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For suppliers, integrators and OEMs using machine vision

August/September 2021
Issue 106

Spectral power in waste sorting

Start-ups push 3D vision envelope

Vision Award shortlist announced

Integrating vision into smart factories

Vision Stuttgart is back!

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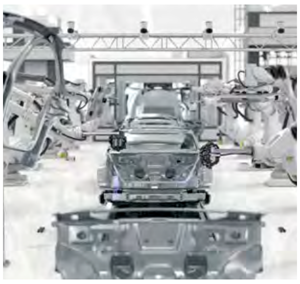
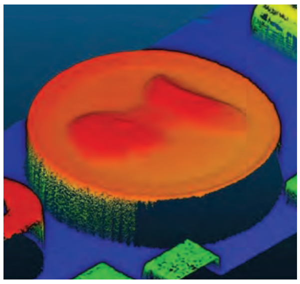
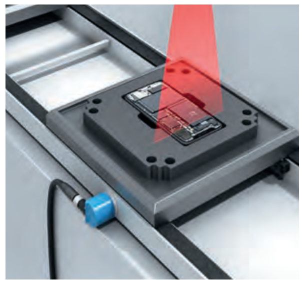

Editorial and administrative team
Editor Greg Blackman
Tel: +44 (0)1223 221042
greg.blackman@europascience.com
Technical writer Matthew Dale
Tel: +44 (0)1223 221047
matthew.dale@europascience.com
Senior designer Zöe Andrews
Tel: +44 (0)1223 221035
zoe.andrews@europascience.com
Partnership & Events Executive Charlie Mitchell
Tel: +44 (0)1223 221033
charlie.mitchell@europascience.com

Advertising team
Advertising sales manager Eleanor Waters
Tel: +44 (0)1223 221031
eleanor.waters@europascience.com
Art/production manager David Houghton
Tel: +44 (0)1223 221034
david.houghton@europascience.com

Corporate team
Managing director Warren Clark
warren.clark@europascience.com

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Leader
Greg Blackman

Back with a bang

The Vision show in Stuttgart is back and that's a cause for celebration! It'll be smaller, undoubtedly, because of travel restrictions, but there's already a lot of buzz from all the new vision technology being brought together under one roof. Plus, it's been three years since the last Vision show, so there's plenty of excitement and anticipation.

One of the highlights will be the announcement of the winner of the Vision Award. Four finalists have been selected by the jury, each of which will present their technology during a special session as part of the Industrial Vision Days on 6 October from 10.20 to 11.20am. At the end of the presentations, the jury will crown a winner. As sponsors of the award, *Imaging and Machine Vision Europe's* Warren Clark will moderate the session; the technology from all four of the shortlisted entries is detailed in this issue, starting on page 4.

Two of the four candidates shortlisted for the Vision Award are innovations based on 3D vision. On page 20 we speak to two young companies – Saccade Vision and Tridimeo – about their novel 3D vision technology, Saccade using a MEMS scanner and Tridimeo using multispectral imaging to speed up 3D vision. Page 24 also has advice from industry experts on working with 3D vision.

There's also a report on page 28 of how Canadian firm Waste Robotics is using hyperspectral imaging and robotics to sort waste, as well as feature articles on vision integration (page 32) and image processing (page 16).

All eyes will be on Stuttgart for what is sure to be a memorable and welcome return to live events for the industry.

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www.linkedin.com/showcase/imaging-and-machine-vision-europe

Four firms make Vision Award shortlist

The prize for machine vision innovation, which this year covers event-based vision, inline metrology and 3D vision, will be awarded at Vision in Stuttgart

The Austrian Institute of Technology, HD Vision Systems, Prophesee and Zeiss have been shortlisted for the Vision Award. The four entries – selected by the jury out of a total of 44 submissions – cover two 3D imaging products, event-based vision and inline metrology.

The prize for technological excellence in the field of machine vision will be awarded during the Vision show, which will take place in Stuttgart from 5 to 7 October.

Each company will present their technology during the Industrial Vision Days on 6 October, from 10.20am to 11.20am. Warren Clark, publishing director of *Imaging and Machine Vision Europe*, which sponsors the €3,000 award, will moderate the session, with a member of the judging panel crowning the overall winner at the end.

While smaller than usual, more than 260 companies will exhibit products at the trade fair, which will be one of the first major in-person shows for the machine vision industry since the beginning of the pandemic.

Xposure:Photometry – fast inline 3D surface scanner

By Ernst Bodenstorfer, Markus Clabian, Christian Kapeller, Philipp Schneider and Petra Thanner, AIT Austrian Institute of Technology

Xposure:Photometry, developed by the Austrian Institute of Technology, is a fast inline 3D surface scanner realised by a high-speed smart camera. It is designed for optical inline surface inspection tasks common in many industrial manufacturing processes.

Conventional 2D scanning methods cannot distinguish between pseudo defects – dirt on the surface of a manufactured part, for instance – and actual 3D defects, such as scratches, ridges, spikes, pinholes or wrinkles. At the same time, existing 3D inspection methods are not able to handle high speeds, neither for single objects nor for high transport speeds of endless material.

Xposure:Photometry addresses this by combining very fast photometric stereo imaging and smart camera technology to highlight inline, actual small 3D defects on the object's surface, while distinguishing them from pseudo defects.

Photometric stereo imaging is known as a shape-from-shading method for reconstructing the 3D object shape from planar images taken from multiple illumination directions. It is sensitive to small deviations in the object surface structure, derived as local changes to the surface normal vector. Photometric stereo processing inherently computes different images of the object's surface structure under different illumination directions, which highlights small 3D surface defects.

'2D scanning methods cannot distinguish between pseudo defects and actual 3D defects'

To illuminate the object, AIT typically uses a set of four fast-strobed line light sources. Xposure:Photometry can be combined with AIT's Xposure:Flash line light sources, but is also compatible with a large variety of fast-strobed, off-the-shelf line lights.

AIT's multi-line-scan camera, Xposure:Camera, is mounted above the inspected object's surface. The camera acquires every point of the object's surface four times, for the four different illumination →

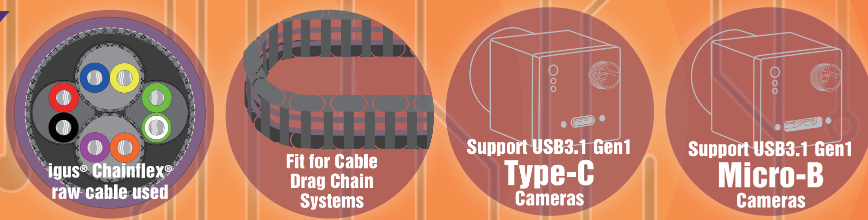
AIT Austrian Institute of Technology

The Austrian Institute of Technology's 3D surface scanner

LONG DISTANCE CONNECTION
for Automated (Machine) Vision Inspection / AOI Systems

HIGH-FLEX

Length: 1m, 2m, 3m, ····· , 20m
O.D.: 6.8mm



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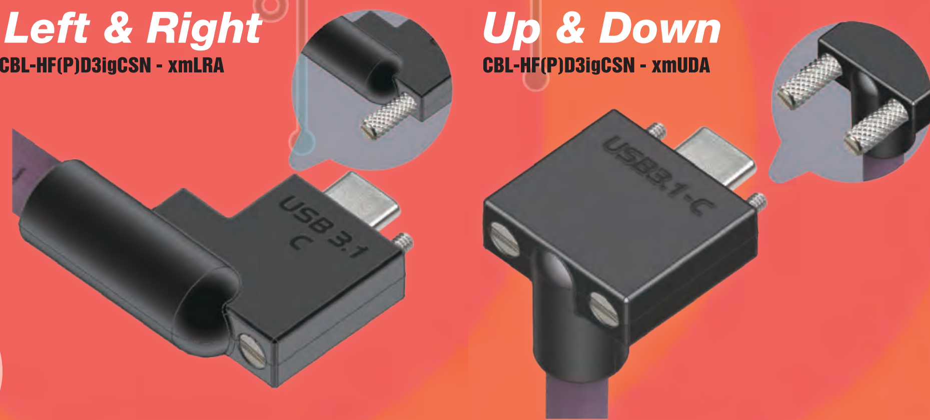
Straight A to Straight C M/M

Standard A Plug with locking screws

Angle C

Left & Right
CBL-HF(P)D3igCSN - xmLRA

Up & Down
CBL-HF(P)D3igCSN - xmUDA



USB3 (USB3.1 GEN1) MICRO-B CABLES

CBL-HFPD3igMBS - 1m, 2m, 3m   CBL-HFD3igMBS - 4m, 5m, ····· , 20m

Straight A to Straight Micro-B M/M

Standard A Plug with locking screws

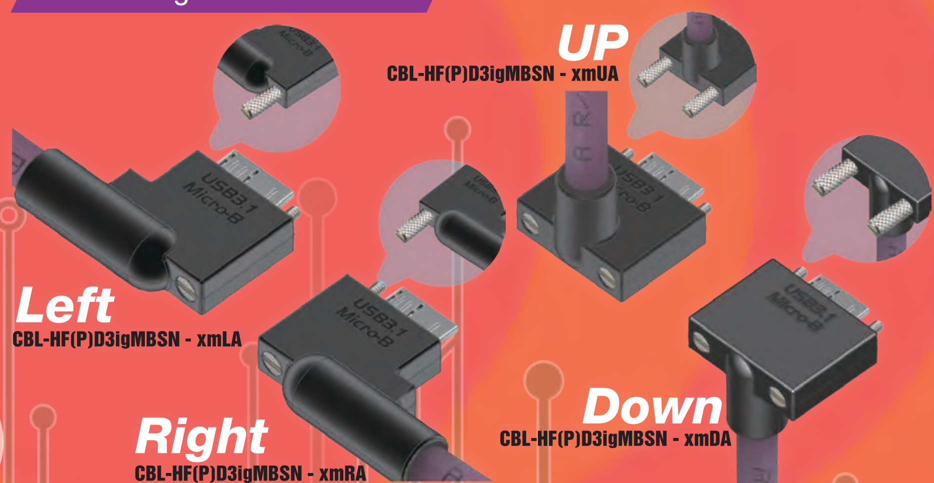
Angle Micro-B

UP
CBL-HF(P)D3igMBSN - xmUA

Left
CBL-HF(P)D3igMBSN - xmLA

Right
CBL-HF(P)D3igMBSN - xmRA

Down
CBL-HF(P)D3igMBSN - xmDA



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directions. An FPGA in the camera calculates an albedo image (conventional 2D image of the surface) and a gradient image representing the surface normal vector at each acquired surface point.

The output of the FPGA can be used for inline 3D surface inspection. Furthermore, the processing can serve as a pre-processing step to supply classical, or AI-based object classifiers, with rich photometric stereo data of the objects' surface, to make the classifiers more discriminative.

Xposure:Photometry combines 2D high-speed capture with on-camera 3D surface capture which, to AIT's knowledge, is currently not on the market. When 1D surface gradients are enough, the system can reach 300kHz acquisition speed using two light directions. When full 2D surface gradients are required, 200kHz is reached using three light directions. Finally, when targeting optimal, 3D information of the surface structure, the system can run at 150kHz using four light directions.

In its high-precision configuration, Xposure:Photometry delivers lines with 2,048 pixels width at a line rate of 150kHz, and with a 300kHz line rate for a lower precision configuration. Potential applications include: wire inspection, where material defects on the surface of wires can be identified as they are drawn at speeds of 100m/s; print inspection, such as inspecting passports, banknotes or other high-quality printed material; traffic infrastructure monitoring; and inspecting battery electrodes, which are made of a very dark material – Xposure:Photometry is sensitive to differences in greyscale value and therefore able to detect defects like scratches and pinholes on dark surfaces.

Prophesee

Prophesee's evaluation kit

Prophesee Metavision technology: a comprehensive event-based sensing and software solution

By Christoph Posch, Prophesee

The Metavision platform provides developers of machine vision applications with a complete solution to implement event-based vision in their systems. It is particularly well suited for applications in high-speed quality control, inspection and analytics, but has proven to have unique capabilities in other areas too, including to help restore or enhance vision in people with conditions that impair their sight.

Event-based vision is a paradigm-shift in imaging addressing the limitations of traditional frame-based cameras. It is based on how the human eye records and interprets visual inputs. The sensors facilitate machine vision by recording changes in the scene, rather than recording the entire scene at regular intervals.

Specific advantages over frame-based approaches include better dynamic range (>120dB), reduced data generation (10x-1,000x less than conventional approaches) leading to lower transfer or processing requirements, and higher temporal resolution (microsecond time resolution – that is, >10k images per second time resolution equivalent). Other advantages are low-light imaging, down to 0.08 lx, and power efficiency, with just 3nW per event and 26mW at sensor level.

At the core of the innovation is the Metavision sensor, a thirdigeneration 640 x 480 VGA event-based sensor. Inspired by the →

Easy pick-and-place for complex objects combining light field technology with artificial intelligence

By Dr Christoph Garbe, HD Vision Systems

LumiScan Object Handling version two and its 3D sensor, LumiScanX, provide an industrial approach to light field 3D imaging. The system is able to image glossy or shiny parts, while also reducing occlusions on objects. Thus, the light field sensor is well suited to inspecting complex objects, such as forged parts, semi-transparent pieces or blunt plastic. At the same time, the compact multi-camera-array consisting of 13 lenses provides more precise information than conventional 3D imaging methods.

On the software side, pre-configured and pre-trained neural networks are used for the vision task. The user can fine-tune the algorithm on labelled images of their parts with the help of intuitive software. If a workpiece has to be picked up in one way and put down upright, for example, staff can simply mark these areas via a drag-and-drop tool in the software. After training, the software learns to locate the objects in the image and determines possible grip points. This information is then used to calculate and send passive way points to a connected PLC or robot controller.

In addition, through LumiScan Object Handling, the sensor can be installed and calibrated in less than two minutes.

Complex objects can now be fully automated with robot pick-and-place using LumiScan Object Handling. The solution can be used for a variety of object detection and object handling tasks in manufacturing.

Alongside numerous applications for

'The light field sensor is well suited to inspecting complex objects'

forged parts in automotive, LumiScan Object Handling version two is also able to automate picking and clearing unsorted bagged goods. Here, the system not only detects the form of unstable bags and their orientation, but also delivers the corresponding information to the robot controller. The bags can then be placed accordingly into the machine and cut open.

→ human retina, each pixel of the Metavision sensor embeds its own intelligence and activates themselves independently, triggering events.

Prophesee has also partnered with Sony Semiconductor Solutions to integrate the Prophesee advantages with a new generation stacked, event-based vision sensor, co-developed with Sony. Prophesee has released two evaluation kits that give developers early access to the sensor, which features 4.86μm pixel pitch and 1,280 x 720 pixel resolution.

Key to implementing the Prophesee solution is the Metavision Intelligence Software Suite. It can be used to perform a variety of design exploration steps and incorporate customised software to meet specific market requirements.

Use cases for the two sensors include high-speed counting, vibration monitoring, object tracking, particle size monitoring and other critical, vision-enabled processes in manufacturing, assembly, logistics, quality control and inspection. As one example, the platform can be used to improve predictive maintenance by measuring and monitoring equipment vibrations from 1Hz to 10kHz remotely, continuously and in real time under normal lighting conditions.

In automotive and mobility, DTS from Xperi has used the sensor to develop a neuromorphic driver monitoring solution, registering saccadic eye movement and micro-expressions. In addition, VoxelFlow, developed by Terranet in conjunction with Mercedes-Benz, uses Metavision to enhance existing radar, lidar and camera systems for autonomous driving.

Another outstanding application of neuromorphic event-based vision can be witnessed in the study conducted by Gensight Biologics. The study, published in

'The Metavision Intelligence Software Suite can be used to improve predictive maintenance'

Nature Medicine, is the first case reported of partial recovery of visual function in a blind patient with late-stage retinitis pigmentosa. The patient is the subject of the ongoing trial of GenSight Biologics' GS030 optogenetic therapy. The study combines gene therapy with a light-stimulating medical device in the form of goggles that uses Prophesee's Metavision sensing technologies.

Zeiss AICell trace – a revolutionary generation of inline measurement technology

By Manuel Schmid, Carl Zeiss Automated Inspection

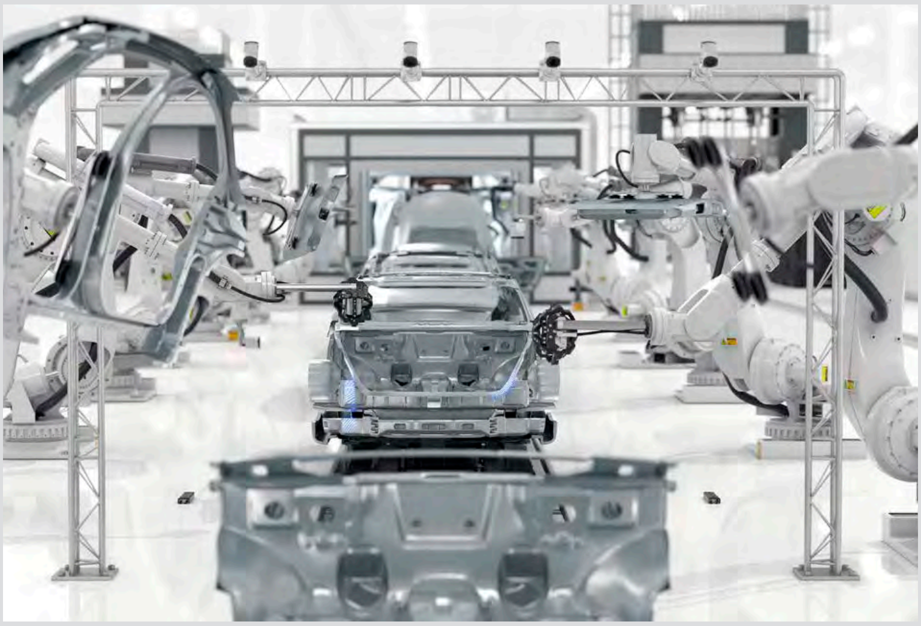
The new generation of inline measuring technology, Zeiss AICell trace, forms the basis for the Zeiss strategy, 'Metrology goes inline.' It provides improved quality assurance in the automotive sector with regard to productivity, efficiency and economic sustainability.

Previously, it was mainly only process control that was carried out on the production line. Now, Zeiss' inline measuring system opens up real traceable metrology tasks in accordance with DIN-standards directly on the production line

'By using this new technology, absolute inline measurement results can be achieved'

which, in the past, were only possible with CMMs in dedicated measurement rooms.

By bundling process control and inline metrology in one single cell, Zeiss AICell trace opens up new possibilities for customers when defining quality assurance strategies. The system provides high-precision digital quality information through point cloud-based feature detection in real time. The system contains the following components: fixed floor markers with integrated LEDs that act as a temperature-independent reference in the coordinate system; tracking cameras that capture both the exact position of the sensors in each measurement position, as well as their own position; and the Carbon Fiber Navigation Tool with integrated active LEDs which forms a fixed unit with the 3D point cloud sensor, AIMax Cloud.


Zeiss

Zeiss' AICell trace measurement system

By using this new optical tracking technology in combination with the AIMax Cloud sensor, absolute inline measurement results can be achieved that were previously not possible on car body construction lines.

This opens up the potential for cost saving and process optimisation, thanks to the ability to carry out traceable inline measurements in the production environment. The automotive industry is currently going through a radical change, with the shift from the combustion engine to e-mobility, as well as an increase in efficiency in factories and the digital transformation of production plants.

To implement these changes as quickly as possible, the original equipment manufacturers have set up various strategy programmes, some incorporating the new Zeiss inline metrology solution. Zeiss has already implemented this inline measurement technology several times at stations with individual components, sub-assemblies and for complete car bodies for customers in the body shop.

Zeiss is also working with Gom to integrate digital inline metrology products into the production lines of car body shops.

The return of Vision!

Here's some of what to expect when the trade fair opens its doors

Messe Stuttgart

More than 260 companies are expected to take part in the Vision trade fair when it takes place from 5 to 7 October in Stuttgart.

This will be the first major live event for the European vision sector since the pandemic began. 'After this enforced break, we the exhibitors and Messe Stuttgart can jointly send a positive signal to the international market and the economy, and show that the machine vision industry is looking to the future with optimism,' said Alexander van der Lof, chief executive of the TKH Group.

'Face-to-face meetings at trade shows are, and will remain, immensely important for interaction and networking. That is why Vision 2021 is an indispensable platform,' added Martin Grzymek, director sales Europe at Teledyne.

Messe Stuttgart believes around one in two exhibitors will be from outside of Germany. The show will be smaller – 472 exhibitors from 31 countries presented technology at the 2018 fair, with 11,106 visitors attending – and the assumption is the fair will have a much more European character this year.

In addition to the joint stand for young companies from Germany, funded by the German Federal Ministry of Economics and Energy (BMWi), Messe Stuttgart will premiere Vision Start-up World.

Christoph Garbe, managing shareholder of HD Vision Systems, one of the Start-up World exhibitors, said: 'The trade fair will not only provide us with a platform for our products and solutions, [but] it will also be a valuable channel to understand and examine the needs of our customers.'

HD Vision Systems, which was named Vision Start-up of the Year in 2020, and is shortlisted for the Vision Award, is planning to present its latest generation of 3D camera based on light field technology in combination with AI algorithms.

The trade fair will also feature an integration area, with integrators like Compar, Euclid Labs and ISW exhibiting. Technology presentations will be held during the Industrial Vision Days forum, organised in combination with the VDMA and will be streamed live and on-demand for the first time.

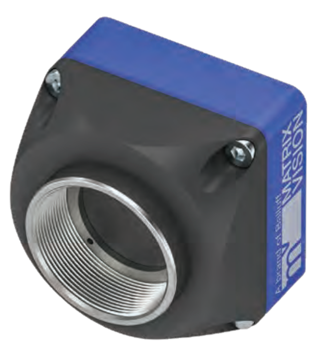
Exhibitors

The latest telecentric lenses from **Opto Engineering** (hall 8, D48) will be on show, including the TCEL series featuring optics with integrated liquid lens technology. Also shown will be the firm's 360°-view PCHIAF lenses, which are optics with adaptive lens focus for hole inspection, as well as its PCBPN boroscopic probes, suited to diameters down to 5.5mm.

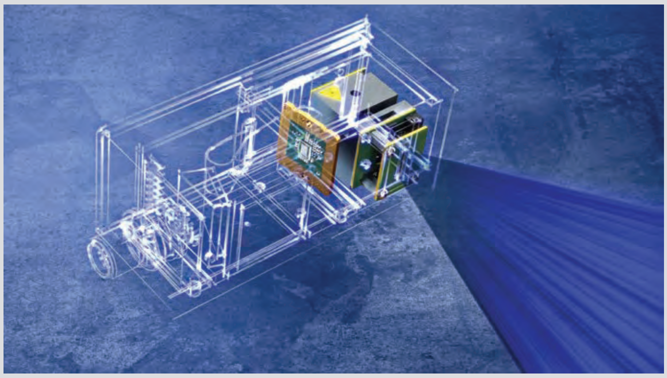
Lighting is also a fundamental part of Opto Engineering's offerings from its years as a manufacturer and supplier of LED illuminators. The latest in this field include the LT2BC series, a continuous high-uniformity LED backlight, now also available with an optional integrated collimation film. Lastly, the firm will also exhibit its LTBRZ3 series, LED bar lights with integrated drive electronics.
www.opto-e.com

On display from **Matrix Vision** (hall 8, C30) will be the new MvBlueNaos product family for embedded vision. The camera modules have a PCI Express interface, which is also responsible for direct access to memory, computer processors and on embedded processor boards. The cameras are equipped with GenICam software support, which ensures compatibility with existing image processing programs, thereby also guaranteeing platform independence on the software side.

The first models, with Sony Pregius and Pregius S sensors, offer resolutions ranging →



Vision Components (hall 8, C31) will present VC PicoSmart, which it says is the world's smallest, complete embedded vision system, having now equipped it with new functions for 3D profile measurement. This enables OEMs to develop low-priced triangulation sensors with less effort.



Anyone who used to be put off by limited cable lengths when connecting Mipi camera modules will also appreciate VC Coax, Vision Components' new cable solution being exhibited, optimised for high-speed data transfer and allowing transmission paths of over 10 metres. This expansion of the manufacturer's Mipi range increases flexibility in application development.

Vision Components also offers various Mipi camera modules up to 20 megapixels that are compatible with all major single-board computers, as well as developer kits for industrial applications. Further innovations are in preparation – such as: an FPGA-based hardware accelerator for image processing.
www.vision-components.

→ from 1.6 megapixels to 24.6 megapixels. The PCIe x4 interface enables transmission rates up to 1.6GB/s, providing enough space for higher bit depths, simultaneous image pre-processing and future sensors with higher frame rates.

Visitors will also be able to see in action a smart 3D camera for robot applications from Matrix Vision's partnership with Roboception, as well as the new 10GigE camera series MvBlueCougar-XT. They can also witness AI-based anomaly detection, and get a glance into Matrix Vision's quality management via a test system for filter cleanliness.
www.matrix-vision.com

Helping customers take imaging 'from concept to production' is the theme of **Framos**' booth (hall 10, E50). The booth will be divided into three key areas: firstly, a variety of off-the-shelf components; secondly, support and solutions for customised products; and finally, live demos.

In the component section, Framos will highlight its Sony sensor portfolio, including the latest time-of-flight and SWIR products, along with the Framos' modules and optics that make use of many of these products. Visitors are invited to take a closer look at the Sony ECX335SN live demo and the SLVS-EC IP core from Framos.

The area focusing on support will show how the firm's custom solutions team mitigate risk and accelerate vision projects. Framos can help customers with optics selection, or to create custom-designed modules, which it can build in a dedicated vision production facility.

Technologies from key partners will be showcased in the demo area, including Sony's latest sensor lines, as well as Prophesee's event-based sensors.

Some examples that will be highlighted in the demos include: the new Sony IMX570 time-of-flight sensor, alongside Sony's visible-SWIR IMX990 and IMX991 sensors; SLVS-EC over GMSL2; and 3D technology with Framos' industrial D400e series cameras, which bring Intel RealSense stereo depth sensing technology into an industrial environment.
www.framos.com

Teledyne (hall 8, B10 and A10) will showcase its vertically integrated portfolio of industrial and scientific imaging technology from its Dalsa, e2v, Flir, and Lumenera business units.

Visitors to the booth will be able to learn about the firm's latest innovations in embedded vision, including the Quartet Solution for multiple cameras with AI and machine learning capability. Also on display will be Teledyne's newest high-performance line and area scan cameras, with data capture rates up to 67 megapixels and innovations in global shutter backside illumination or SWIR sensors. MicroCalibir, a compact, low-power, uncooled thermal camera platform, featuring one of the smallest VGA IR core modules on the market, will be shown as well.

Teledyne will also present its advanced sensor platforms, including: the new Emerald 67M; the latest time-of-flight sensors; Tetra, a low-cost, high-performance quad linear CMOS sensor family; and the Z-Trak series of 3D profile sensors.
www.teledynedalsa.com

Ace 2 cameras will be among the products on display by **Basler** (hall 8, D50). The two product lines – Ace 2 Basic and Ace 2 Pro – are equipped with CMOS sensor technology offering excellent image quality. The Ace 2 features sensors from Sony, including the latest Pregius S sensors, and from Gpixel, and offers resolutions up to 24 megapixels. At the same time, the cameras retain their compact format and are available with C-mount and GigE or USB 3.0 interface.

The difference between the two product lines lies in the integrated features: a powerful computer vision feature set for standard vision needs, or Basler's 'Beyond' features for more demanding tasks with maximum performance. This means customers will only be paying for what they really need.

The cameras also stand out for their compatibility with Basler's extensive accessory portfolio and easy integration into individual applications, thanks to the firm's Pylon camera software suite.
www.baslerweb.com

Alkeria (hall 8, C36) will be exhibiting a new USB3 line scan camera, featuring a high-resolution Necta S short-wave infrared InGaAs sensor. The Necta S comes in two resolution versions: NS05K, with 512 x 1 pixels, and NS1K, with 1,024 x 1 pixels. Both can be equipped with a C-mount lens adapter.

The cameras can reach 40kHz line rate with a 14-bit A/D converter; they offer advanced I/O, and a compact and rugged aluminum case.

Alkeria has also developed a laser triangulation extension.

Thanks to an algorithm running on an FPGA, Alkeria's cameras can define and extract the line position in every column of the acquired frame, with sub-pixel precision. In particular, the profilometer extension enables on-camera acceleration of the line position detection algorithm. The cameras can extract and calculate profile co-ordinates by themselves, greatly reducing the amount of data sent through the USB3 interface. In this way, users can easily reach maximum sensor frame rate and collect only the data useful for the measurement.
www.alkeria.com

Ximea (hall 8, B36) will present new models of the XiX and XiC camera series, equipped with Sony's CMOS Pregius S sensors. The initial lineup starts with models based on IMX540, IMX541, IMX542 and continues with other sensors from the Sony fourth generation Pregius family.

The newest features of CMOS sensors have been integrated into the new cameras, which measure 26 x 26 x 33mm and weigh 38g. They each offer high-resolution, high quantum efficiency, can be customised, low noise and a dynamic range of 71dB in combination with backside illumination technology.

All the sensors offer global shutter readout, making them ideal not only for scientific applications, but also for systems where objects move at a high speed. New x-ray models, larger format cameras, detached sensor heads and cooled sCMOS cameras will also be on display on Ximea's booth.
www.ximea.com

Zebra Technologies and **Adaptive Vision** (hall 8, B30) will be showcasing Zebra's new suite of machine vision smart cameras and fixed industrial scanners. The products use Zebra Aurora, a unified software platform designed for easy set-up, deployment and operation of both cameras and scanners.

The industrial scanners and smart cameras are targeted at manufacturing, warehouse and logistics environments.

Version 5.1 of Adaptive Vision's software will also be presented, which includes new deep learning features and tools – OCR, automated model training, rectangle →

→ detection and a new version of the anomaly detection tool – improved template matching, and program breakpoints. Its intuitive visual environment is suitable for creating both simple applications and complex machine vision projects.
www.zebra.com
www.adaptive-vision.com

Visitors to **MVTec Software's** booth (hall 8, C56) will be able to learn about the latest features of its Halcon standard software, its deep learning tool and its Merlic software. In particular, the new Merlic 5 version will be released just in time for the show, with numerous technical features having been added.

Two interactive demos at the booth will provide in-depth insight into a wide range of machine vision applications, while also creating an opportunity to engage in deepened discussions. The first demo allows visitors to experience topics such as anomaly detection, deep OCR, the subpixel barcode reader, and an agricultural application relating to 3D plant inspection.

In another live demonstration, MVTec experts will show how images can easily be labelled with the aid of its deep-learning tool to optimally prepare it for training.

MVTec will also participate in the Industrial Vision Days, the lecture forum taking place alongside Vision 2021, with a presentation on deep learning.
www.mvtec.com

The HSML-E series of compact laser diode line modules will be on display from **Frankfurt Laser Company** (hall 10, E90) The diode modules deliver an ultra-thin line. The laser head and laser driver are separated, enabling a very compact head size of 12.6mm x 44mm. The driver is 200mm away from the head, with dimensions of 12.6mm x 40mm, and can be operated at 24V.

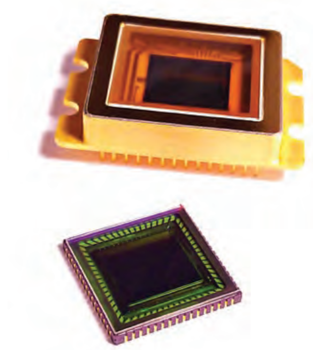
The beam line can be focused too – for example, a thickness of 10µm at 40mm distance. Standard fan angles are 10° to 90°. The wavelength range is from 405nm to 1,060nm with output powers up to 50mW. The

power stability is typically less than ±5 per cent over eight hours at an operating temperature range from 10 to 50°C.

As an option these modules are offered with potentiometer for power adjustment, external TTL modulation up to 1MHz, and analogue modulation up to 100kHz. The housing is electrically isolated and satisfies the protection class IP67, making these modules ideal for use in industrial applications with harsh environmental conditions. The major applications are machine vision, scanning, profiling and laser triangulation.
www.frlaserco.com

Andanta (hall 10, H51) will show the QVGA (320 x 256) and VGA (640 x 512) InGaAs matrix sensors, now available with the spectral range of 0.6 to 1.7µm. They include the uncooled and cooled versions. The quantum efficiency of these sensors is guaranteed to be greater than 70 per cent (often greater than 80 per cent) in the spectral range of 1.0-1.7µm, and still around 30 per cent at 600nm.

The InGaAs sensors can also be supplied with a spectral range of 1.2 to 2.2µm. Noise properties and signal homogeneity across the pixels (subject of cross-hatching effects) have been improved over the past few



years, thanks to new InGaAs epitaxy processes and a two-stage thermal cooler, which is standard for 2.2µm InGaAs matrix sensors.

QVGA and VGA sensors with a spectral range of 1.1 to 1.9µm are also in development and will also come with a two-stage cooler. Noise and uniformity of sensitivity from pixel to pixel are even better here than with the 2.2µm variants.

Also at Andanta's booth will be its low-resolution InGaAs matrix sensor, FPA64x64-C, which has a spatial resolution of 64 x 64 pixels with a pixel size of 40µm. The spectral range reaches from 1.0 to 1.6µm. The readout rate is up to 350Hz with an integration time of 5.5µs, and up to 15Hz with an integration time of 1ms.
www.andanta.de

Kithara Software (hall 8, C12) will show its latest technologies for image capture and processing in real time. For example, the most recent developments of Kithara RealTime Vision, a PC-based software solution, will be shown. Among these is support for 10GigE Vision cameras, including link aggregation for combining multiple 10 Gigabit Ethernet streams into one, thus achieving even higher image data rates. Furthermore, the Kithara real-time system enables implementation of PLC2's PGC-1000 frame grabber card, which allows the CPU to be almost completely offloaded during image acquisition processes within machine vision applications.
www.kithara.com

Advancing inline inspection

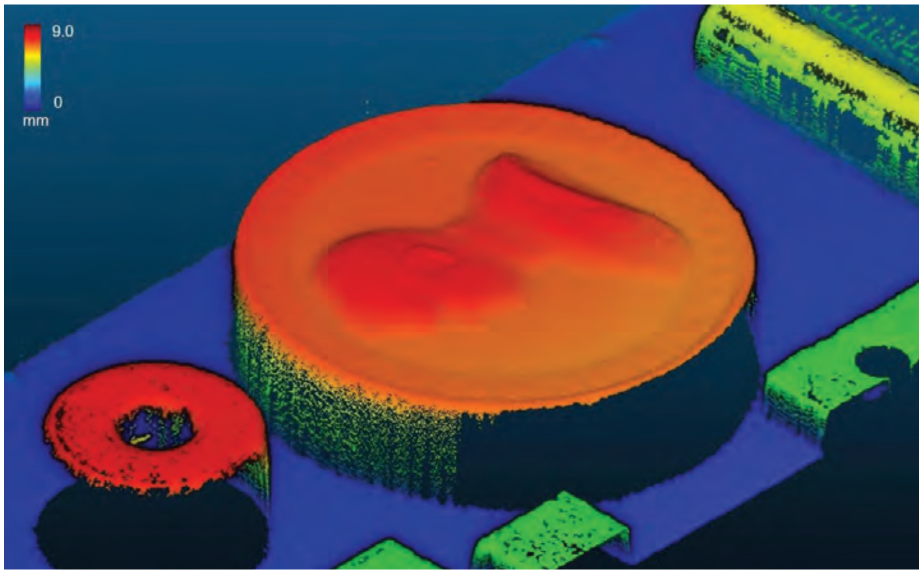
Matthew Dale investigates the technology behind inline computational imaging

Researchers at the AIT Austrian Institute of Technology are seeing increase demand from industry for imaging technology that can deliver both 2D and 3D capabilities in one platform. It is for this reason that over the past five years the institute has been developing inline computational imaging.

Computational imaging is itself a fast-growing research field in which new image acquisition technologies are being combined with intelligent algorithms. By doing this, image information can be extracted, which conventional machine vision can't usually capture.

Two prominent examples of computational imaging are photometric stereo and light field. Photometric stereo involves multiple images of a stationary object taken by a single camera with a fixed point of view. In each image, the scene is illuminated from a different angle. Light field imaging, on the other hand, consists of multiple images of an object taken from different viewing angles, which is often achieved using either multiple cameras, or by putting a microlens array between the lens and image sensor. Combining these multiple views with advanced algorithms gives more accurate and robust depth information.

Inline computational imaging uses a single area scan camera that captures several views of an illuminated moving object simultaneously by exploiting the relative motion between the object and camera. A number of images are taken, with the light coming from a different direction in each, resulting in a stack of images containing varying light field data. High-performance computational processing of this data then makes it possible to derive depth information and obtain an all-in-focus image with increased signal-to-noise ratio. This approach also captures photometric stereo data as the illumination angle varies, thanks to the relative movement between illumination and object. By analysing the reflectance properties, the slope of the object's surface – as well as information about the material – can be obtained. The result is a full 3D reconstruction of the object as a point cloud, as well as enhanced, rectified 2D images of the object.



AIT

A 3D point cloud of a coin, which has metallic, glossy surfaces and a really fine surface structure

'By simultaneously acquiring light field and photometric information, this approach provides a simple, scalable framework for simultaneous, high-speed 2D and 3D inline inspection,' explains Petra Thanner, a senior research engineer for high-performance vision systems at the AIT's Center for Vision, Automation and Control.

'This enables a whole manner of both 2D and 3D inspection tasks to be performed together with a single camera, sensor and lens – that's a really high benefit,' Thanner adds. She says that integration, setup and maintenance is a lot simpler compared to other solutions using an array of cameras, such as light field imaging.

> 'Both 2D and 3D inspection tasks can be performed with a single camera, sensor and lens'

An additional advantage over photometric solutions is that, conventionally, the object has to be stopped underneath a central camera within a bulky light dome consisting of several illumination sources, each of which needs to be activated individually in a sequence as the images are captured. Inline computational imaging differs from this, as it uses four LED lights strobed at high frequency, which allows images to be captured as the object moves under the camera.

Tilting a circuit board

Asked what the motivation for the AIT developing such a solution was, Thanner explains: 'There are lots and lots of requests from industry for this technology, as there's an increasing number of requirements or tasks that can't be solved by 2D or 3D →

→ alone, but instead needs a combination – for example, PCB inspection.

'So, on a PCB there are printed wires, labelling and a number of soldered components that all need inspecting to make sure they are parallel to the PCB, rather than being tilted in an undesirable way. Inline computational imaging... can mimic what a human is doing when inspecting a challenging surface. A human tilts and varies their viewing angle to inspect a surface, with different perspectives and illumination directions. While traditionally machine vision solutions have not been able to solve this task, with inline computational imaging, machine vision can now mimic this human behaviour.'

In addition to PCBs, the technique is suited to inspecting challenging surfaces such as metals, or those where there is a combination of printed and metallic surfaces.

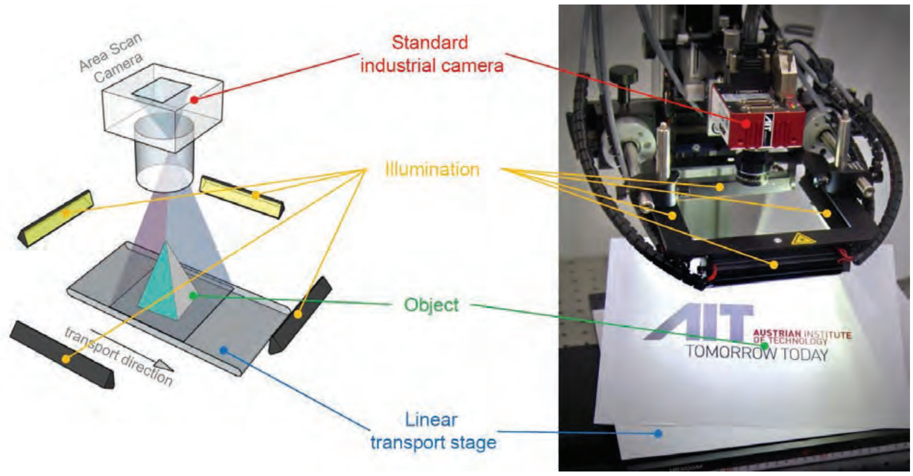
'You can use it on metallic surfaces to detect cracks,' Thanner continues. 'We have also used it to measure connectors, or dark chip sockets with a huge number of tiny metallic pins. Using inline computational imaging enables the socket to be measured to see if there is a label on it, read what's printed on the label, and also to reconstruct the pins and measure the height of each of these pins.'

Dealing with data

The system does produce a lot of data and therefore requires a fast processor. Thanner explains: 'As we are over-sampling the scene to capture the different viewing and illumination angles, you have to deal with a much higher data volume than you would have with traditional 2D or 3D imaging cameras, or solutions where only one image is captured before processing takes place. Instead we capture images while an object moves beneath the camera and then we process all that data together.' AIT's algorithms are optimised to run on a GPU.

While the processing side of inline computational imaging might be a little slower than traditional imaging methods such as light sectioning and stereo imaging, the technique is much more suited to detecting fine surface details.

'The matching between the images is more robust compared to classical stereo imaging, therefore the reconstruction quality of inline computational imaging is traditionally better,' Thanner says. 'It is also better than only doing the light sectioning. The main challenge for sure is the need to have high computational power.'



AIT

The components of an inline computational imaging setup

Working with commercial cameras

The AIT continues to work on inline computational imaging. 'In the past we used a multi-line approach where we didn't use a whole matrix sensor, but only a few lines to speed up the process,' Thanner says. However, since there are only a few cameras available on the market offering multi-line mode, AIT has made the technique compatible with traditional area scan cameras. 'We can use each camera available on the market and adapt it to our acquisition frame,' she adds.

AIT has also increased the number of illumination directions, which makes the reconstruction more robust and gives more detail about the surface of the object.

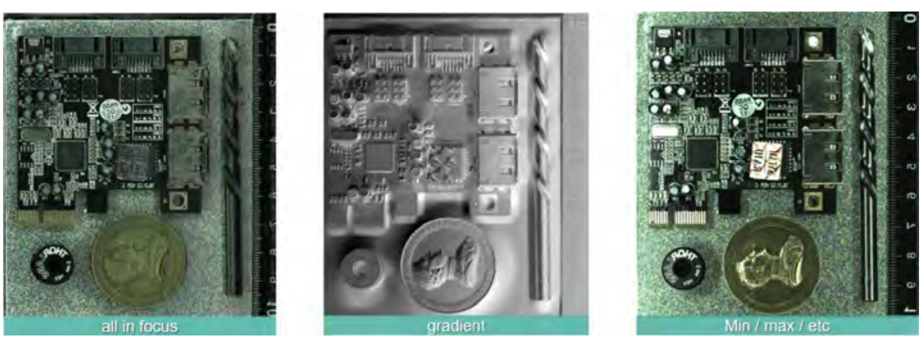
The technique can be scaled to different optical resolutions. Thanner explains that, often, the group uses an optical resolution of about 20μm per pixel, because it's easy to handle. 'With this we can demonstrate most of what we want to demonstrate,' she says. 'We often use coins to illustrate the feasibility of the technology because they have metallic, glossy surfaces and a really fine surface structure. We can reconstruct this very well with inline computational imaging and it demonstrates its comparison with the technical feasibility of other technologies quite well.'

However, for when 20μm isn't enough, AIT has developed a microscopic inline computational imaging setup where resolutions of 700nm per pixel can be achieved.

'This is especially interesting for inspecting ball grid arrays – a type of surface-mount packaging used for integrated circuits – where you can reconstruct the balls of the array,' Thanner explains. 'But then we are very limited in depth range because it is like a traditional optical system, where the smaller the resolution is, the smaller the depth range is. But this microscopy solution can also image printed surfaces very well.'

Traditionally, AIT has worked in security print inspection – it developed the first banknote inspection solution more than 20 years ago. Therefore, the AIT often relates its technologies back to this application, Thanner says, and uses it as a demonstrator application. The inline computation microscopy solution makes it easy to inspect European banknotes for their fine features, printed so that blind people can feel which denomination it is. Thanner notes that the technology can also be used to inspect burrs in sheet metal production, or really any surface – glossy, matt, low texture, holograms – with tiny features that need to be reconstructed in detail.

AIT



Enhanced, rectified 2D images produced by inline computational imaging

Photometric Stereo for 3D surface inspection

Though a large majority of machine vision applications are solved using two-dimensional imaging, machine vision applications using or requiring 3D measurement and inspection are growing significantly. Numerous techniques are used for extracting 3D information from scenes. Let's mention structured light (including laser-scanning based triangulation), stereo or stereoscopic vision and time of flight sensors.

One, probably lesser known, of these techniques is Photometric Stereo. Euresys' Photometric Stereo function estimates the orientation and albedo of each point of a surface by acquiring several images of the same surface taken from a single viewpoint, but under illumination from different directions. The different images are acquired in sequence, in synchronisation with the lighting, thus requiring only one camera.

'Photometric Stereo is suitable for the detection or inspection of details'

Photometric Stereo is suitable for the detection or inspection of details (be they defects or information) present on the surface of objects.

The Photometric Stereo algorithm is available in Euresys' Open eVision Easy3D library. It can be used as a preprocessing phase before other operations, such as code reading (with the EasyMatrixCode, EasyQRCode or EasyBarcode libraries), optical character recognition (EasyOCR), alignment (EasyMatch or EasyFind), measurement (EasyGauge) or defect detection (EasyObject or EasySegment).

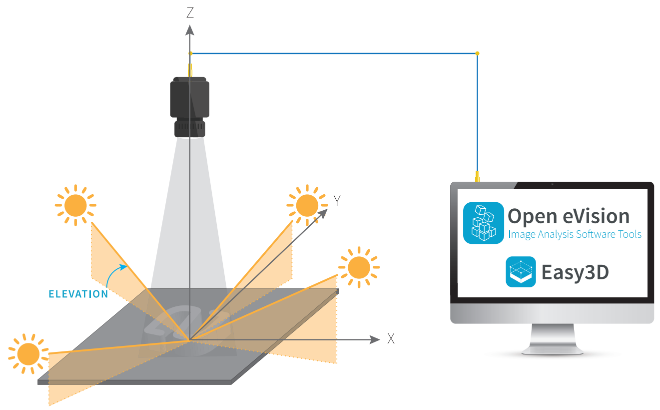


Figure 1. Inspected object with multiple lighting angles in front of the camera

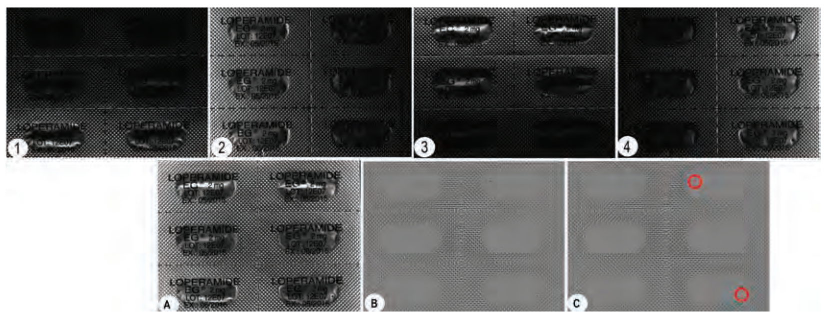


Figure 2. Images of blister under various lighting conditions and inspection

How does it work?

For a given vision set up (positions and angles of the object to be inspected, the lights (typically 3 or 4) and the camera), the software tool first requires the calibration on a reference object [(hemi-)sphere], or the manual introduction of the set up's precise geometric characteristics.

Process

From then on, the image capture of inspected objects is performed in multiple steps corresponding to the various lighting angles.

At the user's request, Photometric Stereo individually extracts a number of variables (normal to the surface, albedo, X & Y gradients, mean and Gaussian curvatures). These are used for the reconstruction/rendering of the 3D information in the 2D domain, making it ready for further processing by other libraries.

The above Figure 2 illustrates the entire process:

- The object captured by the camera under four lighting conditions (images 1 to 4)
- The reconstructed image based on the selected measurements (image A)
- The isolated subset of data useful for the chosen inspection (image B) (here we have chosen to use the Gaussian curvature information)
- The results of the inspection by deep learning, using the Open eVision EasySegment library, supervised mode (image C) applied to the image in (B). The two puncture points can clearly be identified.

Optimisation

A few tests allow the identification by the user of the most appropriate variables to recover for is application. These steps will result in the optimisation and potentially speed up a time-critical process.

For example, some detections will require specific linear detections, or alternatively the detection of sharp edges. The specification of a specific Region of Interest (ROI) is also possible. Tuning these parameters to the actual application results in significant speed improvement.

Considering the occasional less than perfect object position, observation conditions or lighting, the function also allows for the compensation of:

- Ambient lighting (dark image); and
- Non-uniform lighting (flat reference image).

Conclusion

One can see how the useful information originally not detectable from the original image can be enhanced by Photometric Stereo to be effectively exploited by a standard eVision library (EasySegment in this instance). The Photometric Stereo Imager functionality is available in Euresys' Open eVision Easy3D Library.

www.euresys.com/en/Products/Machine-Vision-Software/Open-eVision-Libraries/Easy3D

Spectral and MEMS takes 3D in new directions

Greg Blackman speaks to two young companies with some novel 3D imaging approaches


Both Saccade Vision and Tridimeo are targeting the automotive sector with their 3D vision cameras

A blessing and a curse of 3D imaging is that there are so many ways to do it. Triangulation, stereovision, structured light, time-of-flight, the list goes on, with numerous variations on those themes. This means there's normally a 3D vision technique that will meet the application requirements – if 3D is necessary in the first place – but that choosing the right method requires a certain degree of knowledge.

Using 3D vision can actually simplify inspection if implemented correctly, as noted by vision experts in the article on page 24, and there are now self-contained sensors designed to make using 3D vision easier. This doesn't mean though that all applications can be solved with the existing solutions, or that there's no room for innovation in 3D vision.

Two new techniques entering the market are technology from Israeli firm, Saccade Vision, and French spin-off Tridimeo. Saccade Vision has developed a MEMS-based 3D triangulation profiler. The MEMS-based laser illumination module can scan in multiple directions, and the device is able to create selective resolution and locally optimised scanning.

Tridimeo's device, meanwhile, is a high-speed and multispectral 3D camera. The core technology is called a spectrally-coded-light 3D scanner. It is based on a projector that can encode data directly on the spectrum of the projected light beam. The beam makes it possible to probe both the shape and the optical spectrum of the object in the scene.

Saccade Vision is working on pilot projects with customers at the moment, both in production and as integration projects. A power electronics manufacturer is working with the system – currently as a stand-alone system – to give critical measurements of injection-moulded parts. 'This is a difficult part to measure,' explains Alex Shulman, co-founder and chief executive of Saccade Vision. 'It's black, it has thin walls, so a regular profiler can have issues with under-sampling. In our case, we can optimise the scan for different regions, so if we're scanning a thin wall we can do it more accurately.'

The next step is to integrate the system on an injection moulding machine to make the measurements directly. 'Instead of doing a manual inspection with callipers every two hours, which is how these parts are normally checked, the customer wants to do it automatically with high sampling rates,' Shulman says.

The system can make a pre-scan of the entire part at low resolution to align it. It can

> **‘Solid-state MEMS lidar has brought higher speed and higher quality scanning... We want to do the same for triangulation’**

Supergenijalac/Shutterstock.com

then scan the critical features of the part in high resolution at a precision of 10µm. ‘We scan each critical dimension in such a way as to get very accurate boundaries,’ Shulman explains. ‘This is done by optimising the scanning pattern according to the feature’s specific properties.’

To scan in different directions requires different camera positions, with the image reconstructed by combining profiles from different scans. This system can operate in different configurations, from one to four cameras. This is, firstly, to get views from different angles, and secondly, the camera needs to be positioned perpendicular to the laser line to make the scan.

In another project, vision integrator Integro Technologies is developing an inspection system using the Saccade scanner. The manufacturer with which Integro is working has challenging requirements, including scanning at precisions of 10µm for some sections of an aluminium mould in high-volume production.

The customer wanted to perform 100 →

→ per cent in-process measurement of complex surfaces on a wide variety of mould segments. The moulds are precision machined from aluminium and vary in size – a general nominal size, for example, is about 12 x 6 x 2 inches, explained David Dechow, principal vision systems architect at Integro, who worked on the project.

Currently, specific mould segment features are inspected off line using manual contact measurement tools at a part sample rate of about 20 per cent of the total, Dechow continues. The process requires measurement of the features in 3D. In addition to being a slow process, the existing manual inspection is not able to achieve all the required measurements. The task is made more challenging with the tight measurement tolerances required, in some cases as little as +/- 0.001 inches.

Dechow explains that because of the height and spacing of the 3D mould features, automated 3D imaging systems cannot extract the surfaces that must be measured. 'In particular, features at the bottom surface of the mould are easily obscured by the vertical height of adjacent features when technologies such as laser triangulation profilometry are used,' he says. 'To achieve multiple angles of imaging, a single or even an opposed profilometry device would have to be scanned across the part surface at multiple angles. Furthermore, the scanning of the entire part at high resolution is time consuming, especially when only specific sections of the part are of interest for measurement.'

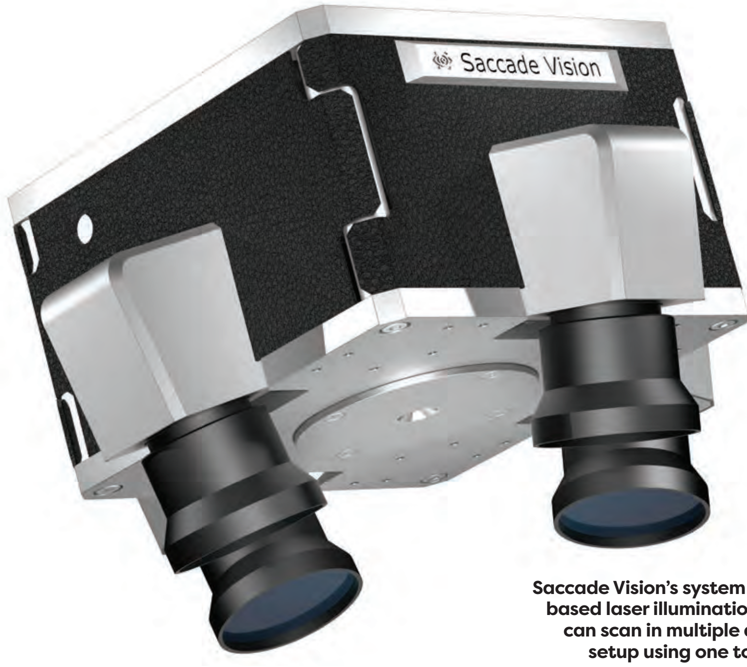
The Saccade-MD system is able to perform static scanning of a single field of view from multiple angles and with variable resolution. The unit can be attached to a robot arm and moved to specific areas of interest on the mould. Without further motion, the system can scan from appropriate angles to overcome 3D dropouts that happen when features are obscured, Dechow says.

The system is also able to image at variable resolutions within each scan, so that the density of data is higher only in the areas of interest, Dechow continues, and the overall size of the point cloud for that view is much smaller than would be produced if all of the scan were at high resolution.

'In execution, the robot would have motion programs for each part type to carry the Saccade-MD to the required views for a given part, and the Saccade-MD would have an imaging configuration for each view on each part,' Dechow says. 'Once images are acquired, standard 3D measurement tools and techniques can be employed to implement the required measurements in each view.'

Dechow notes the point clouds will

Saccade Vision



Saccade Vision's system uses a MEMS-based laser illumination module that can scan in multiple directions, in a setup using one to four cameras

'When picking a flat component, say a few millimetres thick [at the bottom of a bin] – if you don't have multispectral I don't think it's easy'

initially have to be downloaded manually and the measurements run separately, but that the process can be automated with further work. He says, however, that even taking this into consideration, 'throughput will still meet the customer requirements and allow 100 per cent of the product to be measured.'

Shulman says Saccade Vision is targeting discrete manufacturing at the moment, such as plastic injection moulding, extrusion moulding, metal forming, CNC or die casting. All these operations don't have a conveyor, and the part needs to be scanned stationary. 'In theory we can add scanning in motion, because we have everything needed for that,' Shulman says. 'But we are currently not investing in that; it is possible, but it's not our focus at the moment.'

Shulman adds that Saccade Vision's technology's strength lies in its ability to deliver micrometre precision. He says the firm is not targeting bin picking, but is looking at precise pick-and-place applications, requiring 3D position accuracy of 100µm or less in precision manufacturing.

'We're focusing on metrology for discrete manufacturing and process analytics,' Shulman says. 'Industry 4.0 is data-driven manufacturing. However, data collection today, at least in discrete manufacturing, is mainly done by indirect correlated sensors – measuring vibration, acoustics, temperature – and predicting machine health or making process control measurements based on that. Direct measurements, such as from our 3D scanner, have much better fidelity and provide a better basis for decision making.

'Solid-state MEMS lidar has brought cost reduction, higher speed and higher quality scanning than the older galvo-based lidars could provide,' he adds. 'We want to do the same for triangulation in manufacturing.'

Saccade Vision plans to release a commercial product in the first half of 2022. It is also working on an inspection setup guided directly from a CAD model of the part.

Spectral speed

Tridimeo, on the other hand, does consider bin picking, pick-and-place and robot guidance in general within the scope of its 3D technology, alongside quality inspection. Tridimeo was founded early in 2017 as a spin-off from the French research institute, CEA. The company designs and produces high-speed and multispectral 3D cameras and develops vision software.

'It's a new way of performing 3D imaging,' said David Partouche, co-founder and chief executive of Tridimeo. 'Tridimeo is the only provider of high-speed multispectral 3D cameras in the world to our knowledge. All our vision solutions display both 3D imaging and multispectral imaging capabilities that are not accessible to other regular 3D imaging technologies.'

The technology was invented in 2014, primarily by Rémi Michel. The company's 3D scanner, which uses a white LED and a complex optical system to encode the patterns, is used in combination with Imec's snapshot spectral 2D sensor.

A standard structured light projector will project a pattern of light on the object and measure the deformation in the light to get a 3D image. This works by shining a sequence of patterns onto the object.

Tridimeo, by contrast, uses one multispectral camera with 16 bands, and projects 16 patterns – each at a different wavelength – at the same time. 'It's snapshot imaging,' Partouche explained. 'It can make it much faster than regular structured light 3D scanners.' This is the case compared to white or blue light structured-light 3D scanners, although laser-based scanners can also be very fast, thanks to the available laser power.

Tridimeo developed its initial solution for Renault, a robot guidance system for depalletising semi-random kit of car body parts to load robot islands. The robot islands are for welding the parts together.

Renault wanted the camera to be attached to a robot arm, so it contains no moving parts. The car manufacturer wanted a 3D localisation precision of less than 1mm, taking less than two seconds to make the scan plus calculation per part, explains Elvis Dzamastagic, Tridimeo's international business development manager. Renault also wanted something that's fast to implement, that would correct for ambient light, and be robust to bright, stamped car body parts.

In bin picking in general, one advantage of the system is it is able to distinguish between the parts to be picked and the bin itself using spectral information. This means the pickable objects can be detected and the rest of the image discarded, which makes the 3D localisation algorithm fast and avoids collisions between the robot arm and the bin. Being able to remove the bin from the data points making up the scene also makes it a much more robust solution. 'When picking the last part at the bottom of a bin – a flat component, say a few millimetres thick – if you don't have multispectral I don't think it's easy to locate the part robustly and precisely because it's so thin,' Partouche says.

In bin picking, Tridimeo would scan the bin for each pick. 'The specification from our customers was that you need to scan, calculate in 3D, locate the part, and calculate the robot arm trajectory with no collisions in less than three seconds,' Partouche explains. 'We're targeting picking at around six parts per minute. The bin is imaged as the robot leaves the bin to calculate the next pick while the robot is placing the part elsewhere. The snapshot is a few hundred milliseconds at most.'

To make the images robust to ambient light or reflections from shiny parts, two or more acquisitions would be made if needed, either to measure and subtract ambient light, or add images at different exposures together to get a high-dynamic-range image. The solution can be installed in factories using various industrial communication protocols, like Profinet and Ethernet/IP.

Beyond robot guidance, Tridimeo's technology can be used for quality inspection, such as detecting a sealing joint on a car body part, even though both the joint and part are a similar colour – they can be distinguished through spectral characteristics. This could be used in car manufacturing to check whether the joint is absent or present, or identify its location.

In addition, the technology can be used to inspect the colour of car parts directly after painting, where the spectral data gives a colour measurement and the 3D data measures the shape and tilt of the part to take this into account in the apparent spectral output. 'If you don't have the 3D, you don't know what to compare the spectral output with,' Partouche says. 'That is to say, tilting the part or changing the viewing angle would change the spectrum of light reflected back to the camera, so you need 3D information.'

In the future, Dzamastagic says plastic processing and food inspection might be further application markets for Tridimeo's technology, although at the moment its software is more suited to robot guidance.

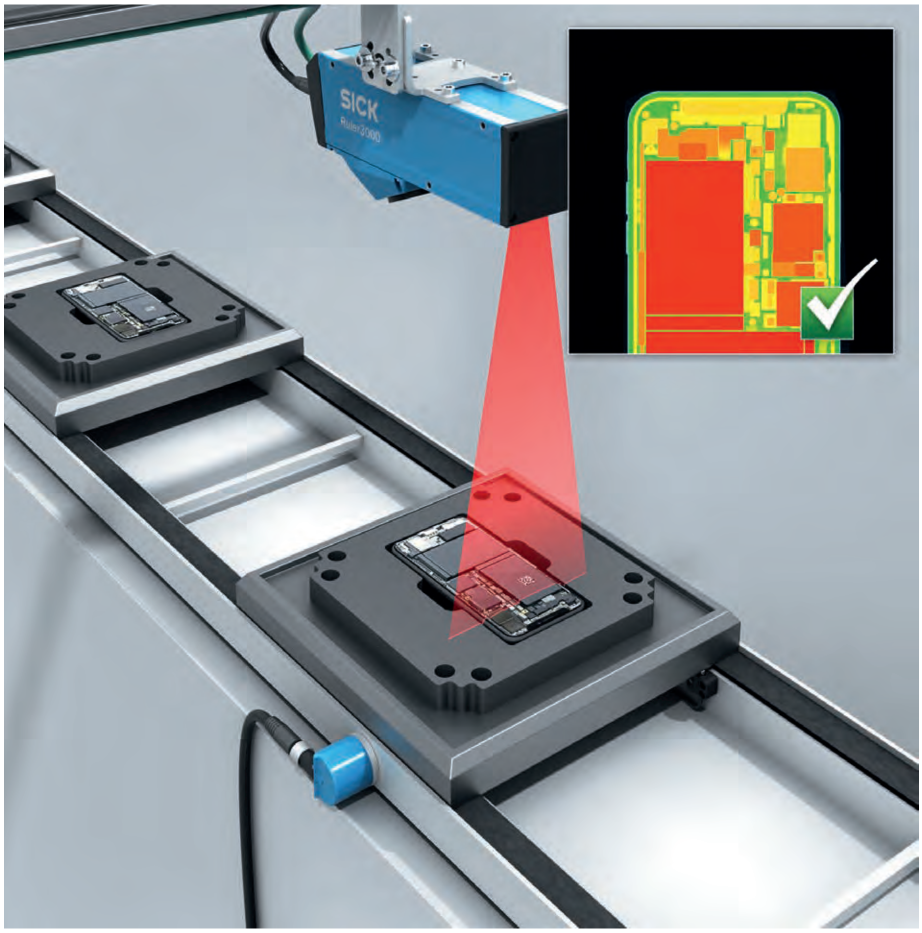
There are now reasonably mature 3D vision products on the market; these two companies show there's also plenty more innovation out there when it comes to measuring the third dimension.

Tridimeo

Tridimeo's high-speed multispectral 3D camera

Lessons when working in 3D

We ask four experts to give their advice for 3D imaging best practices



Sick

Electronics quality checks made using laser triangulation

How do you decide if you can benefit from 3D vision, especially on a limited budget?

Inder Kohli, Teledyne Dalsa: '3D vision helps solve several inspection challenges that are difficult, if not impossible, to be handled by 1D or 2D imaging techniques. For example, variation in height, defects caused by indentation or bubbling of laminate, measuring object thickness, coplanarity of adjoining surfaces [and] uniformity or asymmetry of extruded parts.

'Historically, it required specialist knowledge to build and maintain 3D systems using discrete parts. In expert hands, this might yield the desired performance, but over time field support might erode profits. So, customers can benefit from factory-calibrated, fully integrated 3D profile sensors, like Teledyne's Z-Trak2. When selecting a 3D profiler, users must consider not only the cost of the unit, but also software tools, deployment time and, equally important, in-field service.'

Fredrik Nilsson, Sick IVP: 'For tasks that involve measuring dimensional features, it is very likely that 3D imaging will be the more cost efficient choice in the end. It will provide reliable measurement even if the parts to inspect are presented at different positions in the field of view. In addition, segmentation of the parts from the background is greatly simplified by using 3D vision, where the contrast issues in greyscale or colour imaging is avoided. Pricing for 3D vision solutions is constantly decreasing, and taking the complete solution cost into account from the beginning – including the maintenance – the choice for 3D may even save you money in the long run.'

What factors should be defined to be successful?

Nilsson: 'The first thing to consider is if your application has static or moving parts and how accurately you need to measure them. The answer to this has a big impact on the choice of 3D technology and also to the solution cost. Other topics to consider are what height range and width you need to cover, ambient conditions (that is, interfering sunlight or other light sources, vibrations, available space), surface properties of your parts (for example, very shiny, very matt) and what variety of parts can be expected.'

Yoann Lochardet, Teledyne e2v listed other parameters important for choosing a 3D technology to suit the application: 'Distance range (minimum and maximum); field-of-view; resolution; response time or frame rate; power consumption; lighting budget; compactness of the system; dynamics of the objects of interest (slow- or fast-moving targets); and hardware and software cost and complexity.

'Time-of-flight is a good choice for a maximum distance of more than 1 to 2m, with moderate requirements on precision and accuracy, and is very efficient in managing uncontrolled ambient setups and with moderate to high speeds. For instance, it is a good choice for machine vision applications (distance ranges up to

5m), for construction mapping (up to 10m), or for ITS applications (20m). On the other hand, laser triangulation is a good choice for applications with fast-moving parts, at a small distance range (less than 1m), and requiring very high accuracy (down to micrometres, or even lower). For example, electronics inspection, wood inspection or automotive inspection.

'In the end, each 3D technology has its own pros and cons, and some of them are more suitable than others for different applications.'

Svorad Stolc, Photoneo: 'One of the basic factors that define the achievable acquisition speed is the amount of light. The amount of light the sensor can use depends on multiple factors, including: the power of the light source (in the case of Photoneo 3D vision systems it is a laser that has specific

> **'The first thing to consider is if your application has static or moving parts and how accurately you need to measure them'**

advantages over other illumination types); the working distance (effectiveness of the light emitted by a vision system decreases rapidly with distance from the sensor); parameters of the optics, such as the aperture number, but also the amount of ambient light and other aspects.'

How best do you deal with changing parts or surfaces?

Stolc: 'In general, the best way to deal with diverse scenes or material types (such as matt, glossy, bright or dark materials) is to set up and control environmental conditions in such a way that the sensor works well – which means that its operational dynamic range matches the expected range of the object's properties. Environmental conditions may include the amount of ambient light, the optimal perspective with regard to the scene or object geometries, and other aspects. Alternatively, one can opt for sensors that are more robust against diverse working conditions. For instance, Photoneo achieves a high scanning robustness of its sensors by a well-rounded hardware and software design featuring laser illumination, optical filters and algorithms for data post-processing.

'The robustness of 3D vision systems may be pushed even further – beyond the possibilities of hardware – through AI, the deployment of which is becoming increasingly popular in 3D vision. These approaches are called data-driven as they leverage the information contained in a training data set describing a given problem domain.'

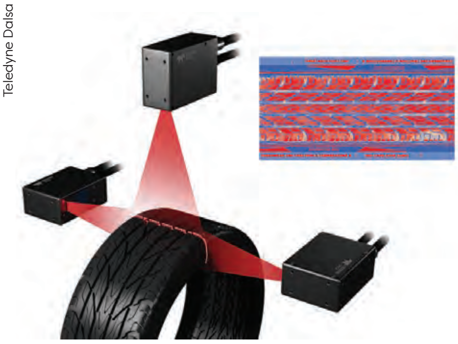
Nilsson: 'Dealing with changing or mixed parts with both very dark and very bright surfaces in the same scene is best done by high dynamic range (HDR) imaging. In our Ruler3000, we use an adjustable, non-linear imager response function to achieve this. Another way to cope with this is to run the sensor in a dual exposure mode – that is, applying one short and one longer exposure time during the same measurement session.'

How complex is 3D vision? How do you reduce complexity?

Nilsson: '3D vision is not necessarily more complex than 2D vision. With a snapshot 3D camera, such as time-of-flight or stereo cameras –for example, our Visionary cameras – you get a 3D image directly and can apply suitable software tools, just as in 2D vision. Furthermore, it is very common to do the image processing on rectified 3D depth-map images, rather than on a 3D point cloud. In this way, the 3D data can, in many cases, be processed with the same tools as for 2D images, which to a large extent removes the complexity issues of image processing.

'When using laser triangulation, you do need to take the movement of parts into consideration, which slightly increases the complexity. However, once set up, the application can be solved by a point-and-click approach, as in our TriSpector1000 series, which does not require a high level of machine vision competence. Actually, for a range of applications, the solution can be even more simple in 3D vision compared to 2D, as illumination is most often included in the device and you get factory calibrated data (such as in Ruler3000). This is a clear benefit as parts will remain the same size regardless of where in the field of view they are presented.'

But **Lochardet** said: 'Thinking of imager integration, 3D vision is much more complex than a conventional 2D vision. It involves optics and an illumination system that →



Teledyne Dalsa

Tyre analysis is one of the applications that can be tackled with triangulation

→ depends on several parameters (such as distance and reflectivity range, field-of-view, light-power budget and so forth) to fit perfectly with application requirements.

'Because of this, a deep knowledge is required to build an efficient 3D vision system, or the help of a 3D vision integrator is needed. Teledyne e2v is able to support at all these levels to shorten a customer's time-to-market and to get the best system to fit the application requirements. For that, we provide both laser triangulation and time-of-flight solutions, ranging from CMOS image sensors and customised camera modules, right up to full system integration support. This includes hardware and firmware development, light and optics assessment, eye safety assessment, application-level simulations, algorithms and factory calibration.'

What are the pitfalls and how do you avoid them?

Kohli: 'Different 3D modalities have different pitfalls. For example, 3D laser triangulation faces challenges due to occlusion. Since the laser and the image sensor are mounted at an angle it is natural for the 3D profiler to encounter occlusion and shadowing. The simplest and proven technique to overcome the occlusion is to use multiple image sensors to look at the object from the other side. Of course, doing so creates the additional challenge of synchronising the image sensors and then combining the two resulting images to create a corrected image.

'The other common problem with 3D profilers is reflections. Although there is no single proven method of eliminating reflection, various techniques are used by 3D profilers to mitigate the effects of specular reflections. These include: changing the angle of the incident light, specialised optics, laser intensity management and filters to remove unwanted peaks. The choice of method depends on the type of object surface, operating and performance requirements.

'Laser speckles are present in every laser because the laser light is coherent. This interference phenomenon is caused by microscopic irregularities of the surface, creating an interference pattern. This pattern manifests itself by making parts of the laser line appear brighter or darker along its length. Such variations limit the uniformity of the laser line limiting the 3D sensor's achievable accuracy. Several techniques, such as the use of a laser with a shorter wavelength, optics with a bigger aperture and profile averaging can alleviate the effects of laser speckles.'

Nilsson: 'Other challenges are the unwanted secondary reflections one may get on shiny metal surfaces. Here, a polarising filter in front of the lens can be used to filter out the second order of reflections.'

Inder Kohli is senior product manager, vision solutions at Teledyne Dalsa; **Fredrik Nilsson** is head of business unit machine vision at Sick IVP; **Yoann Lochardet** is marketing manager, 3D at Teledyne e2v; and **Svorad Stolc** is CTO of 3D sensing at Photoneo.

Commercial products

One of Sick's latest 3D vision products is the Ruler3000. **Sick's Fredrik Nilsson:** 'The Ruler3000 series is well suited for applications with moving objects that require high accuracy, even at very high transportation speed. With the different camera variants, we cover small fields of view, for example, in electronics production and small part assembly; the mid-sized models are aimed at consumer goods packaging and tyre manufacturing, whereas the models with large fields of view are aimed mainly at log inspection and logistics systems. In particular, the Ruler3000 excels in applications that need coverage of a large height range at high speeds as the camera has the ability to use the full sensor image at 7,000 3D profiles per second. If less height range is needed, the speed increases proportionally to the reduction of sensor image in use.

Sick's Ruler3000 and Ranger3 cameras

'The Ruler3000 is based on laser triangulation, but for applications without linear movement, other technologies may be more relevant. The main deciding factors are the frame rate and the resolution needed, as there is often a trade-off to be made between them. For example, a time-of-flight system can run at high frame rates but has limitations in the height accuracy, whereas structured light sensors can achieve really good accuracy at the expense of frame rate. It should not come as a big surprise, but you need to know your application and its specific requirements really well before you decide what technology to choose – this is true regardless of 2D or 3D vision technology.'

Teledyne e2v supplies time-of-flight and laser triangulation sensors, while Teledyne Dalsa offers its Z-Trak2 laser profiler.

Teledyne Dalsa's Z-Trak2 laser profiler

Teledyne Dalsa's Inder Kohli: 'Z-Trak2 comes in a wide variety of configurations and laser options to handle a range of parts, from small electronic components to large automobile engine parts, and door frames to entire chassis. Applications that require height, width, length and volume information of moving parts at a close range are ideally suitable for Z-Trak2. The exact model of Z-Trak2 depends on the size and surface properties of the target object, scanning speed, accuracy and precision of the measurements required.

'Z-Trak2 laser profilers offer speed, accuracy, ease-of-use and help reduce the total cost of ownership by ensuring that systems can be built and maintained with standard, off-the-shelf networking parts, making it the right choice for in-line 3D measurement, inspection, identification and guidance applications.'

Photoneo's 3D camera, MotionCam-3D, can provide a lateral resolution of 2 megapixels with a depth accuracy of 50 to 900µm across the different models, while being able to capture objects moving up to 144 km/hour. **Photoneo's Svorad Stolc:** 'We reduce the complexity of 3D vision by improving hardware robustness and aim to provide flexible enough APIs and tools for our users. Our sensors feature a highly durable carbon body and they are IP65 rated.'

Photoneo's MotionCam-3D

3D vision system nets the right tuna

Matrox AltiZ high-fidelity 3D profile sensors power TUNASCAN vision system, sorting up to 20 tonnes of tuna per hour with accuracy rates approaching 100%

Tuna are scanned by two Matrox AltiZ before being classified; 3D classification results and location data is sent to the sorting section

Each tuna is automatically sorted into its appropriate container

Headquartered in Spain, Marexi Marine Technology Co. has been a marine technology leader for more than 15 years. They develop optical scanning systems for marine species for fishing, canning and aquaculture sectors. Their TUNASCAN® system is Marexi's most state-of-the-art machine, a high-speed, high-throughput vision system that scans and classifies tuna by species, size and quality.

Visual classification of fish is challenging, especially once frozen. Differences between species become practically impossible to discern reliably without exhaustive testing. Using cutting-edge 3D profile sensors along with machine-learning algorithms, TUNASCAN properly classifies and sorts tuna with accuracy rates of more than 95%.

'We are always seeking ways to further enhance our solutions,' notes Pau Sánchez Carratalá, vision and robotics engineer at Marexi. 'In the interest of improving the classification algorithms used by TUNASCAN, we overhauled the entire acquisition system with the support of Matrox® Imaging and Grupo Alava.'

Just keep scanning

TUNASCAN is a major fixture of Marexi's marine technology offerings; this patented two-channel vision system can process up to 20 tonnes of frozen tuna per hour. From the reception hopper, frozen tuna are fed into and pass through the scanning section, where two Matrox AltiZ sensors perform a 3D scan and a computer classifies each tuna individually. Classification results and location data are sent to the sorting system, where each tuna is sorted into its appropriate container.

Clear fishy fishy

Upgrades to the TUNASCAN project centered upon Matrox AltiZ 3D profile sensors. Sánchez Carratalá notes: 'We needed a reliable way to obtain 3D point clouds from objects moving at a fairly fast speed. The application also must deal with point-cloud noise and dirtiness from physical operation of the machine. In the past we used separate cameras and lasers for obtaining 3D data. Matrox AltiZ allows us to integrate these elements into a single sensor that provides exceptional robustness to the application.'

TUNASCAN employs machine learning to accurately classify frozen tuna based on features extracted from the point-cloud representation and calculated weight. Matrox Capture Works – the interactive set-up utility for Matrox AltiZ – was used to configure the sensor and provide the code snippet for the acquisition portion of the actual application.

In the TUNASCAN system, the 3D devices are set to generate a point cloud. Laser lines trace the contours of the fish. Embedded algorithms then produce a point cloud, which is stitched together to create a complete 3D rendering of the tuna. The algorithm ensures greater control over invalid data, resulting in more robust 3D reproductions.

TUNASCAN also includes ultrasonic sensors that trigger 3D capture only when there is a fish available to scan. Special low-temperature infrared sensors are responsible for monitoring the temperature of each fish and assuring the proper behaviour of the system.

Fishing for results

Operator interaction with the system is minimal. In addition to sorting by species, the same species of tuna can be further sorted by weight. Every incoming fish is sorted into the selected categories by container. TUNASCAN manages multiple containers, automatically assigning a new container for output while the full container is being replaced, ensuring the system remains in continuous operation.

TUNASCAN systems are deployed in harsh environments and operate continuously, leaving very little opportunity for maintenance or calibration. 'One of our installations has been working up to 20 hours a day, six days a week for almost three years, with barely any maintenance required,' Sánchez Carratalá smiles. 'All that, and with accuracy rates approaching 100%! Our clients could not be more pleased.'

In the swim of things

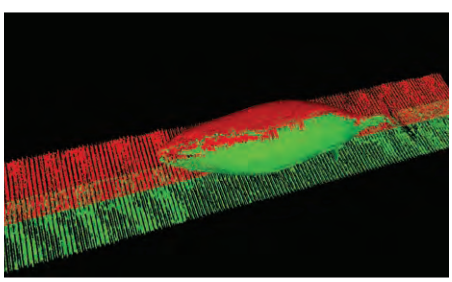
As part of Marexi's commitment to continuous improvement of their products, TUNASCAN has been regularly improved and optimised. 'We faced some challenges at the start, mainly because it is a very complex and disruptive system, and we needed to guarantee its efficacy,' Sánchez Carratalá reports. 'We are happy with the assistance offered by Matrox Imaging's technical support team, as well as the help received from Grupo Alava.'

Building on the success of the TUNASCAN upgrade, Marexi is currently working on a different project for the fish industry that also integrates a Matrox AltiZ, along with Matrox Imaging Library (MIL) X software.

Marexi reports that their current clients are very satisfied with TUNASCAN and the value it provides their businesses. 'Our TUNASCAN application leverages the strengths of a Matrox AltiZ-based system,' Sánchez Carratalá concludes. 'Not only do the sensors deliver very accurate 3D data at really high conveyor speeds while dealing with a challenging product like frozen tuna, but the Matrox AltiZ functions optimally in extremely harsh environments and works for long periods of time without maintenance.'

www.matrox.com/en/imaging

Two Matrox AltiZ 3D profile sensors (on the far left and right) scan each fish as it passes through the dual-sensor TUNASCAN system



An onscreen rendition of the 3D point cloud generated by the two Matrox AltiZ

Trash talk

Greg Blackman reports on a presentation **Eric Camirand** of Waste Robotics gave about hyperspectral imaging and robotics used in recycling plants

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Sorting and recycling waste is not only crucial for the planet, it is also big business.

'One of the key components of waste sorting is quality of the material you are sorting, so you can resell the material – that's getting important nowadays,' Eric Camirand, founder and chief executive of Waste Robotics, noted during a presentation for *Imaging and Machine Vision Europe* as part of a webinar on hyperspectral imaging.

Recycling centres get paid to receive waste and sort it. Everything they can separate out to be recycled – or resold if possible – saves on material going to landfill. The material that's missed and sent to landfill costs money. 'They're trying to avoid the landfill cost and capture quality products. It's all about sorting out quality in the least expensive way,' Camirand explained.

Many recycling centres still rely on hiring people to sort through waste on a conveyor, which can be inefficient and unpredictable, with material that could be reused sent to landfill. It's also not a pleasant job. Waste Robotics, based in Trois-Rivières in Quebec, Canada, is trying to automate this process with robotic sorting. Camirand said sorting should be: inexpensive; effective at capturing quality material; precise, adaptable and reconfigurable; predictable and reliable; and something that improves the overall operation, all of

> **‘It’s all about sorting out quality in the least expensive way’**

which an automated system can offer.

Waste Robotics builds its own scanners incorporating multiple sensors, including RGB, 3D and hyperspectral cameras, and uses AI to make sense of the data. The company develops tailored robotic solutions for different types of waste. It has several projects deployed in Canada and the US, as well as France; lines include those for sorting different plastics, as well as construction and demolition debris.

Hyperspectral imaging gives Waste Robotics the ability to differentiate between different types of plastic, or to sort construction material, like wood, depending on whether it has glue or paint on it. It gives additional information that other imaging systems don’t provide.

Camirand said that near-infrared optical sorters have been used to separate waste in combination with air jets to eject material, but optical sorters can’t distinguish between objects. Containers made of multiple plastics, for example, can be identified as individual containers with hyperspectral imaging and put aside for further processing. These containers are really difficult to recycle, so they are removed from the line to stop cross-contamination of other plastics.

‘Sorting plastics is difficult,’ Camirand said. One problem is that packaging changes. ‘If I train an RGB-based AI model – →

Steps for spectral imaging success

During our recent webinar, Steve Kinney, director of engineering at Smart Vision Lights, gave his advice on designing a spectral imaging solution for factories. Firstly, he said that multispectral is more practical for production environments, as it reduces the complexity of hyperspectral imaging.

To move from hyperspectral to multispectral, the first step is to start with a full hyperspectral image of the sample and background. Compare each sample’s relative intensity, and compare the peaks in common axes over normalised ranges. Then overlay the data to identify peaks and contrast of unique areas.

Step two is to identify the spectral peaks of interest which, if you’re lucky, might only be one peak. Identifying bruising on an apple, for example, is relatively straightforward and might only require one wavelength band.

Sometimes one peak is not enough – for example, when imaging different species of tree in a forest canopy. Here, additional information might be needed to highlight the different plants.

Optical filters can isolate areas of interest from the rest of the spectrum. Multiple bandpass wavelengths can be built into one filter. The aim is to achieve high transmission and steep cut-off to isolate the narrowband edges. Kinney suggests an optical density of five for band-pass filters.

Broadband lighting – halogen or sunlight, for example – is more flexible in combination with narrowband filters, but it requires enough light energy across the target spectrum. Broadband lighting also introduces heat, and there can be loss of spectral efficiency outside of the spectral peaks, so the dynamic range of the camera is dominated by light outside the wavelengths of interest.

LED lighting, such as that offered by Smart Vision Lights, is a more targeted alternative to a broadband illumination source. It has the advantage of higher intensity in the wavelength bands of interest, and might mean filters aren’t necessary.

→ based on colour or shape – I'm going to put all the containers in the HDPE bin. But in reality [packaging] switches back and forth between PET and HDPE.' Camirand showed an example of two lids that are identical to look at, but made of different plastics. 'We really need hyperspectral,' he said. 'They all look white, crushed containers, which humans or [RGB] AI cannot differentiate between. We really need to rely on additional signal, which is hyperspectral, to classify them.'

One of Waste Robotics' projects in Prévost, QC, Canada, is sorting 30 parts per minute of polystyrene. 'Right now it's not using hyperspectral, but the client has ordered a second line for differentiating the subtleties and different types of styrofoams. Hyperspectral is really key to deliver quality sorting,' Camirand said.

Waste Robotics is also working on other

'Hyperspectral imaging gives Waste Robotics the ability to differentiate between different types of plastic... or wood'

functionality in its robot solutions, such as destacking items lying on top of each other on the conveyor. 'We believe in multi-robots and the ability to scan once and dispatch pictures to robots,' Camirand said. To do that the firm uses 3D sensors to give as precise a location of each piece in the stack as possible. The aim is that none of the material is displaced as the robots handle the stack, so when the items get to the third robot they are still at the same location as when the original scan was made. 'There's a lot of people who think having a fast robot is a solution, but having one fast robot is not as good as having two slower robots because you can distribute the workload,' he added.

AI is useful for distinguishing between plastic bags on a conveyor, for instance, which is a complex computer vision challenge. The AI algorithm will learn to see features like the knot in a refuse sack, or the valleys in between two bags.

Every image from every sensor Waste Robotics uploads to the cloud; it is building a huge database of images, including hyperspectral, 3D and RGB. That allows the company to train its neural networks centrally. If the client participates in collective robot learning – if they share their data – then whatever one robot is trained on, other robots within the network will benefit. 'If a new container comes on the market and appears in Singapore, and the robot is taught there and starts picking it,

Latest products

Among the recent products launched that are suitable for spectral imaging are lenses from Kowa, with a transmission of 450 to 2,000nm. The lenses also have a reduced focus shift over this wavelength range – without visible-to-shortwave-infrared optics, users might need to adjust the focus by changing the illumination and changing the lens.

The one-inch format lenses are available with focal lengths of 12mm, 25mm and 50mm, with 8mm, 16mm and 50mm following in October.

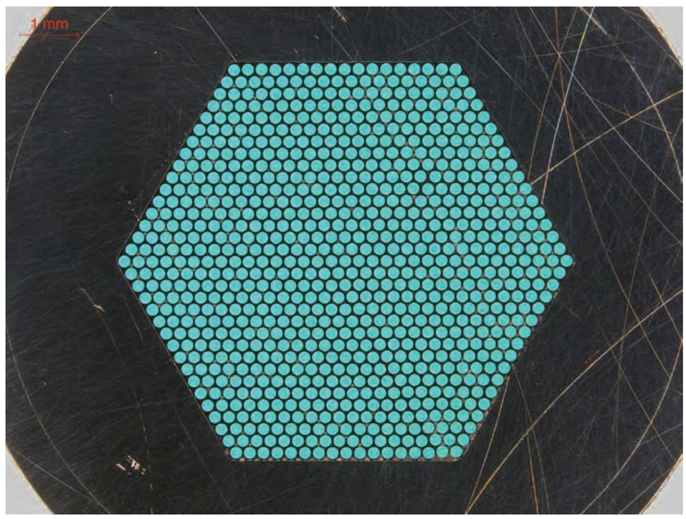
Ximea has released a new generation of hyperspectral cameras in the XiSpec series. The new cameras, using sensors from Imec, include line scan and snapshot mosaic versions.

The XiSpec2 cameras measure 26.4 x 26.4 x 32mm and weigh 32g. The band-pass filters have been optimised to improve spectral performance. The cameras are ideal for applications like precision agriculture, material science and medical imaging. For projects where integration into limited space is required, models with USB3 flat-ribbon connection or PCIe interface are available.

Lighting provider Ushio has updated its Spectro LED series with an indium gallium nitride (InGaN) chip that achieves an output power of 180mW at 500 to 1,000nm. The $1mm^2$ chip emits a total broadband visible to near-infrared spectrum, meaning multiple LEDs are not necessary to cover this hyperspectral wavelength band. The SMBB package means there is no need for a heat-dissipation jig to accompany it.

ProPhotonix has added a hyperspectral LED line light to its Cobra MultiSpec platform. It has a spectral range from 400 to 1,000nm and excellent spatial and spectral uniformity. The spectrum is well-matched to the Specim FX10 camera, for example, or machine vision cameras using the Sony IMX174 sensor. For applications covering an extended spectrum, the Cobra MultiSpec can be developed in configurations of up to 12 wavelengths, from 365 to 1,700nm.

LEDs offer advantages over traditional halogen light sources, including compactness, longer lifetimes and greater control of the emission spectrum. System designers will benefit from reduced-form factors, without the need for additional heat extraction equipment, and excellent spectral control, allowing improved system optimisation and enabling new applications.



Optical fibre bundle from Sedi-ATI

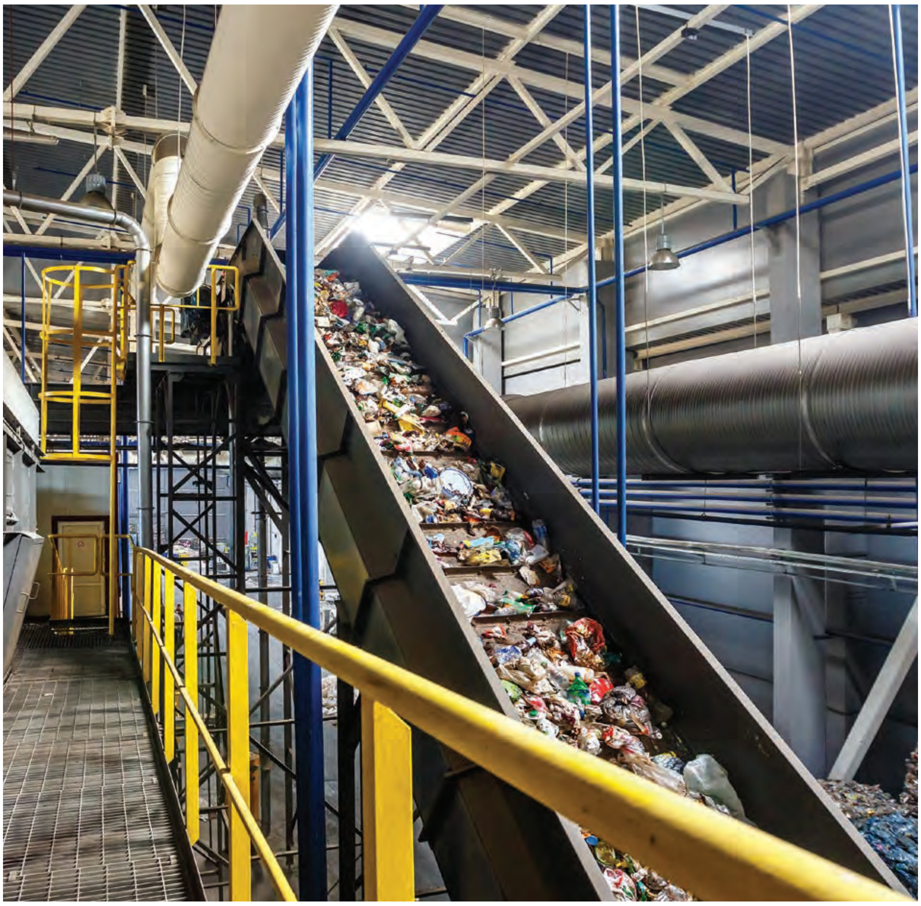
Finally, French fibre optic provider, Sedi-ATI, suggests using custom fibre-optic bundles to perform hyperspectral imaging.

Fibre optic bundles are a flexible option for spectral or hyperspectral imaging, the firm said. Broadband optical fibres are particularly well suited to this type of application.

The image is reconstituted by using masks ordering each optical fibre – the same imaging principle used in telescopes. A spectrometer would generally be used to get a reading from the fibre optic bundles.

The number of optical fibres and their respective core diameters constitute the pixels of the transported image. Bundles of several hundred fibres can be assembled, with offsets of several tens of metres.

One example Sedi-ATI gave is a bundle of 200µm core diameter broadband optical fibres to form an image of about 800 pixels over a spectrum from 300nm to 2.1µm.



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then if that container shows up in Montreal we'll pick it because we're sharing the same database,' Camirand explained.

In addition, because all the images are saved it means the client can replay the tape if needed. There's not always time to analyse everything, Camirand said, but images can be looked at again, which is useful for the client to find out what's happening on their sorting lines, to analyse the overall productivity or the quality of the material being brought into and sent out of the plant.

Waste Robotics uses Specim FX17 hyperspectral cameras; for lighting it uses halogen bulbs. 'We've tried other more concentrated [lighting] solutions,' Camirand said, with little success. He said that, ideally, he'd like to bring all the halogen light into a narrow line for line-scan imaging. 'At the moment we use diffuse lighting, which is okay, but we're using too much light and there's too much heat to manage,' he said.

Filament-based light sources, like halogen or tungsten, have a broad spectrum with a lot of shortwave infrared content and therefore radiate a lot of heat. Speaking during the webinar, Steve Kinney, director of engineering at Smart Vision Lights, explained that a light source with a broad spectrum can result in big differences between the highest spectral peaks of the light and the lowest spectral components in the area of interest, which makes it difficult for the camera to assimilate all the wavelengths.

'The material that's missed and sent to landfill costs money'

He said using filters can help here or, by using LED illumination, the output can be tuned to the wavelengths needed. There is less heat with LEDs, but also the narrowband nature of them – and the fact that each band can be tuned and the peaks flattened – means there is less dynamic range to soak up by the camera. Therefore, the camera's dynamic range is used on the scene and not in the differences in the light source spectrum.

Smart Vision Lights provides LED lighting for both multispectral and hyperspectral imaging, although Kinney said that, largely, LED illumination is more suited to multispectral imaging.

Camirand said that, at the moment, waste sorting lines are being automated alongside manual labour. However, the end game is for fully autonomous lines that feed themselves. 'Maybe they'll go a little slower, but for longer days,' he said. 'That's what we're aiming for.'

Building towards Industry 4.0

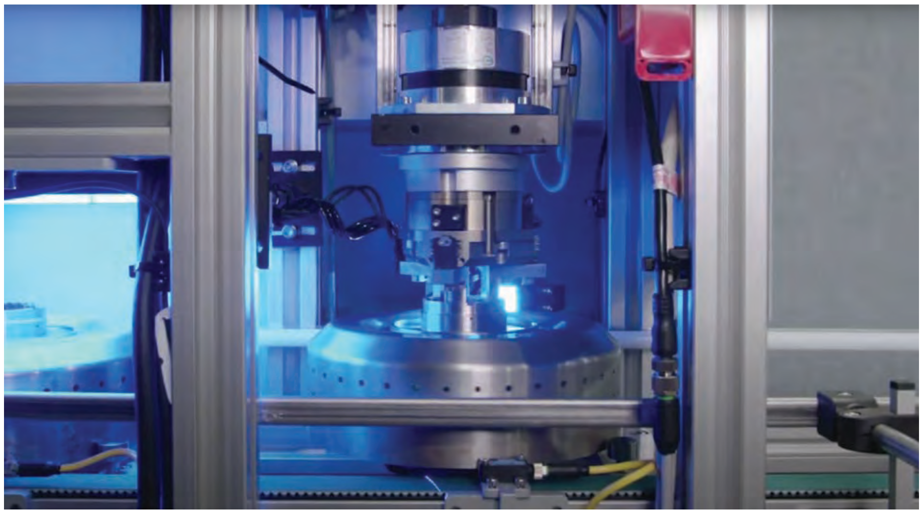
Keely Portway finds out how vision systems can be more tightly integrated within factory machinery

The concept of the fourth industrial revolution, or Industry 4.0, has been around for more than a decade, with many big names such as Amazon, Siemens and Boeing early adopters of smart factory technology to make their production processes more efficient.

While many markets have been negatively impacted by Covid, manufacturing has been considered an essential or frontline service. Now, orders for automation equipment in manufacturing are coming thick and fast, and businesses are recognising a need for digital technologies to run more smoothly.

As an example, telecoms vendor Huawei last year launched its 5G digital engineering solution, based on the idea of site digital twins. It involves creating a digital replica of a physical site, so that factory infrastructure can be managed digitally throughout its lifecycle, from planning and design, to deployment and maintenance. Based on the digital twins, Huawei is using advanced photogrammetry and AI to help with digital network specification for telecoms.

This is something with which vision integration firm, Asentics, has been closely involved. The firm's chief executive, Dr Horst Heinol-Heikkinen, is also chairman of the VDMA OPC Vision group, a joint standardisation initiative led by the VDMA and the OPC Foundation, which aims to include machine vision in the industrial interoperability standard, Open Platform Communications Unified Architecture (OPC UA). The open interface OPC UA was established as a standard in Industry 4.0, leading to the creation of the series of companion specifications to ensure the interoperability of machines, plants and systems.



Integro Technologies

Intergro Technologies has several patents in machine vision

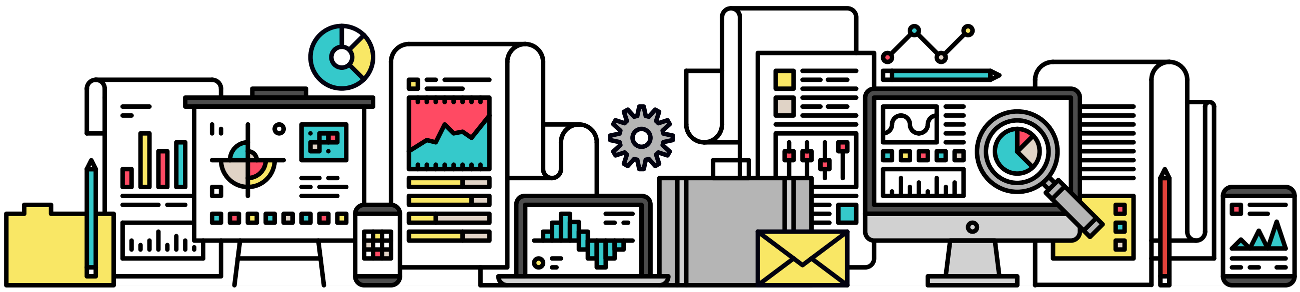
Under control

The machine vision companion specification for OPC UA was launched to facilitate the generalised control of a machine vision system and abstract the necessary behaviour via a state model. The assumption of the model is the vision system in a production environment goes through a sequence of states that are of interest to, and can be influenced by, the environment. In addition to the information collected by image acquisition and transmitted to the environment, the vision system also receives relevant information from the environment. Because of the diversity of machine vision systems and their applications, other methods and manufacturer-specific extensions are necessary to manage the information flow. The vision companion specification is therefore an industry-wide standard that is designed to allow freedom for changes or individual additions. While part one of the companion specification focuses on the standardised integration of machine vision systems into automated production systems, part 2, currently in progress, will use this to describe the system and its components.

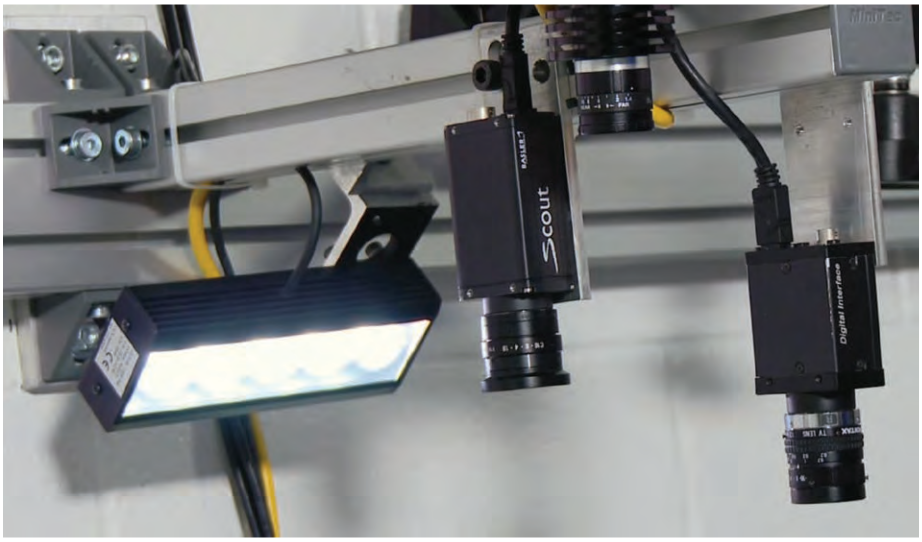
> 'We need to make sure that [Industry 4.0 hype] doesn't dilute understanding about what machine vision can do'

The focus will be on asset management and condition monitoring of these components. It's not only image processing that is establishing a standard; the number of information models in general is increasing, with more companies and industry sectors getting involved. It is these models that form the foundation for the next goal: the digital twin.

Asentics is heavily involved in this development process and is a member of the recently formed Industrial Digital Twin Association (IDTA). The aim of the association is to use the already established digital twin as an interoperable core technology for all future developments with regard to Industry 4.0. Heinol-Heikkinen is deputy chairman of IDTA. He says: 'The digital twin is the key investment in the future viability and crisis resilience of mechanical engineering. It is also an →



Leoni Vision Solutions



Leoni Vision Solutions builds and integrates custom inspection systems

→ effective tool for implementing all of those Industry 4.0 standardisation measures. But, above all, it is the enabler of our future business fields.'

Integrators remain vital

Industry 4.0 might lead to further demand for automation and vision systems, but integrating vision technology for manufacturing has been around long before Industry 4.0, as David Dechow, principal vision systems architect at vision integrator, Integro Technologies, can attest. 'During the 40 years in which I have been working [with vision], there have been significant advances in machine vision systems,' he says. 'I think the growth and the capability of that technology has never before been as good as it is now. It is a fantastic enabling technology for other technologies within automation and what makes it fun is the diversity of what you work with, even the most challenging applications.'

In terms of whether new technology or concepts, such as Industry 4.0, means there's a shift in the role of the machine vision integrator, Dechow is not so sure. 'The machine vision industry has evolved,' he says, 'but end users look to developments like Industry 4.0 and smart manufacturing or the industrial internet of things in the same way they have always looked to machine vision integration: to improve their processes and make them more efficient.'

The more cutting-edge application areas, Dechow explained, as with all machine vision integration tasks, will still require a detailed process with steps for planning, design, implementation and deployment, but applications such as deep learning in industrial applications, for example, may require a larger team, or different skill sets than those used in standard machine vision.

'While Industry 4.0 has a lot of buzz surrounding it,' Dechow says, 'with many articles warning that manufacturers who don't adopt it early enough will fail, we need to make sure that this doesn't dilute the end user's understanding about what machine vision can do. They [end users] have always turned to machine vision integrators to improve their processes. It has always been our role to make the system work, even in more complex applications, using the most successful machine vision solution for their particular requirements.'

Seat of power

Likewise, Leoni Vision Solutions, part of Leoni Engineering Products and Services (LEPS), emphasises the important role that vision integrators play. The company has an in-house machine vision development laboratory to run feasibility studies, and ultimately create a custom solution.

One of the inspection systems Leoni has built is for checking seat mould assembly. This is a challenging vision task, where the system is used to verify components that have been encapsulated into each foam piece. The increasingly complex design and large variety of seat moulds requires an inspection system capable of adapting without interrupting the run.

The inspection process begins right after the operators finish placing components into the cavity. One of the inspection system's cameras captures images of predetermined points in the cavity where most variation occurs. The system uses a dedicated camera to measure the intensity of the mould, so that the main inspection cameras can be offset to create maximum contrast between the components and the mould itself.

'It additionally compensates for different seat geometries and mould depths by strobing an extraordinary amount of light and using a novel optics and lighting setup,' says Jim Reed, vision product manager at LEPS. This increases depth of field, which enables the system to cover the full range of depth required to inspect all seats and moulds. 'Whether the cavity is four, eight or 10 inches deep, we can keep that whole range in focus,' he adds.

Next, the main inspection cameras verify that correct components are placed in the proper locations in the seat cavity. Once the system software confirms the presence of the components, it issues a pass or fail determination. When a mould passes, the system sends a signal to the programmable logic controller. The mould then travels to the robot pour station, where it's filled with foam, the lids close and the feed is completed. If the system detects missing components, it alerts the controller to not pour that seat mould.

Deep learning can be incorporated for instances when moulds have handwriting or machining marks, or if they look different from one another, even if the machine is producing the same part. Previously, each mould had to be programmed individually,

'While deep learning isn't a magic bullet in industrial inspection, it can offer value'

but by incorporating deep learning into the process, operators can program a single part number rather than every seat cavity in-house, saving a lot of time in the process.

Deep impact

While deep learning isn't a magic bullet in industrial inspection, it can offer value, especially when features to be detected require subjective decisions like those that might be made by a human. 'These systems are incredibly complicated from a vision standpoint, because of the sheer volume and variation between part numbers and models, as well as the programming and changes,' says Reed. 'One mould may have 30 inspections being performed on it, so if you take those inspections and multiply it by 200 part styles for 1,500 different models, you can quickly see how this becomes quite complex.'

One of the potential advantages of using deep learning to accommodate more variation in the part is there's less time spent programming and maintaining the system. 'These and many other advanced vision techniques,' says Reed, 'provide a wide range of integrated solutions for many potentially challenging applications, beyond just the mould insert verification and inspection.'

Food branding with support of 3D sensors: how effective process optimisation works in the food industry

- AT – Automation Technology develops 3D application for fruit and vegetable labelling
- 3D sensor technology from AT enables future-oriented food tracking
- EcoMark relies on sensor solution from AT from the very beginning

By Nina Claaßen

Fast, precise, flexible: AT – Automation Technology has made an international name for itself with its 3D sensor portfolio and has always been one of the leading industry suppliers. The reason for this is the individual development of the 3D sensors, so that the company from northern Germany can offer a suitable solution for almost any application, which is then manufactured exactly according to the customer's specifications – even without extra costs for custom manufacturing, without minimum order acceptance and also without long waiting times.

One company that benefits from these advantages of AT 3D sensors is EcoMark GmbH, which specialises, among other things, in labelling food directly on the tray via laser marking. On the one hand, it's done to produce less plastic and packaging in the future, but on the other hand, to provide an effective process under the aspect of sustainability and environmental friendliness, which at the same time is also demonstrably economical. However, food branding required a great deal of technical know-how right from the start, as there were a number of important details to consider when labelling food.

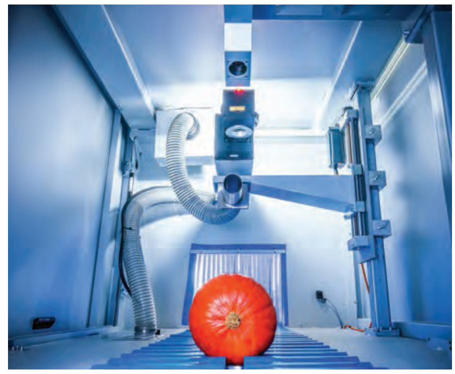
Technical requirements for the 3D application of food branding

To be able to position the marking laser individually for each product and thus guarantee a 100% hit rate for the marking of groceries, an individual application was required. With the help of a 3D sensor, this application had to be able to determine the position of the fruit and vegetables on the conveyor belt. The challenge was to develop a 3D scan solution that is not only highly precise and fast, but also sends reliable data to the marking laser, despite changing measurement widths and different positions of the fruit and vegetables. AT's solution: a product from the C5-2040CS sensor family. The 2040 sensors not only combine speed and accuracy, they also allow a measuring width of up to one metre, with a high resolution of 2,048 measuring points. Furthermore, they are virtually maintenance-free and require hardly any support, as they are already factory calibrated and can be easily integrated into any existing system via Plug&Play using their GigE Vision interface without much installation effort.

'EcoMark is a perfect example of the unique diversity of AT's 300+ sensor variants,' explains Michael Wandelt, chief executive of AT. 'Based on the customer's technical data, we were able to deliver the right 3D sensor to meet their exact requirements. We always try to offer the best possible product for each of our customers to significantly benefit their processes and increase their effectiveness.'

Food branding is significantly more economical than packaging

However, the focus is also on the cost-effectiveness of this process optimisation. 'We are very optimistic that the trend of food labelling directly on the tray will become established in the future,' says Richard Neuhoff, chief executive of EcoMark. 'Ultimately, this method is significantly cheaper than previous plastic solutions, as packaging costs are completely eliminated. We only incurred costs at the beginning of production due to the purchase of the labelling system, further follow-up costs are very low.'



Inside a branding machine

Even before EcoMark developed machines for food branding, the company was already specialised in laser machines for marking any material. Due to years of expertise in this area, the idea of so-called natural branding was born in 2018, with which the company was able to attract global attention. EcoMark GmbH is now one of the largest international providers of food and natural branding. In general, their labelling machine marks up to 100,000 fruit products per hour, depending on the thickness of the tray and the nature of the variety. 'Each fruit and vegetable product has a different size and, of course, a different peel, so we always have to be careful to find the best compromise between the visibility of the marking and the shelf life of the product,' Neuhoff continues. 'If the laser were set incorrectly, for example, the peel would be destroyed in the process, so you have to know very well what you are doing.'

3D application with future

For the application that EcoMark has developed, it is irrelevant whether a kiwi or a cucumber is lying on the conveyor belt. The 3D sensor scans the fruit and vegetables flexibly and creates a 3D point cloud for each product within milliseconds, according to which the marking laser is then aligned. To date, AT EcoMark has already supplied 15 C5-2040CS sensors for the food branding application, with further sensors for other industries in the pipeline, as they have been in continuous use since first being integrated into the labelling system.

Further information www.eco-mark.de; www.youtube.com/watch?v=jpcbInyUtv0

Association news

EMVA plans for Vision 2021 as membership grows

By Thomas Lübkemeier

At Vision 2021 in Stuttgart, from 5 to 7 October, the EMVA will again host the International Vision Standards Booth located in hall 8, B50. Visitors will find information on the most commonly used machine vision interface standards and be able to speak to experts regarding future developments. During Vision the EMVA will announce details about its new online autumn webinar concept, the EMVA Spotlight series. The EMVA has decided to postpone the popular International Vision Night to the 2022 edition of Vision.

Board meeting defines roles

During its recent in-person meeting, the new EMVA board of directors confirmed Dr Chris Yates as EMVA president and elected Professor Dr Bernd Jähne as EMVA vice president, while Arndt Bake from Basler was elected as new treasurer of the association.

Market trends

The EMVA quarterly machine vision sales report for the second quarter of 2021 gives mixed messages for the vision sector. While the second quarter of this year was extremely strong, with a 25 per cent sales increase compared to the same quarter a year ago, industry sentiment for the coming six months has darkened. While in the first quarter of this year 82 per cent of the statements said sales would increase in the coming six months, the supplier outlook has changed to a more pessimistic view, with 72 per cent predicting the next six months of sales will be flat.

New members

EMVA membership has risen again during the summer and becomes even more diverse. It is our pleasure to welcome six new EMVA member companies and institutes, starting with Fraunhofer Institute for Production Systems and Design Technology (IPK), which presents itself as a research partner for digitally integrated production.

Secondly, Taiwan's Neousys Technology has joined the association. The company designs and manufactures industrial-grade embedded modules and systems, with core expertise ranging from embedded computing to data acquisition and processing, generating solutions for automation, machine vision, transportation, GPU computing, surveillance and video analytics.

Our third new member is Zebra Technologies Europe. Zebra supplies a wide range of industries with solutions, such as barcode scanners, mobile computers, RFID and real-time location systems, intelligent workforce management and execution solutions, data services and prescriptive analytics, and intelligent automation systems.

Bright Machines, headquartered in San Francisco with research and development centres in the US and Israel, is another new EMVA member. It was founded in 2018 by industry veterans with a software-first approach to transform industrial manufacturing processes. With its deep technical expertise in software and hardware, the company offers a complete solution for industrial automation.

The fifth new member is Bizerba Luceo. The French specialist in industrial inspection solutions has been designing, manufacturing and installing vision solutions for quality control of processed products and individual packages for more than 30 years.

Last but not least, we are proud to welcome our newest member, Venturi Astrolab, which opens up new ways to explore distant planets. Based in Hawthorne, California, the team builds and operates a fleet of commercial, multipurpose planetary rovers.

A warm welcome to all our new members!

Anticipation building for Vision Stuttgart

By Dr Klaus-Henning Noffz, chairman of the board of VDMA Machine Vision and director of new business development at Basler

The VDMA's machine vision group – and also the entire VDMA with its 36 trade associations and 3,200 members – is incredibly excited about Vision 2021. As one of the first trade fairs in Germany to take place again after one and a half years of digital events, Vision will have a great impact and signal progress far beyond the machine vision industry. And once again, it is the machine vision industry that is moving forward with dynamism and optimism.

Preparations for Vision 2021 are in full swing, not only among exhibitors, but also among the board and at the VDMA Machine Vision office. In August, we had to review more than 65 submissions for the Industrial Vision Days, and select who would get one of the much sought-after presentation slots.

The selection was particularly difficult this year. Exhibitors are eager to present recent trends and innovations in as practice-oriented, comprehensible and entertaining a manner as possible. Also, VDMA Machine Vision is organising two panel discussions, one on smart cameras and smart sensors, the other on deep learning.

Like all of the more than 260 Vision exhibitors, VDMA Machine Vision is hoping for full halls and lively participation in the presentation forum and at the exhibition stands. But we already know: not everyone who had intended to come to Stuttgart in 2021 will be able to do so.

Those who cannot attend the trade fair will be missing out on a lot! Fortunately, Messe Stuttgart will be streaming the Industrial Vision Days. This does not replace meetings and exchanges on site – be it at product demonstrations on stands or during the discussions and presentations at the forum – we are all aware of that. But we hope that many new and old customers will be able to attend this year's Vision, and that others will be able to connect digitally via the forum. And that there will be a general feeling that the machine vision community around the globe will look towards Vision in Stuttgart, the leading trade fair for machine vision.

You will find the VDMA team at the Industrial Vision Days forum, at Vision Start-up World, at the international vision standards booth and, of course, at the VDMA booth opposite the Industrial Vision Days.

We look forward to meeting and exchanging ideas with you!

Forty presentations form online UKIVA tech hub

UKIVA
UK Industrial Vision Association

By Neil Sandhu, UKIVA chairman

How long does it take for new machine vision technology to become adopted as a 'standard tool' in real-world applications? This was one of the many interesting questions posed to the panel of experts at the recent UKIVA round-table webinar, chaired by *Imaging and Machine Vision Europe's managing* director, Warren Clark. It provided an excellent opportunity for attendees to have direct interaction with some of the leading figures from the UK and European machine vision industries, with the focus on the latest machine vision trends and technologies.

The webinar followed hot on the heels of the launch of UKIVA's Machine Vision Conference Technology Presentation Hub 2021 (www.machinevisionconference.co.uk) on 15 July. The hub hosts a set of more than 40 new online video presentations that would have been delivered in person had UKIVA's Machine Vision Conference and Exhibition (MVC) gone ahead.

The new presentations, from an array of renowned experts in machine vision, cover the latest developments and practical uses of vision technology. The most popular content to date, based on unique page views, has once again been deep learning and embedded vision, and camera technology, as it was for the 2020 hub.

Three key factors influence the adoption of new technologies such as deep learning: capabilities, ease of use and affordability, and in machine vision these are often driven by software developments and processor performance. This has certainly been the case in recent years for deep learning and embedded vision as well as other techniques such as hyperspectral imaging, which are now much more readily accessible. During the UKIVA webinar, the panel discussed these factors and looked at the parallels with 3D imaging, which is now a well-established machine vision tool. A full recording of the webinar is available at www.ppma.co.uk/ukiva/vision-events/machine-vision-trends-technologies.html.

While it was not possible to hold MVC as an in-person event this year, it will return to the Marshall Arena, Milton Keynes, UK, on 28 April 2022. In the meantime, other events in the UK, such as the PPMA show 2021 at the NEC, Birmingham (28 to 30 September), are providing opportunities for face-to-face discussion. Eleven UKIVA members who are involved in serving the processing and packaging industry are taking part in the PPMA show. It is also good to see that the Vision show in Stuttgart has been confirmed as taking place.

Webinars and online events will continue to provide access to important information. However, the return of conferences and trade exhibitions will no doubt prove to be popular with exhibitors and visitors alike. They offer a unique platform for discussing application problems with experts in the field, finding out about the latest technology in a single location, and developing genuine networking opportunities.

Products

More products now online at
www.imveurope.com/products

Lenses

Fujinon releases HF-XA-1F series

Fujifilm has released a series of industrial lenses designed to withstand shocks and vibrations. The Fujinon HF-XA-1F series is suitable for image sensor sizes from 2/3 inches to 1/1.2 inches, and resolutions up to 5 megapixels with 3.45µm pixel sizes.

The HF-XA-1F series carries over the optical design and performance of the HF-XA-5M lenses, but with Fujifilm's anti-shock and vibration technology, along with a mechanical design with no moving parts inside the lens.

The lenses give low distortion and consistent image sharpness at the edges, even with a short minimal object distance (starting at 100mm), as well as consistent image quality regardless of the object distance.

The focus is adjusted with a special C-mount and its nut and counter-nut system: the user attaches the lens to the camera by turning it into the C-mount thread until the correct focus is achieved. This position is then locked using the mount nut on the lens. In this way, the lens is adjusted to the sensor without moving optical glass parts inside the lens.

Similarly, the iris is fixed to avoid moving parts. Users can adapt the iris to their needs by exchanging the fixed iris plate. Three different plates are provided with every lens: F open, F4 and F8. They can be exchanged by the user and are screw-locked to ensure they can withstand heavy shocks and vibrations.

Fujifilm has tested the lenses by applying forces of up to 10G in six directions and measuring the shift of the optical axis after the test. The range includes five models with 8 to 35mm focal lengths.

www.fujifilm.com

Complete vision systems

TM-X5000 telecentric measurement by Keyence

Keyence has introduced a range of inline telecentric measurement systems employing advanced silhouette-based analysis.

Designed to measure parts rapidly and consistently as they pass through the system, the TM-X5000 boasts an exposure time of 25µs. It provides a versatile solution for a broad spectrum of industrial measurement applications, offering geometric dimensioning and tolerancing; outer diameter and profile measurement; abnormality detection; and runout and positioning.

The telecentric optics improve measurement repeatability by increasing uniformity throughout the field of view. The dual telecentric silhouette-based system provides stability, while the large ±15mm depth of field, based on telecentric lenses in both the transmitter and receiver, provides clear, sharp edges and stable measurements, even where the target position varies.

An optical alignment function enables rapid, simple installation, while the user interface features a wide variety of measurement tools.

The range has three models: the compact, ultra-high accuracy TM-X5006; the standard TM-X5040; and the TM-X5065 for wide field applications.

www.keyence.co.uk/tmxrelease

Computing

New FantoVision 20 embedded computer

Gidel has introduced a small and robust embedded computer for high-throughput image acquisition and image processing. FantoVision 20 can carry out image processing, compression and recording of video streams with up to 20Gb/s in real time.

The computer is equipped with two 10GigE and Camera Link 80-bit (deca) connections. Its architecture combines an Nvidia Jetson Xavier NX embedded computer with an Intel Arria 10 FPGA. This gives high-end frame grabbing with real-time AI and image processing.

Algorithms are programmed using C/C++, Cuda and Nvidia's AI, image processing and compression libraries. The FPGA offers pre-processing and compression capabilities. Using multiple FantoVision 20s and Gidel's open-FPGA InfiniVision acquisition flow, more than 1,000 camera streams can be captured and synchronised simultaneously.

The computer has a 134 x 90 x 60mm^3 form factor and the hardware is designed to operate under industrial conditions. Passive and active cooling options are available. Using a 10Gigabit Ethernet switch, multiple GigE cameras can be networked for 360° inspection or 3D scanning.

Potential applications include high-speed inspection, intelligent transportation systems, broadcast, medical devices, agriculture and aerial mapping, among others.

www.gidel.com

Cameras

Hypersen cameras launched

Scorpion Vision is launching two low-cost, high-speed, high-resolution machine vision cameras at the PPMA show in Birmingham, UK. They are both characterised by ultra-fast frame rate capabilities at full resolution.

The 25-megapixel Hypersen HPS-HSC5K offers frame rates of 150fps at full resolution, while the 2.2-megapixel Hypersen HPS-HSC2K offers frame rates of 1,490fps. They are suited to applications where spatial resolution and speed are critical, including inspection applications on high-speed production lines, process and machinery diagnostics, and logistics applications.

The standard C-mount cameras use global shutter CMOS sensors with large pixel sizes to reduce noise. The models have GenICam and GenTL support, and a 40 Gigabit Ethernet optical fibre interface is included.

Flexible triggering options are provided. Built-in image processing capabilities include denoising, photo response non-uniformity correction, gamma and lens correction, adjustable region of interest, gain adjustment, horizontal and vertical binning, and left/right and up/down mirroring.

www.scorpionvision.co.uk

Ensenso S 3D camera introduced

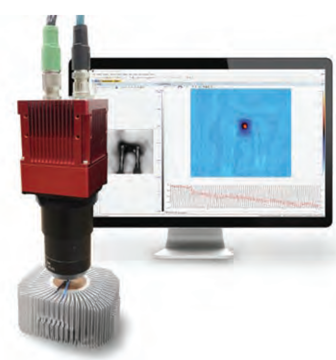
IDS Imaging Development Systems has introduced a 3D camera, the Ensenso S, designed for 3D applications that require budget-friendly, easy-to-integrate and industrial-grade camera technology.

The Ensenso S10 has a compact, IP65/67-protected housing and generates 3D data using laser point triangulation, supported by AI. It is equipped with a 1.6 megapixel Sony sensor. A narrowband infrared laser projector creates a high-contrast dot pattern, even on objects with difficult surfaces or in low-light environments. The camera's laser point triangulation is accelerated by a neural network for reliable mapping of the pattern points to the hard-coded positions of the projection. This results in geometrically precise 3D data with high-depth accuracy.

At object distances of 50cm, the maximum deviation is 0.6mm. At full projector power, the Ensenso S10 3D system achieves up to 20 point clouds per second. With a rugged zinc die-cast housing, the camera has a 60° field of view and a working range of 0.5 to 3 metres.

https://en.ids-imaging.com

Infrared camera with microscope optics developed



Developed for use in non-destructive testing, the new infrared camera with microscope optics from Automation Technology offers numerous advantages for inspecting small components.

Electronic components, for instance, are often so tiny that normal infrared cameras reach their limits in terms of resolution – detailed analyses in the micrometre range can usually only be carried out with cooled infrared cameras, which are expensive. Automation Technology's infrared camera with microscope optics is cost-effective and maintenance-free, and is an optimal solution for inspecting these parts.

With the help of microscope optics, a resolution of 10μm is possible at a distance of 12mm from the object. The camera with optics is compact and can operate in a temperature range from -35C to +55C.

www.automationtechnology.de

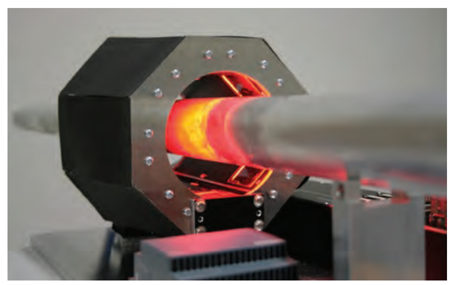
CX.XC cameras with a cooling pipe from Baumer

New from Baumer are CX.XC industrial cameras with a cooling pipe integrated directly into the housing. This makes them suitable for highly precise image capture, or for inspection in higher ambient conditions – for example, near furnaces during glass production.

The CX.XC models can be cooled with compressed air in the two- to three-bar range, or with liquids up to six bar. Effective heat dissipation means the CX.XC cameras provide images with very low noise and few defective pixels, with a dynamic output. They can be used for precise measuring tasks, such as inspecting silicon wafers in the micrometre range, without thermal effects on the lens or the image characteristics.

The cameras eliminate the need for additional cooling components, saving time and costs. The serial production of the CX cameras with an integrated cooling pipe will begin with the five megapixel models using Sony Pregius sensors in the fourth quarter of 2021.

www.baumer.com



RingCIS contact image sensor released by Tichawa Vision

Tichawa Vision has released the RingCIS, a sensor ring from the CIS-Profile-Scan product family. The device is designed for quality assurance of the outer sides of tubes, profiles and pipes, giving a 360° view of the surface.

Transport speeds of up to 600 metres per minute can be achieved, and the sensor geometry can be adapted to the different fixed or variable diameters of the profile shapes. It is possible to obtain images with resolutions of up to 600dpi, corresponding to a pixel size of 0.04mm. Users have the choice of black and white or colour RGB imaging.

Based on an eight-camera system and an image stitching process, RingCIS uses production-induced movement to scan the complete circumference of an elongated test object. The image data generated is available in Camera Link format.

www.tichawa-vision.de

Image sensors

Omnidirectional time-of-flight sensor to open up robotics use

A new time-of-flight depth sensor with a field of view of 360° x 60° has been announced by Jabil Optics.

The omnidirectional sensor is designed to support lower-cost autonomous mobile robots and collaborative robots.

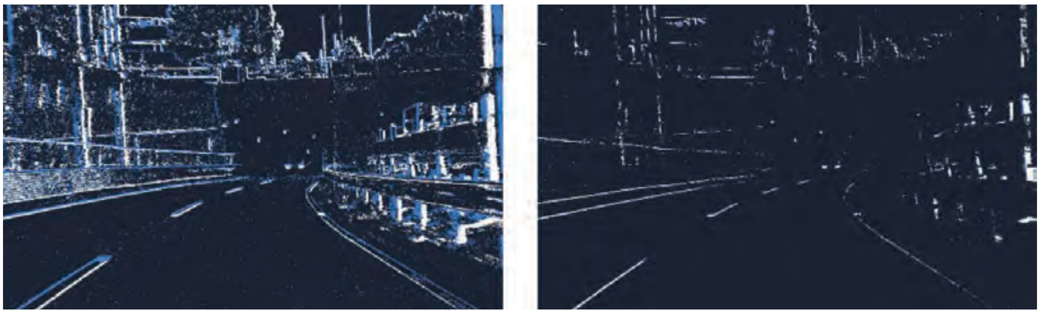
Jabil's sensor combines a custom optical assembly with an active illumination. In contrast to conventional time-of-flight cameras, the 360° field of view of Jabil's sensor means all objects within a robot's path can be tracked. This improves obstacle avoidance and worker safety. Additionally, its use of scene information to control illumination reduces sensor noise while improving data quality and power management.

The Jabil Optics team is optimising the performance of the sensor to address the needs of the robotics industry. Ian Blasch, senior director of business development at Jabil Optics, said: 'Our design goal is to provide customers with optimal sensor performance in the smallest, lowest cost and lowest power solution possible. Factors such as data formats, on-sensor processing and connectivity are moving targets in the quickly evolving robotics industry. Our beta-testing programme for the omnidirectional sensor will allow us to continue to collect targeted feedback from customers and partners in the robotics ecosystem.'

Donnacha O'Riordan, director of Analog Devices, which assessed the omnidirectional sensor for use with mobile robots, said: 'Jabil's wide field-of-view depth-sensing approach is opening up new possibilities for human interaction with robots.'

With 170 employees across four locations, Jabil Optics' designers, engineers and researchers specialise in solving complex optical problems for customers in 3D sensing, augmented and virtual reality, action camera, automotive, industrial and healthcare markets.

www.jabil.com



Sony releases event-based sensors with Prophesee

Sony Semiconductor Solutions has announced the upcoming release of two types of stacked event-based vision sensors. The industrial sensors, with a 4.86μm pixel pitch, are the result of work with Prophesee presented last year at the International Solid-State Circuits Conference.

The sensors have a dynamic range of 86dB, and resolutions of 1,280 x 720 pixels (IMX636) and 640 x 512 pixels (IMX637).

Event-based vision sensors asynchronously detect luminance changes for each pixel and output the changed data. This is combined with information on pixel position (xy coordinates) and time, thereby enabling high-speed, low latency data output.

This is different to standard frame-based imaging, where the entire image is output at certain intervals determined by the frame rate. The sensors are based on Sony's stacked structure using Cu-Cu connection to achieve conduction between the pixel chip and the logic chip. The logic chip is equipped with a signal processing circuit for detecting luminance changes for each pixel.

The sensors use event-filtering functions developed by Prophesee for eliminating unnecessary event data. Using these filters helps eliminate events that aren't needed for the recognition task, such as LED flickering (anti-flicker), as well as events that are highly unlikely to be the outline of a moving subject (event filter).

The filters also make it possible to adjust the volume of data when necessary to ensure it falls below the event rate that can be processed in downstream systems (event rate control).

Prophesee's Metavision Intelligence Suite is available for application development and provides solutions for various use cases. Prophesee has also released an evaluation kit for developing applications with the sensors.

www.prophesee.ai

Silina curves 275 CMOS sensors in world-first

French start-up Silina has developed a technology that can curve hundreds of image sensors at the same time.

In a world-first, Silina curved 275 units of one-inch CMOS sensors simultaneously in under an hour. A curved image sensor can improve image quality without expensive and complex lenses. However, until now, most curved sensors have been made with single-chip manufacturing processes. Silina's multi-sensor curving processes open up the ability to scale and reach high-volume markets.

Wilfried Jahn, CTO and co-founder of Silina, commented: 'Our innovation has been driven to unlock the technological barriers of scalability. We can control all the parameters that make the process reliable and repeatable, reducing significantly the cost of production.'

Silina does not design or manufacture image sensors, but offers a service to curve existing flat sensors. Its curving process is the same whatever the sensor format and technology, notably CMOS and CCD. It can be applied to front- and back-side illuminated sensors, and on various spectral bandwidths, from ultraviolet to visible and infrared.

Various shapes can be obtained: spherical, aspherical, freeform and custom shapes. The manufacturing process has also been developed to keep the same original packaging used for classic flat sensors, meaning the mechanical architecture and electronic board remain the same, facilitating the integration of the technology on current production lines.

Michaël Bailly, the firm's CEO and co-founder, said: 'Our services are offered to optical system designers and manufacturers, camera integrators and sensor manufacturers to [help them improve] their imaging system while reducing their cost of production. Our offer is made of two propositions: a support in optical system design to integrate the curved sensor technology in their specific applications, and an on-demand service to curve their imaging sensors.'

The company offers its services for small-volume applications of several thousand sensors a year, according to Bailly in an article for *Yole Développement*. It plans to reach high-volume markets through IP licensing.

In the article, Bailly said by curving the sensor, Silina can improve contrast and sharpness by up to five times at the image edge. Light transmission is up to three times better, offering higher performance in low light. Chromatic aberration is reduced by up to 50 per cent for better colour rendering and colour fidelity. Removing vignetting provides better illumination uniformity and better performance in low light.

He added that there can be up to 50 per cent reduction in the number of optical elements, such as lenses and mirrors, needed in a camera.

silina-57.webselfsite.net

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Alkeria
Tel. (+39)050-778060
www.alkeria.com

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Tel: +44 1635 30345
sales@alrad.co.uk
www.alrad.co.uk

AT – Automation Technology GmbH
Tel: +49 (0)4531 88011-0
info@automationtechnology.de
www.automationtechnology.de

Avnet Silica / Avnet EMG GmbH
Tel: +49 (0) 8121 777-02
yourmessage@avnet.eu
avnet-silica.com

BitFlow, Inc.
Tel: +1 781 932 2900
sales@bitflow.com
www.bitflow.com

CCS Europe N.V.
Tel: 32-2-333-0080
info@ccseu.com
www.ccs-grp.com

Cognex
Tel: +44 121 296 5163
contact.eu@cognex.com
www.cognex.com

EBV Elektronik
GmbH & Co.KG
Tel: +49 (0)8121 7740
www.ebv.com/locations
www.ebv.com

Edmund Optics
Tel: +44 (0)1904 788600
sales@edmundoptics.eu
www.edmundoptics.eu

Emergent Vision Technologies
Tel: +1-866-780-6082
sales@emergentvisiontec.com
https://emergentvisiontec.com

Hikrobot
Tel: +86-0571-88967998
hikrobot@hikrobotics.com
www.hikrobotics.com

JAI A/S
Tel: +45 4457 8888
camerasales.emea@jai.com
www.jai.com

JARGY CO., LTD.
Tel: +886-2-2662-5200
sales@jargy.com.tw
www.jargy.com.tw

Kowa
Tel: +49 211-542184-0
lens@kowaoptimed.com
www.kowa-lenses.com

LMI Technologies Inc.
Tel: +1 604 636 1011
contact@lmi3d.com
www.lmi3d.com

LUCID Vision Labs GmbH
Tel: +49 (0) 7062 97676 12
sales.emea@thinklucid.com
www.thinklucid.com

Macnica ATD Europe
Tel : + 33 (0) 1 30 15 69 70
sales@atdelectronique com
www.atdelectronique.com/macnica

MATRIX VISION GmbH
Tel: +49 7191 94320
sales@matrix-vision.com
www.matrix-vision.com

Midwest Optical Systems
Tel: +1 847 359-3550
info@midopt.com
www.midopt.com

Navitar
Tel: +1 585-359-4000
info@navitar.com
www.navitar.com

Opto Engineering®
Tel: +39 0376 699111
press@opto-e.com
www.opto-e.com

Pixelink
Tel: +1-613-247-1211
sales@pixelink.com
www.pixelink.com

Sill Optics GmbH & Co. KG
Tel: +49 9129 9023 0
info@silloptics.de
www.silloptics.de

Smart Vision Lights
Tel: +1 (231) 722-1199
sales@smartvisionlights.com
www.smartvisionlights.com

SVS-VISTEK GmbH
Tel: +49 (8152) 99 85 0
info@svs-vistek.com
www.svs-vistek.com

The Imaging Source Europe GmbH
Tel: +49 421 335910
info@theimagingsource.com
www.theimagingsource.com

TPL Vision
Tel: +44 (0)1738 310 392
www.machinevisionbar.com
www.tpl-vision.com

XIMEA GmbH
Tel: +49-251-202408-0
info@ximea.com
www.ximea.com

Suppliers by industry sector

Accessories
Alkeria
ALRAD IMAGING
Avnet Silica / Avnet EMG GmbH
BitFlow, Inc.
Cognex
Edmund Optics
JARGY CO., LTD.
Kowa
LUCID Vision Labs GmbH
MATRIX VISION GmbH
Midwest Optical Systems
Opto Engineering
SVS-VISTEK GmbH

Cameras
Alkeria
ALRAD IMAGING
AT – Automation Technology GmbH
Avnet Silica / Avnet EMG GmbH
Cognex
Edmund Optics
Emergent Vision Technologies
Hikrobot
JAI A/S
LUCID Vision Labs GmbH
MATRIX VISION GmbH
Opto Engineering
Pixelink
SVS-VISTEK GmbH
The Imaging Source Europe GmbH
XIMEA GmbH

Complete vision systems
ALRAD IMAGING
AT – Automation Technology GmbH
Avnet Silica / Avnet EMG GmbH
Cognex
LMI Technologies Inc.
Pixelink

Consulting services
Avnet Silica / Avnet EMG GmbH
Macnica ATD Europe
MATRIX VISION GmbH
SVS-VISTEK GmbH
The Imaging Source Europe GmbH

Frame grabbers
ALRAD IMAGING
Avnet Silica / Avnet EMG GmbH
BitFlow, Inc.
SVS-VISTEK GmbH
The Imaging Source Europe GmbH

Illumination
ALRAD IMAGING
Avnet Silica / Avnet EMG GmbH
CCS Europe N.V.
Cognex
Edmund Optics
Macnica ATD Europe
MATRIX VISION GmbH
Opto Engineering
Smart Vision Lights
SVS-VISTEK GmbH
TPL Vision

Lasers for machine vision and inspection
ALRAD IMAGING
AT – Automation Technology GmbH
Avnet Silica / Avnet EMG GmbH
LMI Technologies Inc.

Lenses
ALRAD IMAGING
Avnet Silica / Avnet EMG GmbH
Edmund Optics
Hikrobot
Kowa
LUCID Vision Labs GmbH
Macnica ATD Europe
MATRIX VISION GmbH
Navitar
Opto Engineering
Pixelink
Sill Optics GmbH & Co. KG
SVS-VISTEK GmbH
The Imaging Source Europe GmbH

Sensors
ALRAD IMAGING
AT – Automation Technology GmbH
Avnet Silica / Avnet EMG GmbH
Cognex
LMI Technologies Inc.
Macnica ATD Europe
Pixelink

Software
Avnet Silica / Avnet EMG GmbH
BitFlow, Inc.
Cognex
LMI Technologies Inc.
LUCID Vision Labs GmbH
Macnica ATD Europe
MATRIX VISION GmbH
Opto Engineering