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VISION focus

Delivering the latest news from the Imaging and Machine Vision markets

Novel optics for ultrafast camera creates new imaging methods

Image courtesy of the researchers.

optics.org: Contact Rob Fisher, Advertising Sales tel: +44 (0)117 905 5330   fax: +44 (0)117 905 5331   email: rob.fisher@optics.org

SPIE.

Germany calling

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 the bi-annual VISION expo in Stuttgart. In this issue, we review the booming state of Germany's MV business and present a host of new vision technologies and applications, many of which will be on show.

Germany's machine vision industry achieved a record turnover of €2.6 billion in 2017, representing an increase of 17% over 2016. Turnover in the industry has doubled within the past decade, according to a report by VDMA Machine Vision *(page 4)*.

Also from Germany, the patented laser sensor SensePRO developed by Hamburg's Fraunhofer Research Institution for Additive Manufacturing Technologies, gives an all-round 360-degree field of view for robot machining applications *(page 6)*.

Cognex has recently posted another solid set of financial results – significantly boosted by business from China's carmakers. It has shrugged off weak recent demand from manufacturers of OLED displays to post a sharp year-on-year increase in sales *(page 8)*.

Acquisitions and research

Jenoptik has expanded its presence in the machine vision sector, with the acquisition of both Otto Vision Technology and Ovitec. Camera maker Basler has bought up Silicon Software to target the performance segment of computer vision market *(pages 9 and 10)*.

This issue's cover story reports on how researchers at MIT, Cambridge, US, have developed a novel optics that captures images based on the timing of reflecting light inside the optics, instead of the traditional lens-element approach. The new design promises new capabilities for time- or depth-sensitive cameras *(page 12)*.

Another mind-expanding vision-related research innovation – involving five dimensions – concerns how researchers working in Jena, Germany, have developed a compact imaging system that can measure the shape and light-reflection properties of objects. This so-called "5D" hyperspectral imaging system could benefit a variety of applications in manufacturing and security *(page 16)*.

Plus we report on the latest product launches from within the industry, including LG Innotek making a move into thermal imaging, SiOnyx's day-night action camera, and Montreal's Algolux launching its NaturalIQ and CRISP-ML packages aimed at improving autonomous vision technology through machine learning.

If you are attending the VISION show please come and visit us in Hall 1 *(Gallery)* on stand 1Z126. See you in Stuttgart.

Matthew Peach, Contributing Editor
matthew.peach@optics.org

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Publication and Editorial Schedule 2019

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German MV industry sales grew 17% in 2017 to €2.6 bn

VDMA Machine Vision Group reports record numbers for sector and booming, bi-annual VISION show.

The German machine vision industry achieved a record turnover of €2.6 billion ($3.0 billion) in 2017, representing an increase of 17 per cent compared with business in 2016. Turnover in the industry has doubled within the past ten years, according to the market report just published by the VDMA Machine Vision, sector group of the German Mechanical Engineering Industry Association.

According to VDMA Machine Vision, the reason for the boom is that machine vision technology made in Germany is not only

2016 rose for the first time to more than 11,000 m2 and will increase again in 2018 to over 12,000 m2.

Image: Cognex.

Visionaries: Olaf Munkelt (VDMA and MVTec) and Florian Niethammer (VISION).

This picture corresponds with the latest industry figures from the VDMA: whereas the turnover of the machine vision industry on the German market grew by 8 per cent in 2017, exports rose by 23 per cent. Germany's two most important export targets are still China and North America which, together, make up 26 per cent of the German MV industry's total turnover.

"As a driving force for Industry 4.0, machine vision is now indispensable in modern factories, having long been part of our everyday life," said Dr. Olaf Munkelt, co-founder of MVTec Software and chairman of the board of directors of the machine vision group of the VDMA.

Image: Cognex.

Industry 4.0, or "The Industrial Internet of Things," will rely upon machine vision to revolutionize industrial automation.

being increasingly used in automation systems in traditional industry sectors worldwide, but it is also reaching new industries. The industry-driven platform expects growth to continue in 2018 with a 7 per cent increase in turnover to €2.8 billion.

This market surge is also recognized by Messe Stuttgart as the organiser of VISION, taking place between 6-8 November. This year VISION is expected to break the exhibition records set in 2016: for example, the amount of rented exhibition space in

For the first time, the gallery in the expo's "L-Bank Forum", in Stuttgart's Hall 1, will therefore also contain exhibition stands. The number of exhibitors, set to exceed 460, will also beat the record of 440 companies from 2016. Moreover, around 25 per cent of exhibitors will be new to VISION.

International exhibitors up

In 2016, 57 per cent of VISION exhibitors came from outside of Germany while the proportion this year will exceed 60 per cent.

"Whether in traffic management systems, autonomous driving, rubbish separation, recycling or health care, machine vision makes all these applications possible. Embedded vision in combination with deep learning is stimulating additional growth."

This view shared by Florian Niethammer, VISION's Project Manager: "The trending topics in the industry will also be some of the focal points of VISION 2018. In Stuttgart, industry experts and trade visitors alike will have the opportunity to be inspired by practical examples and discuss their needs."

Matthew Peach, Contributing Editor, optics.org

http://optics.org/news/9/9/16

© Fraunhofer IAPT.

Conventional location perception sensors typically limit the directional flexibility of robots.

Robot eye gives an all-round field of view

Conventionally, robots can move – but not see – in all directions. The patented laser sensor SensePRO developed by the Fraunhofer Research Institution for Additive Manufacturing Technologies (IAPT), Hamburg, Germany, offers a solution to this problem.

By Matthew Peach, Contributing Editor

What is the motivation for the IAPT's development? Humans can almost always instinctively answer the question "where am I?". But with the increasing deployment of robots and robot-based manufacturing and transport systems, these machines also need to be able to answer this question, even as they tirelessly glue, weld or apply seals to work pieces.

The Fraunhofer IAPT contends that the production of precision products depends on robot control systems being aware of the exact location of the adhesive bonding head or welding head to the nearest millimeter at all times. This means the robot needs some sort of eye, i.e. a smart camera based system that can somehow contextualize surrounding locational information in all directions around the robot.

In the automotive industry and many other sectors, specialized sensors perform this function, most of which operate on the principle of laser triangulation. A laser diode projects a line of red light onto the work piece, from which the light is reflected at a specific angle before being detected by a camera. From the position of the light striking the camera chip, the position and distance of the sensor with respect to the work piece within the coordinate system can be calculated.

However, says the IAPT, there is a problem with such systems: "Shadowing effect limits the flexibility of existing sensors. They also restrict the freedom of movement of the robot systems and integrating them is very labor-intensive," says Mauritz Möller, head of the additive

manufacturing systems department at the IAPT in Hamburg.

The only way to measure height with conventional sensors is to mount them along the direction of processing. With these sensors, however, the robot is effectively "blind" when it changes its direction of movement. Having to predefine the processing direction significantly limits the flexibility of the handling systems. The only alternatives are to use several sensors or additional axes – either of which, given today's state-of-the-art technology, can sometimes cost more than the robot itself.

Patented measuring technique

Mauritz Möller and his colleagues Malte Buhr, Vishnuu Jothi Prakash and Julian Weber have developed an innovative solution called SensePRO. This compact sensor system measures 150mm in diameter and it is equipped with specially developed image processing algorithms, thus providing a shadow-free all-round field of view, and generating a 360° measurement field, offering complete flexibility with regard to the direction of measurement. No matter where the robot moves, at least one laser line is always optimally positioned, supplying precise positional information to the camera.

This approach also solves another problem – shadowing of the laser light by components with complex shapes. The researchers have now patented the technique. No additional programming is required to integrate the new sensor system in existing robot systems. It can be employed completely flexibly and, above all, reliably in all adhesive bonding and welding processes. The technique significantly simplifies process control and quality assurance – with just one sensor.

Intelligent thermal management

To operate over long periods in harsh production environments, the sensor contains a cooling module, which utilizes either water or air. To enhance cooling, the optical bench on which the laser diodes and cameras are mounted has an internal cooling structure. Due to its highly complex shape, the only way to produce it is by 3D printing.

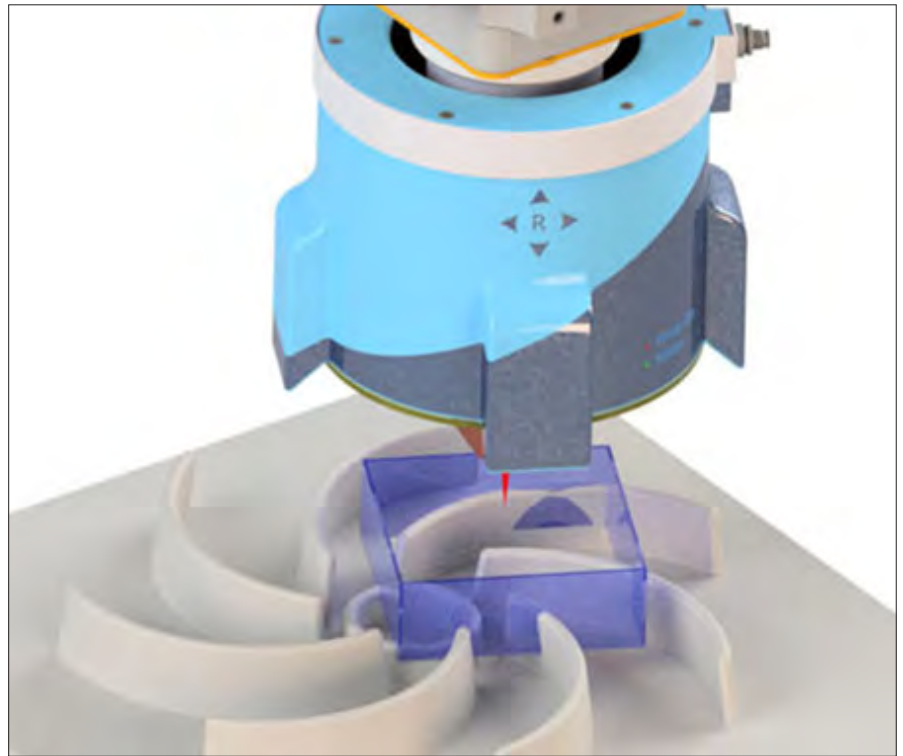## Robot eye gives an all-round field of view

This intelligent thermal management system extends the sensor's service life. The sensor is designed to fit robots made by all leading manufacturers, from Kuka to Fanuc, and is well suited for any conceivable application scenarios. As a result, it can be easily integrated into existing production systems.

The developers say that the SensePRO system is expected to be ready for full-scale production in 2021. "Since no competing systems are currently available, SensePRO has a good chance to successfully establish itself in the rapidly growing industrial robot market," says Möller. "In Germany, around 1,300 new robots for welding or adhesive bonding applications that require such a sensor are sold every year."

For Möller, Buhr, Prakash and Weber, the next aim of the project is to assess

Graphic: © Fraunhofer IAPT.

All-seeing eye: SensePRO developed by the Fraunhofer IAPT gives an all-round field of view.

how SensePRO might be commercially exploited, for example in a spin-off. With this in mind, the four pioneering researchers have applied for and received approval for EXIST funding. The German Federal Ministry of Economic Affairs and Energy's EXIST program supports start-ups from universities and research institutions individually with up to one million euros in funding.

Cognex boosted by China's auto makers

Machine vision company posts another solid set of financial results as the technology continues to proliferate.

Cognex, the Nasdaq-listed developer of machine vision technology, has shrugged off weak recent demand from manufacturers of organic LED (OLED) displays to post a sharp year-on-year increase in sales.

At just over $211 million, revenues in the three months ending July 1 were up 19 per cent on the same period last year, with company founder and chairman Robert Shillman remarking:

markets, led by logistics and automotive," Willett told an investor conference call to discuss the latest results, adding that demand from automotive companies in China had increased substantially in recent months. Overall, Cognex' sales to China rose more than 50 per cent year-on-year.

Asked about the potential effects of new tariffs resulting from the US-China "trade war" instigated by the Trump
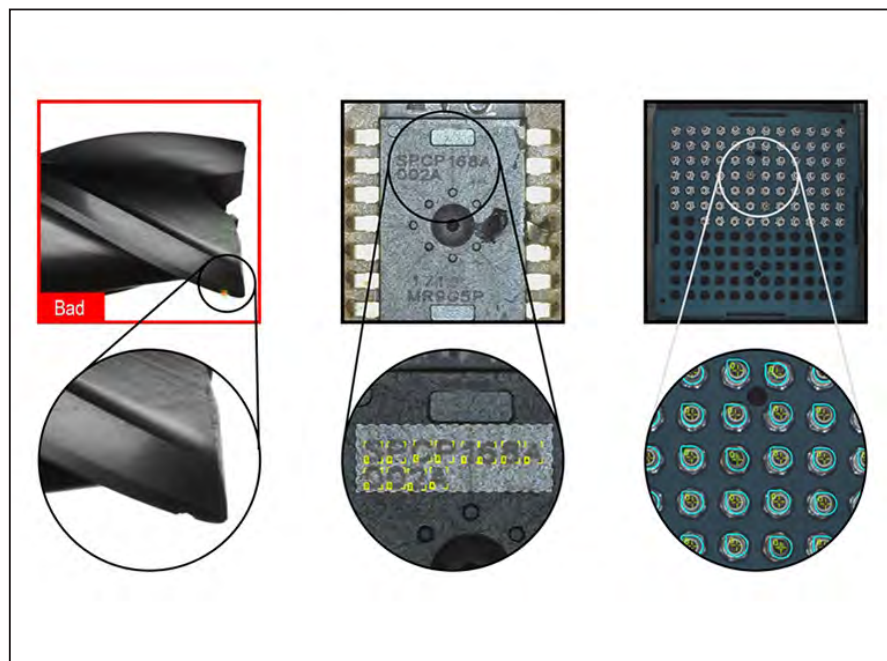
Cognex recently expanded its scope of products with the release of new image analysis software. 'VisionPro ViDi' is said to combine artificial intelligence with Cognex's existing machine vision software, and is aimed at more challenging applications in manufacturing.

"Our results for Q2 of 2018 were rather good. Revenue was the second highest of any quarter in our company's 37-year history. And operating margin was at our 30 per cent long-term target."

Automotive momentum

Cognex' CEO Robert Willett added that despite the significantly lower demand from OLED manufacturers compared with last year's boom in the sector, opportunities in other applications continue to grow rapidly.

"We performed well across most end

administration, the CEO said that so far Cognex had seen little or no impact on its business.

"Our product we sell in China is manufactured outside of the US, so it's not as if that's necessarily in the first line of fire for any trade stuff that would be going on," Willett told analysts. "We're positive about China. We're very positive about the long-term effects. Our business is doing well there. We don't see any short-term impacts based on what we're reading in the news, [but] we're watching very carefully."

OLED effects

Projecting sales in the current quarter, Willett and Shillman said that revenues would likely rise to between $220 million and $230 million – although that would represent a substantial decline compared with the third quarter of 2017, when the company posted a record $260 million in sales.

That prospective downturn reflects the much lower investment in OLED display production lines in 2018 compared with last year, but Willett said he remained positive about the long-terms prospects of that sub-sector.

"I think we all know that investments in new technologies like OLED displays tend to come in phases," the CEO told the analyst call. "It appears that investments in capacity are lower this year, [but] we think they'll be up over three years. [Though at this point] it's very hard to make a call about next year."

Despite the strong sales performance for the second quarter, increased costs saw Cognex' net income decline slightly on the same period last year, to $56.2 million.

However, the firm's profit margins remain enviably strong, and the executive team says it is planning to capitalize on the wider proliferation of machine vision by investing more heavily in product development and sales resources.

With more than three quarters of a billion dollars now on its balance sheet in the form of cash and equivalents - and no debt – Cognex will be able to support its growth plans easily while keeping plenty of ammunition available for any acquisitions, shareholder dividends, or share buy-backs.

- Following the latest financial update, Cognex' stock price rose some 7 per cent in pre-market trading on July 31*. At $47.50, though down significantly from the record high of $73 it hit in late 2017, the company's market capitalization currently stands at around $8 billion.

✳ Cognex' stock closed the day up nearly 20 per cent, at $52.78 and equivalent to a market capitalization of just over $9 billion.

Mike Hatcher, Contributing Editor, optics.org
http://optics.org/news/9/7/46

Jenoptik makes machine vision move

Double acquisition of Jena-based companies specializing in optical inspection systems.

Image: Jenoptik AG.

Germany-headquartered photonics technology vendor Jenoptik has expanded its presence in the machine vision sector, with the acquisition of both Otto Vision Technology and Ovitec.

Like Jenoptik, both the companies are based in Jena. Together they are expected to generate a turnover of around €8 million this year, and employ 32 people. Founded by brothers Reinhard and Gunter Otto, the two companies will augment Jenoptik's existing activity in the industrial metrology sector.

"Otto Vision Technology GmbH and Ovitec GmbH specialize in optical inspection systems for quality assurance and process optimization, as well as in complex imaging systems for applications in the field of part dimensioning, surface inspection and position detection," Jenoptik announced, adding that the two firms' key customers are involved in the automotive, stamping and glass industries.

Both the acquired companies are said to be making a profit slightly higher than the existing Jenoptik Group.

Jenoptik CEO Stefan Traeger said in a company statement: "With the acquisition of the two companies and our product range, we are taking a further step towards becoming an integrated provider for sophisticated measuring tasks and efficient production processes."

'Ideal fit'

The product ranges of Otto and Ovitec are said to provide an "ideal fit" for Jenoptik, with the acquisition expected to open up additional areas of application in the field of 2D and 3D metrology.

While they currently sell customized products and a range of services for solving complex inspection tasks, the plan is to use Jenoptik's capability and global footprint to extend that offering.

"We are convinced that we can benefit not only from Jenoptik's extensive know-how in production metrology but also from the Group's financial strength and global presence and substantially expand our international sales activities in the future", said Reinhard Otto, who along with brother Gunter will continue to work in a managing director role.

Aside from its latest acquisitions, Jenoptik is expanding its industrial metrology unit with a new building in Villingen-Schwenningen set to employ 220 people. Construction is slated to begin in early 2019.

Gunter added: "My brother and I are happy that this acquisition - and what's more by a Jena-based company - will provide a long-term perspective for our employees and their families."

Founded back in 1992, Otto Vision Technology has since installed more than 1000 systems, and had expanded into both China and the US with distribution deals. Earlier this year the company introduced 3D scanners based around 12 megapixel cameras for the first time.

The additional sales from the two acquired firms should help Jenoptik achieve its full-year revenue target for 2018. Last month that was increased to between €805 million and €820 million, when the company reported continued buoyant demand across all its main market sectors.

Mike Hatcher, Contributing Editor, optics.org
http://optics.org/news/9/8/49

Camera maker Basler buys up Silicon Software

Acquisition of card and software firm extends Basler's portfolio towards performance segment of computer vision market.

Industrial camera manufacturer Basler, based in Ahrensburg, Germany, has acquired Silicon Software, a German manufacturer of image acquisition cards and software for the graphical programming of vision processors.

The partners anticpate that by combining Basler's cameras with intelligent image acquisition cards from Silicon Software, customers will benefit from obtaining solutions from a single source, which already allow pre-processing and analysis
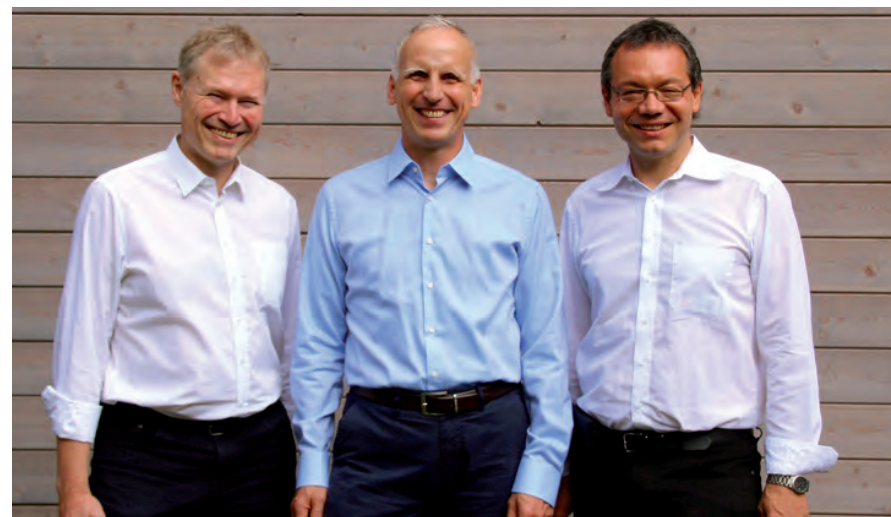
makes for shorter development times and faster time-to-market cycles for customers, say the partners.

Dr. Dietmar Ley, CEO of Basler AG, commented, "Silicon Software's product portfolio complements ours and will significantly contribute to successfully implement our planned expansion strategy towards the performance segment of the Computer Vision Market."

Dr. Klaus-Henning Noffz and Dr. Ralf Lay, CEOs of Silicon Software, added, "The strategic alignment of the two companies fits together well. Basler and Silicon Software can now offer solutions from image acquisition to analysis for all performance areas worldwide. There are two strong brands that also stand for innovations in embedded and Industry 4.0."

The Silicon Software acquisition closely follows the announcement of Basler's establishing a joint venture with Chinese distributor Beijing Sanbao Xingye. Both companies agreed to transfer the Machine Vision division to the newly established Beijing-based Basler China.

Image: Basler.

Integrated: New partners Dr. Klaus-Henning Noffz (CEO, Silicon Software), Dr. Dietmar Ley (CEO, Basler AG), Dr. Ralf Lay (CEO, Silicon Software).

The deal announced recently, sees Basler take over 100% of the shares of Silicon Software with immediate effect. The two managing directors Dr. Klaus-Henning Noffz and Dr. Ralf Lay will be working for Silicon Software and Basler in the future. Financial details were not disclosed.

Basler stated that by this acqusition it is continuing to expand its product portfolio for computer vision applications: "Camera customers will benefit from comprehensive and easy-to-integrate solutions for capturing and processing images in the future. With a view to next-generation image sensors and their associated higher data rates; easy-to-use high-performance image acquisition cards are becoming increasingly important."

of image data "on board" and open up cost-cutting potential. The graphical programming of the vision processors via Silicon Software's VisualApplets software

Replacement for cameras with discontinued Sony sensor

Last month, Basler recently announced a new ace U camera model that enables 1:1 replacement of older CCD cameras that incorporate Sony's popular but discontinued ICX618 sensor.

Basler's patented algorithm allows the sensor characteristics of the Sony ICX618 to be reproduced 1:1 without distorting the EMVA values of the camera. With identical exposure scenarios, the new ace U delivers comparable gray values; at the same working distance, it delivers the same image detail and the same resolution.
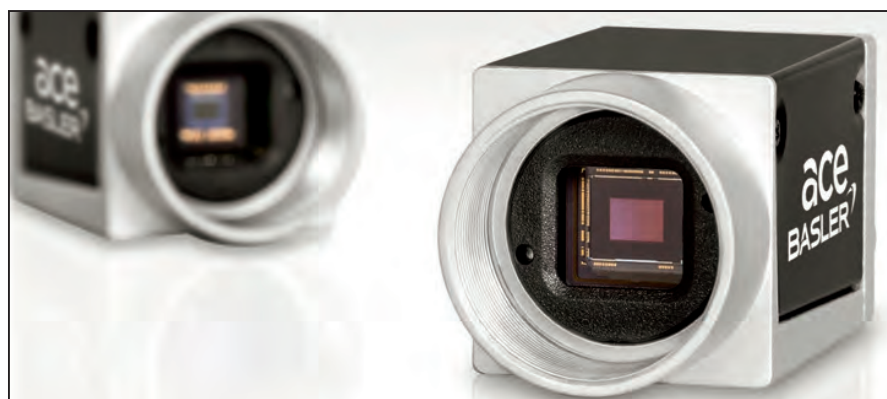
Matthew Peach, Contributing Editor, optics.org
http://optics.org/news/9/7/35

Image: Basler.

Sony equivalent: Basler's BAS1806 ICX618M camera.

Novel optics for ultrafast camera creates new imaging methods

MIT develops "time-folded" optics for ultrafast cameras: captures image at multiple depths simultaneously in one shutter click.

Researchers at MIT, Cambridge, Ma, US, have developed novel photographic optics that capture images based on the timing of reflecting light inside the optics, instead of the traditional lens-element approach. The new design promises new capabilities for time- or depth-sensitive cameras, which are not possible with conventional optics.

The new optics are designed for an ultrafast sensor, known as a streak camera, which resolves images from ultrashort pulses. Streak cameras can make a trillion-frame-per-second video, scan through closed books, and provide a depth map of a 3-D scene, for example. However such cameras have, so far, relied on conventional optics, which have various design constraints.

MIT Media Lab researchers have developed a technique that makes a

light signal reflect back and forth off carefully positioned mirrors inside the lens system. A fast imaging sensor captures a separate image at each reflection time. The result is a sequence of images, each corresponding to a different point in time, and to a different distance from the lens. The researchers have called the technique time-folded optics. The work is described in Nature Photonics.

How it works

Barmak Heshmat, first author on the paper, commented, "When you have a fast sensor camera, to resolve light passing through optics, you can trade time for space. That is the core concept of time folding. You look at the optic at the right time, and that time is equal to looking at it in the right distance."

The MIT architecture includes a set of semireflective parallel mirrors that reduce, or fold, the focal length every time the light reflects between the mirrors. By placing the set of mirrors between the lens and sensor, the researchers condensed the distance of optics arrangement by an order of magnitude while still capturing an image of the scene.

The researchers' system consists of a component that projects a femtosecond laser pulse into a scene to illuminate target objects. Traditional photography optics change the shape of the light signal as it travels through the curved glasses. This shape change creates an image on the sensor.

Instead of heading right to the sensor, the signal first bounces back and forth between mirrors precisely arranged to trap and reflect light. Each one of these reflections is called a "round trip." At each round trip, some light is captured by the sensor programed to image at a specific time interval, for example, a 1ns snapshot every 30ns.

By placing the sensor at a precise focal point, determined by total round trips, the camera can capture a sharp final
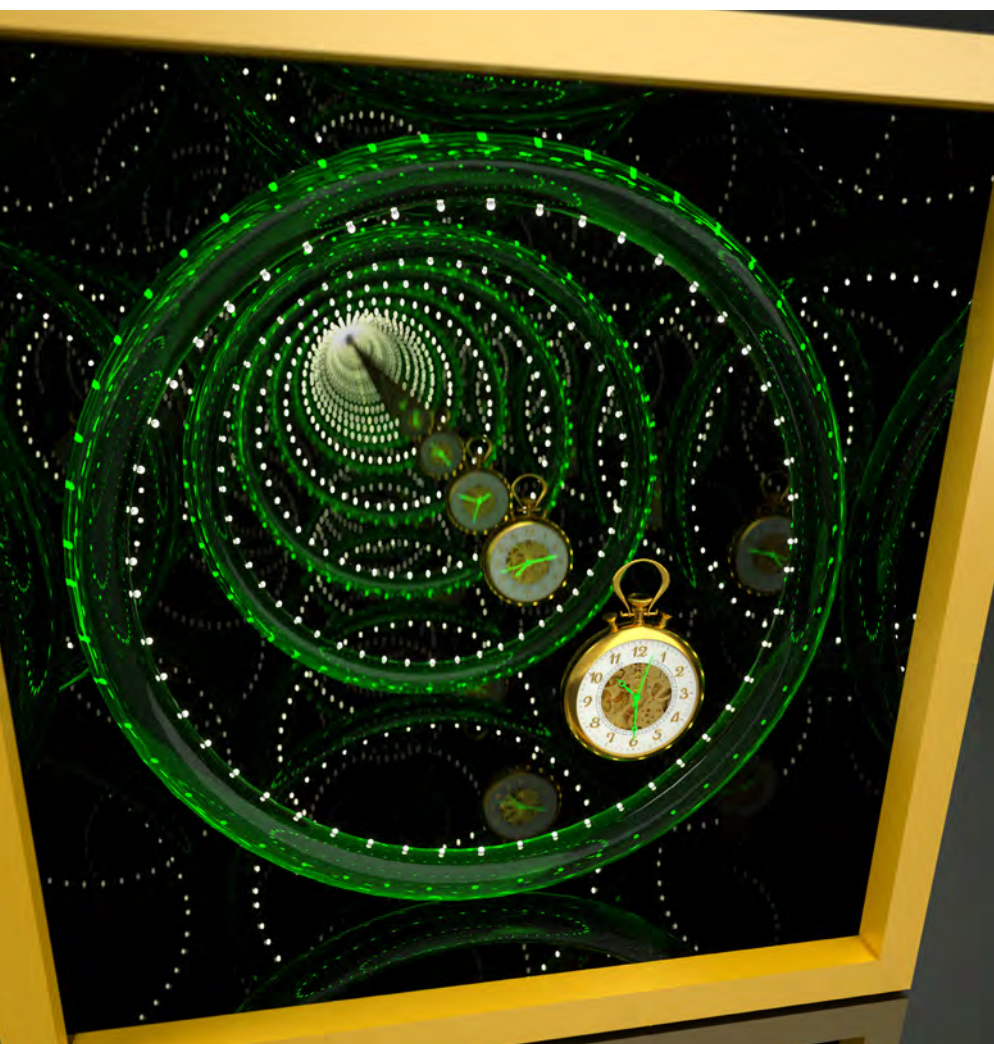
Time of flight: MIT researchers have developed novel photography optics, dubbed time-folded optics, that captures images based on the timing of reflecting light inside the lens, instead of the traditional approach that relies on the arrangement of optical components. The invention opens doors for new capabilities for ultrafast time- or depth-sensitive cameras.

Image courtesy of the researchers.

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Novel optics for ultrafast camera creates new imaging methods

image, as well as different stages of the light signal, each coded at a different time, as the signal changes shape to produce the image. Heshmat noted, "The first few shots will be blurry, but after several round trips the target object will come into focus".

This new architecture could be useful,

Heshmat says, in designing more compact telescope lenses that capture, say, ultrafast signals from space, or for designing smaller and lighter lenses for satellites to image the surface of the ground.

Multizoom and multicolor

The researchers have imaged two patterns spaced about 500mm apart from each other, but each within line of sight of the camera. An "X" pattern was 550mm from the lens, and a "II" pattern was 40mm from the lens. By precisely rearranging the optics, in part, by placing the lens in between

Mirror man: Barmak Heshmat simulates the principle of time-folded optics.

the two mirrors, they shaped the light in a way that each round trip created a new magnification in a single image acquisition.

The researchers then demonstrated an ultrafast multispectral camera. They designed two color-reflecting mirrors and a broadband mirror — one tuned to reflect one color, set closer to the lens, and one tuned to reflect a second color, set farther back from the lens. They imaged a mask with an "A" and "B," with the A illuminated the second color and the B illuminated the first color, both for a few tenths of a picosecond.

Heshmat commented that the work "opens doors for many different optics designs by tweaking the cavity spacing, or by using different types of cavities, sensors, and lenses. The core message is that when you have a camera that is fast, or has a depth sensor, you don't need to design optics the way you did for old cameras. You can do much more with the optics by looking at them at the right time."

This work "exploits the time dimension to achieve new functionalities in ultrafast cameras that utilize pulsed laser illumination. This opens up a new way to design imaging systems," said Bahram Jalali, director of the Photonics Laboratory and a professor of electrical and computer engineering at the University of California at Berkeley. "Ultrafast imaging makes it possible to see through diffusive media, such as tissue, and this work hold promise for improving medical imaging in particular for intraoperative microscopes."

Matthew Peach, Contributing Editor, optics.org
http://optics.org/news/9/8/28

optics.org: Contact Rob Fisher, Advertising Sales tel: +44 (0)117 905 5330 fax: +44 (0)117 905 5331 email: rob.fisher@optics.org

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FLIR ticks up as earnings rise

Continued strength in machine vision and elsewhere sees stock price hit all-time high.

Thermal imaging giant FLIR Systems has reported a sharp increase in earnings for its latest financial quarter, sending the US company's stock price to an all-time high during its 25 years on the Nasdaq index.

At $453 million, revenues in the second quarter of 2018 were up 4 per cent on the same period last year – with organic growth significantly higher at 11 per cent when the recent sale of FLIR's security business is taken into account.

But there was greater traction on the bottom line as FLIR's net earnings jumped almost one-third, to $71.6 million. Those figures and a slight upward shift in the company's sales guidance for the full year cheered the markets, sending FLIR's stock price up nearly 10 per cent and to its highest valuation since the company floated on the Nasdaq back in 1993.

Automotive dataset

CEO Jim Cannon highlighted a wealth of new products released over the past few months, including the availability of a "machine learning thermal dataset" aimed at advanced driver assistance systems and self-driving vehicles in development.

"Featuring a compilation of more than 10,000 thermal images, it's the first of its kind to include annotations for cars, other vehicles, people, bicycles and even dogs," he told an analyst call. "The machine learning thermal dataset enables automotive researchers and developers to accelerate testing of thermal sensors on self-driving systems."

Cannon added: "Recent high-profile autonomous driving-related accidents show a clear need for affordable, intelligent thermal sensors to enable safer autonomous vehicles."

Of FLIR's three business units the industrial division provided the sharpest growth

in the latest quarter, with sales up 14 per cent year-on-year to $188 million thanks to particular strength in optical gas imaging, unmanned aerial systems, and automotive applications.

Cannon, who says that the current momentum will continue through the second half of the year, remains focused on refining the company's product portfolios in some areas, and streamlining operations to ensure that product backlogs and lead times are kept under control.

Machine vision targets

The CEO also highlighted how machine vision has become a key part of FLIR's industrial business unit since its acquisition of camera firm Point Grey Research back in 2016.

The former Point Grey business registered what Cannon described as "tremendous"

growth in 2017 – largely thanks to a welter of new smart phone launches that had prompted investment in production lines fitted with machine vision.

This year has proved something of an "off" year in terms of smart phones thus far, but the FLIR unit is still registering growth – partly because of that control over backlogs. Cannon said: "So while we've seen some other competitors in that space have flattish growth because the comp[arison versus 2017] again is so strong, our business is continuing to grow and benefiting from the lead time reductions that we've had."

He also indicated that FLIR would look to further build its presence in the machine vision sector, telling the analyst call:

"We are acquisitive in that area, and we're looking for opportunities. It's a very fragmented market space in some cases with a lot of regional players involved as well. But you can expect to see us continue to be very active, looking for more Point Grey-like targets to consolidate the market space."

Mike Hatcher, Contributing Editor, optics.org
http://optics.org/news/9/7/44

optics.org: Contact Rob Fisher, Advertising Sales   tel: +44 (0)117 905 5330   fax: +44 (0)117 905 5331   email: rob.fisher@optics.org

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Zeiss APEER: a cloud based digital solutions platform

Optics giant develops package for managing image processing workflows.

For the past 170 years, since Carl Zeiss fabricated the first optical microscope, the microscopy industry has made incredible contributions that led to revolutionary breakthroughs in science and technology. Innovations enabled by microscopy affected our daily lives with advancements in fields like electronics, energy, construction, medicine, and nanotechnology.

Modern microscopes have broadened the scope of research making it impossible for any single organization to address all applications. New developments in software made it possible to address some of these applications. However, each researcher has unique needs and no single software offers exact solution to their specific jobs. Some code-savvy researchers write custom software but they make up only a tiny fraction of the vast research community.

As a result, most researchers use multiple disconnected software packages to stitch together a complicated workflow. The cobbled-together workflow makes it impossible to repeat experiments, not only by others but also by the same researcher. In addition, significant amount of valuable research time is wasted in converting file formats and moving data from one piece of software to another.

APEER appears

To address these and many more challenges faced by today's researcher, ZEISS initiated APEER, the cloud based digital solutions platform. APEER enables researchers to create and customize image processing and data analysis workflows for their specific jobs – all the way from image acquisition to reporting.

It offers infrastructure necessary for researchers to develop custom 'modules' using a scripting language of their choice. These reusable modules can be easily combined to create workflows for various tasks. Researchers can choose to keep their modules private for personal use or share them with the APEER community. Researchers also have a choice of making their source code public to create an open source module.

APEER is a cloud solution, which makes it easy for researchers to have access to their data all the time and also to execute workflows and scale computational resources on demand. In the digital age, there is no need for researchers to spend money upgrading their workstations every couple of years.

While the application scope is unlimited, the early version of APEER is well suited for microscopy related applications for the academic researcher. Currently there are over 50 public modules for various tasks including, microscope connectivity, image format conversion, basic image processing, and advanced machine learning & machine vision modules for event detection. The data handover between modules in a workflow happens automatically and settings & results are stored for every experiment making them highly repeatable.

The following figure illustrates a sample workflow being built using the workflow builder on APEER. This workflow detects and analyzes additive manufacturing powder particles in microscope images using five separate yet connected modules.

APEER currently hosts about 300 active users. Today's early version of APEER is free to use and open to anyone from North America, Europe, and India. Interested candidates can join the APEER community by signing up at **www.apeer.com**.

Matthew Peach, Contributing Editor, optics.org

optics.org: Contact Rob Fisher, Advertising Sales tel: +44 (0)117 905 5330   fax: +44 (0)117 905 5331   email: rob.fisher@optics.org

SPIE.

Compact hyperspectral system captures '5-D' images

Temporal, spatial and optical properties of targets give researchers a big picture of materials and living tissues.

Researchers working in Jena, Germany, have developed a compact imaging system that can measure the shape and light-reflection properties of objects with high speed and accuracy. This so-called "5D" hyperspectral imaging system—which captures multiple wavelengths of light (1D…) plus spatial coordinates (+3D…) as a function of time (+1D = 5D) —could benefit a variety of applications including optical-based sorting of products and identifying people in secure areas of airports.

The researchers say that with further miniaturization, the imager could enable smartphone-based inspection in applications such as fruit ripeness testing, or in personal medical monitoring.

"Because our imaging system does not require contact with the object, it can be used to record historically valuable artefacts or artwork," commented research team leader Stefan Heist of Friedrich Schiller University Jena and Fraunhofer Institute for Applied Optics and Precision Engineering (IOF), also in Jena.

"This approach can be used to create a detailed and accurate digital archive, he added, while also allowing study of the object's material composition." Hyperspectral imagers detect dozens to hundreds of colors, or wavelengths, instead of the three detected by normal cameras. Each pixel of a traditional hyperspectral image contains wavelength-dependent radiation intensity over a specific range linked to two-dimensional coordinates.

The new hyperspectral imaging system, developed in collaboration with Gunther Notni's research group from Germany's Ilmenau University of Technology, advances this imaging approach by acquiring additional dimension information. The work is described in a new paper in Optics Express, in which the researchers describe how each pixel acquired by their new 5D hyperspectral imager contains the time; x, y and z spatial coordinates; and information based on light reflectance in visible through NIR wavelengths.
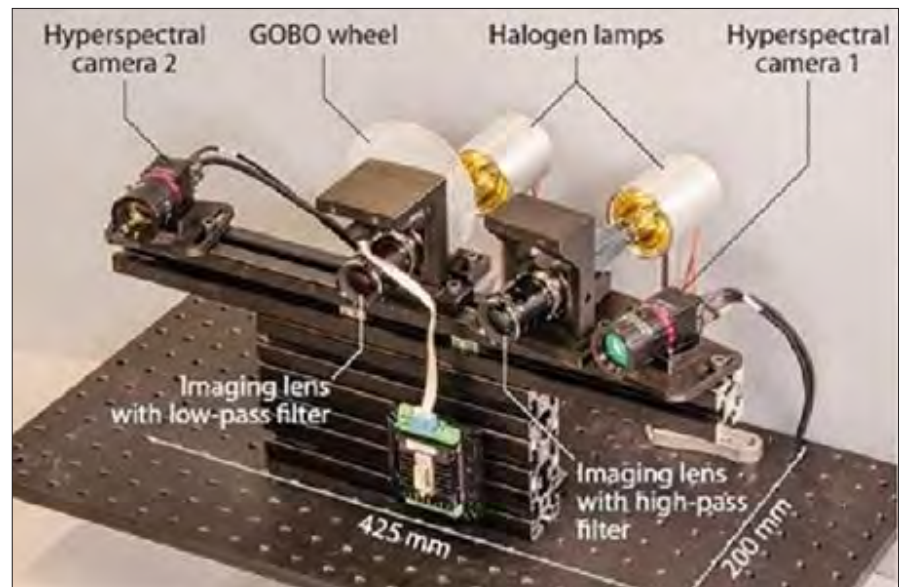
Fifth dimension: hyperspectral imager contains two cameras and measures just 425x200mm. With further miniaturization it could be incorporated into smartphones for personal use.

Image: Stefan Heist, Friedrich Schiller University / Fraunhofer IOF.

This allows 3-D reconstruction of the surface. Spectral information obtained by the different channels of the hyperspectral cameras are then mapped onto these points.

"Our earlier development of a system projecting aperiodic patterns by a rotating wheel made it possible to project pattern sequences at potentially very high frame rates and outside the visible spectral range," said Heist. "New hyperspectral snapshot cameras were also an important component because

Heist added, "State-of-the-art systems that can determine both the shape of the objects and their spectral properties are based on multiple sensors, offer low accuracy or require long measurement times. In contrast, our approach combines excellent spatial and spectral resolution, great depth accuracy and high frame rates in a single compact system."

Compact prototype

The researchers created a prototype system with a footprint of just 200 x 425 mm—about the size of a laptop. It uses two hyperspectral snapshot cameras to form 3D images and obtain depth information. By identifying particular points on the object's surface that are present in both camera views, a complete set of data points in space for that object can be created. However, this approach only works if the object has enough texture or structure to unambiguously identify points.

To capture both spectral information and the surface shape of objects that may not be highly texturized or structured the researchers have incorporated a specially developed high-speed projector into their system. Using a mechanical projection method, a series of aperiodic light patterns artificially texture the target object's surface.

they allow spatially and spectrally resolved information to be captured in a single image, without any scanning."

High-speed hyperspectral

The researchers characterized their prototype by analyzing the spectral behavior of the cameras and the 3D performance of the entire system. They showed that it could capture visible to near-infrared 5D images as fast as 17 frames per second, significantly faster than other similar systems.

To demonstrate the usefulness of the prototype to analyze culturally significant objects, the researchers used it to digitally document a historical relief globe from 1885. They also created near-infrared 5D models of a person's hand and showed that the system could be used as a simple way to detect veins. The imager could also be used for agricultural applications, which the researchers showed by using it to capture the 5D change in reflection spectrum of citrus plant leaves as they were absorbing water.

Matthew Peach, Contributing Editor, optics.org

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LG Innotek makes a move into thermal imaging

Korean maker of LEDs and displays looking to reduce cost of technology with in-house sensors and camera modules.

LG Innotek, the Korea-headquartered electronic component manufacturer, has revealed plans to enter the market for thermal imaging technology.

The company said it was already working with domestic firms on sensor development, and added that it would accelerate in-house work on core technologies including thermal imaging camera modules.

$3.3 billion this year to some $4.4 billion in 2022, LG Innotek sees cost reduction as critical for the technology to move beyond its traditional applications in the defense sector.

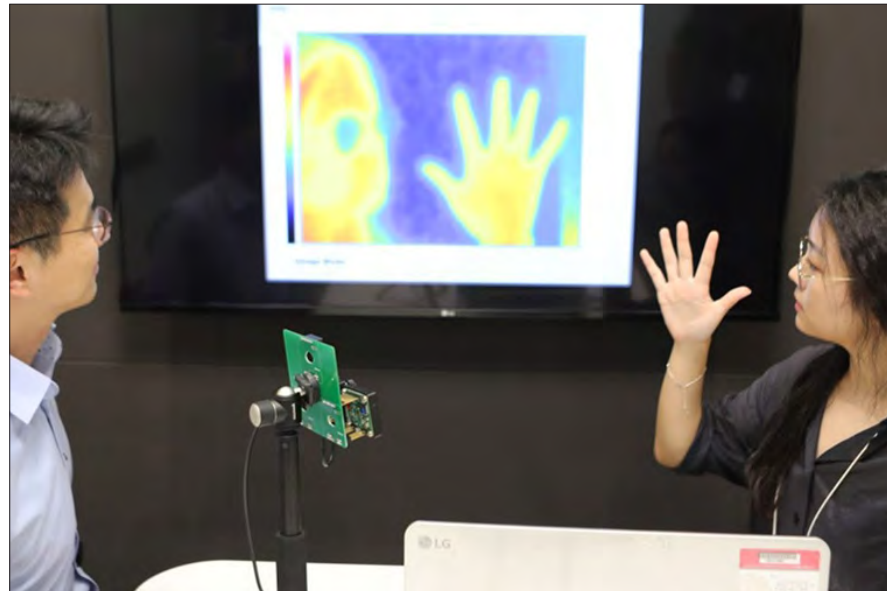"LG Innotek intends to make inroads into the market with thermal imaging camera modules, whose thermal sensing and image processing performance and price competitiveness have been greatly enhanced by the innovative technologies," announced the Seoul-headquartered firm, which is aiming to launch its first original products in the second half of 2019.

"Recently, the company started the joint development of the next-generation thermal imaging sensor together with Truwin," added LG Innotek. Daejon-based Truwin is largely focused on automotive electronic components, including actuators and air pressure sensors.

But LG Innotek says that its new partner also has expertise in the area of infrared sensors, and that by working together it will be able to produce "world-class quality" in the design and production of thermal imaging camera modules.

"This is because the structure and manufacturing process of this module is similar to those of the smart phone camera module," added the firm. "The company has been the number one in the global smart phone camera module market for seven consecutive years."

Personalized cooling

LG Innotek thinks that by improving the performance and reducing the cost of thermal imagers it will rapidly expand the number of viable application areas. "The first goal is to expand the market from military application to non-military applications such as home appliances, automobiles, and drones," it stated.

One suggested new application is personalized air conditioning, where cooling power can be optimized according to the body temperature of an individual – as monitored with the thermal camera.

Unsurprisingly, LG Innotek is also hopeful of penetrating the growing market for advanced driver assistance system (ADAS) and the emerging area of autonomous driving.

Company CEO Park Jong-seok summed up: "The thermal imaging camera module is a product that can make our life safer and more convenient. We will continue to release competitive thermal imaging camera modules so that they can be utilized more widely in various areas."

Mike Hatcher, Contributing Editor, optics.org

http://optics.org/news/9/8/42

Already a key supplier of camera modules for smart phones, LG Innotek wants to enter the market for thermal imaging - incorporating in-house developed sensors.

Photo: LG Innotek.

Beyond defense

Quoting figures from the French market research company Yole Développement suggesting that global sales of thermal imaging cameras will grow from around

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SPIE.

SiOnyx launches day-night 'action' camera

Aurora said to turns night into full-color daylight, features OLED display, IP67 protection and AR-compatibility.

Aurora is based on SiOnyx's Ultra Low Light technology.

SiOnyx, based in Beverly, MA, a developer of infrared imaging technology has launched the Aurora, which it claims is the only HD action video camera with true day and night color imaging. The camera made its public debut at the Outdoor Retail Show, in Denver, CO, which concludes today.

Available in August, direct from SiOnyx for $799, the Aurora, which weighs 8 ounces (225g) and fits in one hand, is based on SiOnyx's patented Ultra Low Light technology. The company claims such low-light performance was previously only available "in the highest-end night vision optics costing tens of thousands of dollars."

SiOnyx has developed a new semiconductor process that enhances the infrared sensitivity of silicon-based imaging. Its ultra low-light technology enables richly-defined color images and video during the day and twilight, combined with unmatched high-resolution viewing in near total darkness.

Immediate and rugged

Through the free companion apps on iOS and Android, users can review their experiences in real-time or control the Aurora directly from a smart phone. The camera is also designed for active outdoor use: the camera is certified with an IP67 waterproof rating.

Suggested uses include "boating, hunting, fishing, nature watching, emergency response and other activities where clear night-vision is of importance. The Aurora uses GPS combined with an accelerometer and compass to accurately guide users, in day or night time.

Stephen Saylor, President and CEO of SiOnyx, commented, "Outdoor enthusiasts play day and night; capturing those adventures doesn't need to stop when the sun goes down. The Aurora's Ultra Low Light technology enables night video that people will swear was taken in full daylight."

SiOnyx was founded in 2006 by Professor Eric Mazur and Dr. James Carey of Harvard University. The company has commercialized a patented semiconductor process that dramatically enhances the sensitivity of silicon-based photonics.

SiOnyx's platform is said to represent a significant breakthrough in the development of smaller, lower cost, high-performing photonic devices in applications ranging from simple light detection to advanced digital imaging and more. The company markets its low-light technology under the XQE family of CMOS images sensors and has also entered the consumer electronics market with the launch of the Aurora day/night action camera.

Matthew Peach, Contributing Editor, optics.org

http://optics.org/news/9/7/42

CMOS image sensor sales 'set for further strong growth' – analyst

Yole Dévelopement raises CIS forecasts again through 2022 with growth seen in all segments except computing.

Market analyst Yole Développement has published its annual Status of the CMOS Image Sensor Industry report on the "CIS" industry, which covers the period 2017 to 2023.

The report's headline figure is that in 2017 the CIS market achieved sales of $13.9 billion. Yole is also forecasting that the CIS sector will enjoy a 9.4% CAGR between 2017 and 2023, "driven mainly by smartphones integrating additional cameras to support functionalities like optical zoom, biometry, and 3D interactions".

As well as giving a clear picture of the CIS ecosystem and its prospects, the Yole analysts also give a detailed description of recent M&A activities, an overview of the dual and 3D camera trends for mobile devices. Mobile and consumer applications are also detailed, "with a deep added-value section focused on technology evolution."

"2017 was an excellent year for CIS, with growth seen in all segments except for computing," commented Pierre Cambou, Principal Analyst, Technology & Market, Imaging at Yole. "Driven by new applications, the industry's future remains on a strong footing."

In collaboration with Jean-Luc Jaffard, formerly at STMicroelectronics and part of Red Belt Conseil, Cambou has conducted an investigation into this sector for the past year. Cambou commented, "Within five years we at Yole believe CIS sales will almost double to more than $23 billion per year. Year-on-year growth will peak at about 20% due to the exceptional increase in image sensor value, across almost all markets, but primarily in the mobile sector."

Key players and shares

In the CIS sector, revenue is dominated by mobile, consumer, and computing, which represent 85% of total 2017 CIS revenue. Mobile alone represents 69%. Security is the second-largest segment, behind automotive.

The CIS ecosystem is currently led by the three Asian heavyweights: Sony, Samsung, and Omnivision. Europe has made a noticeable comeback, Yole notes. Meanwhile, the US maintains a presence in the high-end sector.

The market has benefited significantly from the operational recovery of leading CIS player Sony, which captured 42% market share, state the report authors.

"Apple's iPhone has had a tremendous effect on the semiconductor industry, and on imaging in particular," commented Pierre Cambou in his article Image sensors benefit hugely from Apple's avant-garde strategy posted on i-micronews.com.

"The iPhone offered an opportunity for its main supplier, Sony, to reach new highs in the CIS process, building on its early advances in high-end digital photography."

TheYole report continues, "The CIS industry can grow at the speed of the global semiconductor industry, which also had a record year (in 2017), mainly due to DRAM revenue growth. CIS have become a key segment of the broader semiconductor industry, featuring in the strategy of most key players, and particularly the newly-crowned industry leader Samsung. Mobile, security and automotive markets are all in the middle of booming expansion, mostly benefiting ON Semiconductor and Omnivision."

Yole concludes that these markets are "boosting most players that can keep pace with technology and capacity development through capital expenditure." It added, "There are opportunities all across the board, with new players able to climb the rankings, such as STMicroelectronics and Smartsense. Technology advancement and the switch from imaging to sensing is fostering innovation at multiple levels: pixel, chip, wafer, all the way through to the system."
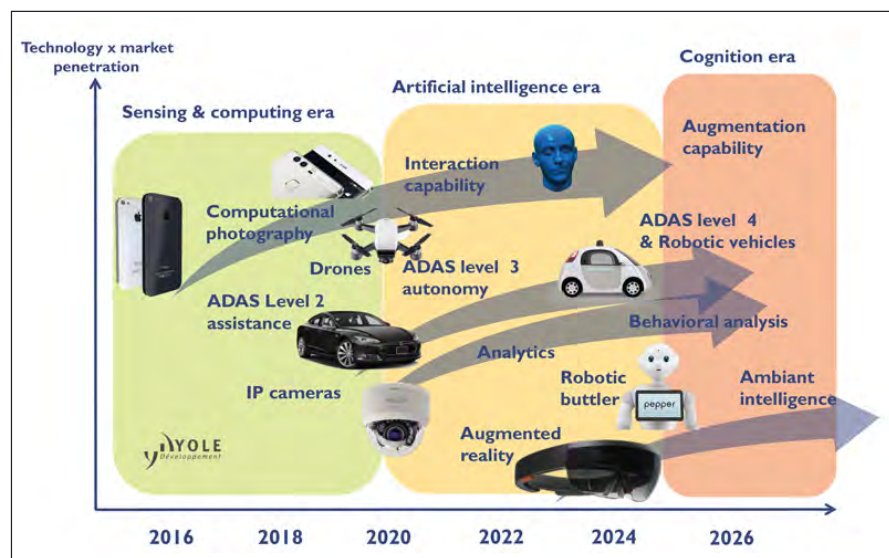

Image: Yole (2018)

*Yole's expectations of what is next for image sensing.*

CMOS image sensor sales 'set for further strong growth' – analyst

CIS sensors are also now at the forefront of 3D semiconductor approaches. They are a main driver in the development of artificial intelligence. Yole's analysts foresee new techniques and new applications all ready to keep up the market growth momentum.

Matthew Peach, Contributing Editor, optics.org

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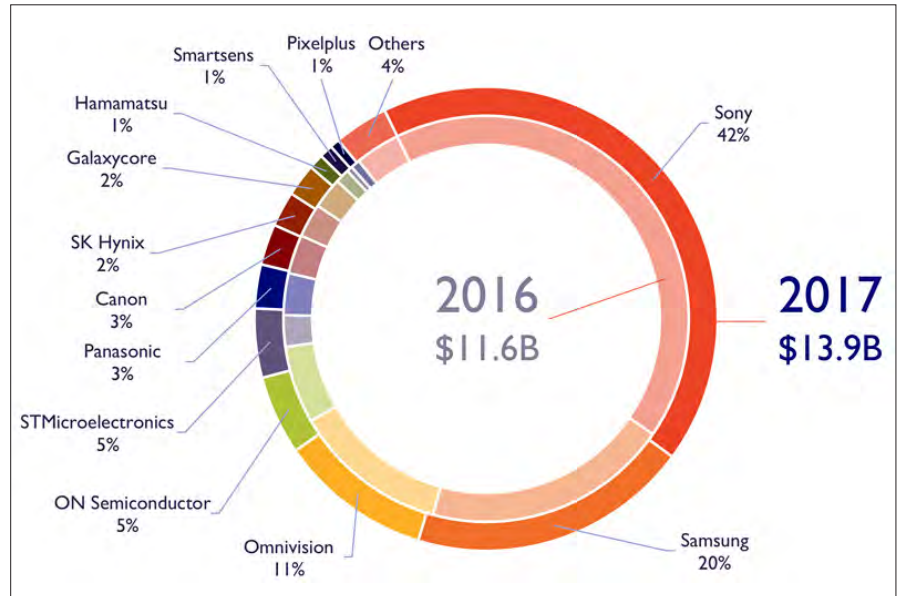
Figures: Yole (2018).

Diverse market: CIS market revenue shares 2016-17 by supplier.

Frankfurt Laser Company
Vision 2018
Hall 1 – Booth#1G89

New High Power Line Laser Modules

The ML2040-Series deliver high output power of up to 2W and are ideal for the use in industrial applications with harsh environmental conditions.

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SILIOS Technologies
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The New SILIOS' 4 Mpx compact lightweight Multispectral cameras, the CMS4 Series, unveiled at VISION 2018

These VIS/NIR snapshot multispectral cameras, based on the proprietary COLOR-SHADES® technology, offer the same excellent spectral features as the 1.3Mpx CMS Series and 4 times more spatial resolution.

The CMS4 cameras include a 3x3 mosaic filter (8 wavelengths plus 1 B&W) and offer USB3.0 or GigE interfaces.

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contact@first-light.fr
Tel : +33 (0) 4 42 61 29 20

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optics.org: Contact Rob Fisher, Advertising Sales tel: +44 (0)117 905 5330   fax: +44 (0)117 905 5331   email: rob.fisher@optics.org

SPIE.

Machine learning meets machine vision

At September's AutoSens Conference in Brussels, Belgium, the Canadian firm Algolux launched a pair of new products aimed at improving autonomous vision technology through machine learning.

The Montreal company, bolstered by a $10 million series A funding round back in May, revealed details of its forthcoming "NaturalIQ" package, as well as a new version of its "CRISP-ML" approach to camera tuning with embedded vision systems.

NaturalIQ is intended to overcome the difficulties in achieving a natural look with embedded cameras, enabling users to tune against a dataset of their preferred image types. "This image dataset can be easily created with photo editing tools or captured with a best-in-class camera of choice, dramatically simplifying the subjective tuning process," claims the company, which emerged from the TandemLaunch startup "foundry" in Montreal and has attracted backing from General Motors Ventures, among others.

Algolux says that the NaturalIQ software is currently in initial trials, with availability slated for the end of the year and the company seeking collaborators. Interested parties are invited to get in touch via the company's contact page at https://algolux.com/contact-us/

Meanwhile the "CRISP-ML" release represents the latest update to Algolux' existing package for image quality tuning through machine learning with objective metrics. "CRISP-ML can effectively combine large real-world

Photo: Algolux.

Dave Tokic, Algolux' VP of marketing and strategic partnerships, at the recent AutoSens event in Brussels.

combinations of components and operating conditions previously deemed as unfeasible, it claims, adding: "By exploiting our innovative machine-based approach, CRISP-ML automates the tuning steps that are otherwise painful, costly, and time-consuming."

At the AutoSens event in Brussels, Algolux picked up first place in the "software innovation" category during the associated awards ceremony – the latest in a string of accolades picked up by the firm in recent months as it targets the high-profile autonomous driving sector.

Commenting on the win, event organizer Robert Stead said: "One of the greatest challenges to deploying an imaging or perception system is the constraints of current tuning methodologies or even a camera system's architecture. A key reason Algolux was recognized by this award is the impact [its] groundbreaking machine learning innovations can have to reduce this challenge."
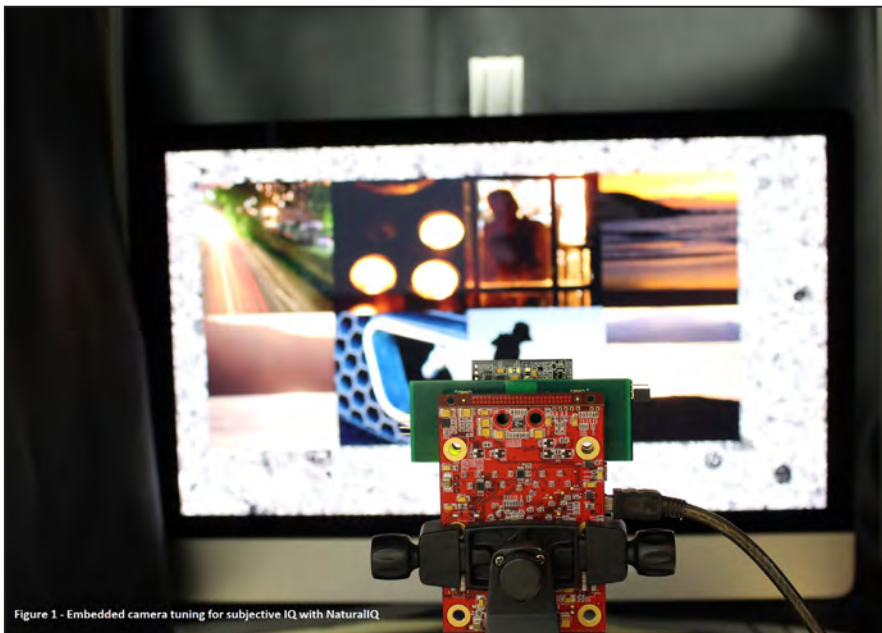
Mike Hatcher, Contributing Editor, optics.org

Figure 1 - Embedded camera tuning for subjective IQ with NaturalIQ

Photo: Algolux.

Scheduled for full release by the end of the year, Algolux' "NaturalIQ" software is designed to deliver a more natural look to images captured with autonomous embedded cameras.

It adds that the approach significantly reduces the effort and uncertainty associated with subjective image quality requirements, providing a more intuitive method for differentiating cameras and responding quickly to changing needs.

computer vision training datasets with standards-based metrics and chart-driven key performance indicators to holistically improve the performance of your vision systems," states the firm.

Image quality can be tuned across

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