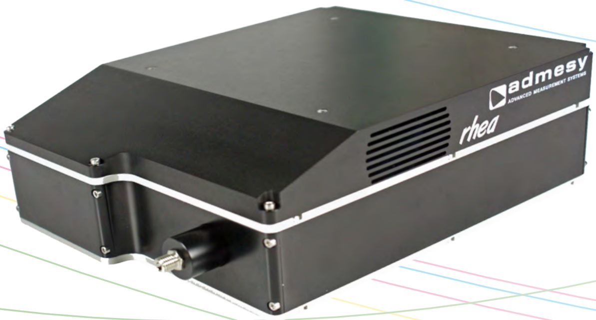

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