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October/November 2022
Issue 113

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Sights on Stuttgart

It has been a successful year for the machine vision sector. At the opening of the Vision show in Stuttgart, Mark Williamson, Chairman of the Board of VDMA Machine Vision, said the VDMA was predicting 8% growth in turnover from German vision suppliers, a cautious estimate coming off the back of a much better than expected 2021 that saw 16% growth in the sector in Germany.

The Vision show itself – news from the trade fair starts on page 10 – was packed with the latest products and innovations. GigE was particularly prominent, with cameras boasting 5GigE, 10GigE, 25GigE and even 100GigE capability on display (our Tech Focus on page 32 gathers together some of the latest product releases in this area).

The Vision Award was won by Kitov for its robot path planning software, designed to make it easier to automate inspection tasks from a CAD model (more on Kitov's technology on page 14). The other award winner at the show, Visometry, which won best start-up, is also using CAD models in its industrial augmented reality software. Both are examples of new digital approaches to manufacturing as factories get smarter.

The number of 3D imaging solutions seems to grow at every Vision, and this year's event was no different (see the article on page 16). AI was another trend that was everywhere at the show.

The next Vision Stuttgart won't be until 2024 and, with the pace of change accelerating in the vision sector, it'll be interesting to see how technology and businesses progress over the coming two years.

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News

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Prophesee raises €50m for neuromorphic imaging

The Prophesee team

Neuromorphic vision technology provider, Prophesee, has announced it has raised €50m in series C funding.

The investment makes the firm the EU's most well-funded fabless semiconductor start-up, having raised a total of €127m since its founding in 2014.

The latest investment round was from Prosperity7 Ventures – part of Saudi Aramco – Sinovation Ventures and Xiaomi. Other firms that have invested in Prophesee to date include: Intel Capital, Robert Bosch Venture Capital, 360 Capital, iBionext, and the European Investment Bank.

Prophesee's event-based sensor technology is able to asynchronously detect luminance changes for each pixel and output the changed data. This is different to standard frame-based imaging, where the entire image is output at certain intervals determined by the frame rate.

Sony and Prophesee released event-based sensors last year, a milestone that makes event-based vision more available.

Prophesee has also recently established new commercial partnerships with a range of machine vision suppliers including Lucid, Framos, Imago and Century Arks, and most recently with Datalogic for new industrial products, and MVTec Software, to integrate its technology into MVTec's Halcon software library.

It has also announced work with CIS Corp to develop an evaluation kit for implementing 3D sensing based on structured light point cloud generation using event-based vision.

The solution with CIS uses VCSEL technology that can generate 3D point clouds in the kilohertz range, with a light burst emission period in the order of 100µs.

Among the benefits of Prophesee's sensor and AI technology are ultra-low latency, robustness to challenging lighting conditions, energy efficiency, and low data rate. This makes it well-suited for a broad range of applications in industrial automation and IoT, as well as consumer electronics, which require real-time video data analysis while operating under demanding power consumption, size and lighting requirements – such as AR/VR headsets and smartphones.

The €50m investment round will allow Prophesee to accelerate the development and commercialisation of its hardware and software products, target new markets, and scale the company.

Advanced Illumination bought by Exaktera

Advanced Illumination, a US manufacturer of LED lighting assemblies and drivers for machine vision, has been acquired by Exaktera, a company that also owns lighting firms Z-Laser and Prophotonix.

Exaktera is a holding company formed by the private equity firm Union Park Capital. Exaktera states it is creating a family of companies focused on critical components that define the precision performance for OEMs.

Prophotonix was bought by Exaktera at the end of 2021 for a reported $11.6 million.

Advanced Illumination's LED components, current mode drivers and strobe sources, combined with optical and thermal design techniques, enable factory automation and machine vision across a wide variety of industrial applications. The company was established in 1993.

John Thrailkill will continue as president of Advanced Illumination.

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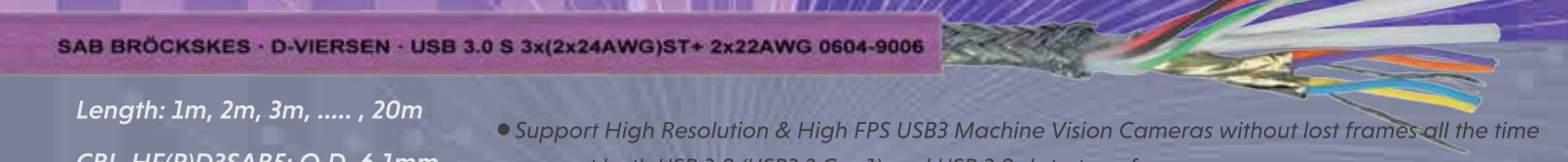

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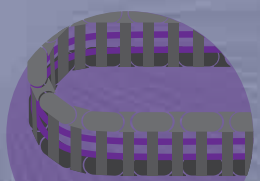

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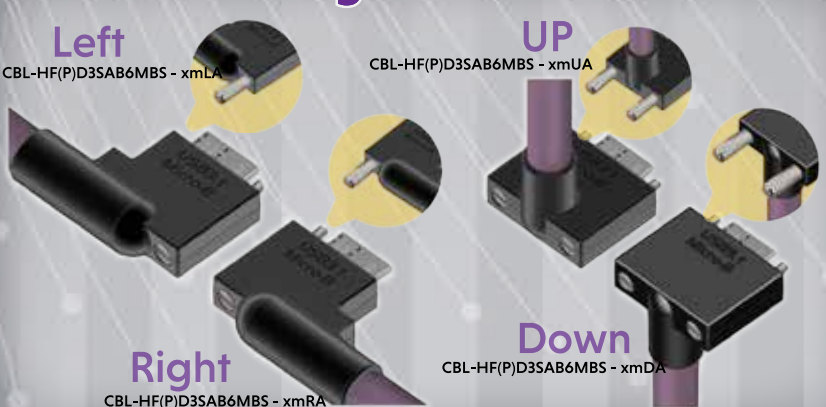
UP
CBL-HF(P)D3SAB6MBS - xmUA



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Down
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Vision for the future: highlights from MVC

UKIVA
UK Industrial Vision Association

By Neil Sandhu, UKIVA chairman

Machine vision technology is part of our everyday lives – seen everywhere from QR code readers to facial recognition on smartphones. It's also continuously evolving in numerous directions, several of which were discussed at the UKIVA Machine Vision Conference (MVC) earlier this year.

The growing importance of waste recycling means that efficient sorting systems have huge commercial potential and are critical in the future of sustainability. UK recycling specialist Recycleye has developed a deep learning vision system, which uses a huge dataset of images to sort waste streams more effectively. The system uses RGB sensors and an innovative algorithm to identify elements in the waste stream. It is more cost-efficient than existing methods such as NIR sensors and manual sorting, says Recycleye's Seb Millar.

A technique called quantisation allows it to round data without introducing errors. This enables much faster line speeds, while reducing accuracy by only 1%. Millar says that testing the system in large recycling facilities has made it very robust – meaning that it could be adapted for a range of other applications.

The extra dimension of 3D vision helps users gather more detailed information. One way of gathering 3D data quickly is with time of flight. This can capture whole scenes in one frame – rather than point by point – to enable high-speed applications, says Tim Dodd of IFM Electronic. Factors such as blind spots and noise can be a problem – but can be solved. Shadows, for instance, can be overcome using multiple cameras. Applications include pallet detection, supermarket shelf checking and even a milking robot.

Pattern projection lighting can increase inspection stability in 3D imaging, says Cameron Millar of Keyence. Here, a set of eight lights

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project stripes onto a 3D surface – generating a 3D image. This is typically used to inspect parts such as plastic mouldings but has also been applied to check circuit boards by assessing surface height.

A relatively new machine vision technique is terahertz technology, covering the spectrum between microwave and infrared. It has many uses, from quality control in manufacturing to medical diagnostics and security screening. Julian Parfitt of Alrad cites another: determining whether food, such as nuts in their shells, or corn, contain a fungus that can produce harmful toxins. The technique has also been used to probe the internal structure of wood for features such as voids and water content – and to check if opaque packaging is short of contents, such as pills in blister packs.

This is a selection of recent developments in vision systems. Many more will be seen at next year's MVC, **www.machinevisionconference.co.uk**, held in June 2023 in Coventry, UK.

CMOS sensor market to begin new growth phase

Market research firm Yole Intelligence, part of the Yole Group, expects the CMOS image sensor (CIS) sector to begin a new growth cycle, after 2021 saw only 2.8% year-on-year (YoY) growth.

Yole predicts CIS industry growth of 6.7% CAGR, with the market expected to reach US$31.4 billion by 2027.

In 2021, the CIS market experienced the slowest YoY growth in a decade (2.8%), reaching US$21.3 billion. This was caused by CIS stockpiling because of US sanctions against major China-based companies.

According to Yole, the market has now stabilised, with the fourth quarter of 2021 being the best ever for CIS production.

One of the consequences of the pandemic and the US Huawei ban was to reduce Sony's market share. However, in June 2022, according to Yole, Sony confirmed its ambition to reclaim its market share, aiming at achieving 60% by 2025.

Yole says that Chinese CIS leaders – OmniVision, GalaxyCore, and SmartSens – are, in the meantime, outperforming competition. "They are growing strongly as an immediate consequence of US-China trade tensions, particularly in the mobile market," Yole states. GalaxyCore is strengthening its fifth position, approaching US$1 billion in revenue.

Yole Intelligence has now released its annual CIS report: 'Status of the CMOS image sensor industry'.

New Camera Link standard announced

A new version of the Camera Link HS standard has been announced at The Vision Show in Boston.

Version 1.2 pushes the standard to speeds of 25Gb/s on an FPGA using 25Gb/s transceivers over fibre with SFP28, QSFP28, or MPO connectors.

No changes to the IP core are necessary, and the new 25G products are backward compatible with existing 10G products. The forthcoming CLHS speed update was made possible through the low-cost CLHS IP core, which is available from the Association for Advancing Automation (A3) for $1,000.

"The standard is designed to take advantage of the ever-increasing speeds of proven telecom technology, and the IP cores enable smooth transitions from 3G to 10G and now to 25G," said Bob McCurrach, A3 Director of Standards Development. As well as supporting fibre connections, the specification revision validates CLHS as having up to 100Gb/s (4 x 25Gb/s) available bandwidth using a single MPO connector.

"Since CLHS was first introduced in 2012, the 64b/66b encoded X Protocol has been in production and has a long history of field-tested stability," said Mike Miethig, Chair of the CLHS technical committee and Technical Manager at Teledyne Digital Imaging. He added: "Furthermore, the technical committee has a clear road-map to 50Gb/s and beyond."

Computer vision takes flight for pilot awareness

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An eye tracking and gesture recognition system for pilots has been developed by the Swiss institute CSEM.

The computer vision system has been tested by 10 pilots in a Lufthansa cockpit simulator, and was built under the EU project Peggasus – short for Pilot Eye Gaze and Gesture tracking for Avionics Systems using Unobtrusive Solutions.

The research was coordinated by CSEM and financed by the EU. Other consortium members include ETH Zurich, Serma Ingénierie and Swiss International Air Lines.

The dashboard-mounted camera can track a pilot's gaze and recognise their hand gestures in real time inside the cockpit. It gives pilots feedback to improve their situational awareness when executing complicated tasks.

"The Peggasus system addresses the unique challenges encountered in aeronautical context situations, such as extreme variations in light intensity," said Andrea Dunbar, the consortium coordinator at CSEM. "It improves pilots' situational awareness, and consequently decision-making, and makes it easier for the flight crew to work with aircraft controls."

The algorithm pipeline for eye tracking combines analytical and data-driven approaches, operating in real time at 60 frames per second with minimum latency while achieving eye-tracking accuracy of better than 1°. To enable hand-gesture recognition, a deep neural network model was successfuly developed and incorporated into the final system.

The research was coordinated by CSEM and financed by the EU; as well as other consortium members including ETH Zurich, Serma Ingénierie and Swiss International Air Lines.

The pilots that tested the vision system rated it better than head-mounted eye-tracking systems in terms of comfort and low distraction.

Recap on Vision 2022

By Anne Wendel, VDMA Machine Vision

With a total of 6,505 visitors and 378 exhibitors, the 30th Vision proved once more that the trade fair is the place to be for everyone interested in machine vision. There were many highlights: the Industrial Vision Days with more than 70 presentations – in sessions on camera technology, robot vision, 3D vision, software and AI, optics and lighting, hyperspectral imaging, machine vision standards, new applications or start-ups; a top class panel discussion, 'How smart are smart vision sensors'; three daily start-up pitch sessions; and presentation of the Vision Award shortlist submissions.

There were also international vision standards activities, and a great Vision exhibitor evening featuring the Vision band – with Florian Niethammer, Dietmar Ley and Peter Stiefenhöfer – and most importantly the opportunity to meet with customers, suppliers, partners and competitors, friends and former colleagues, as well as newcomers in the field (about 45 companies participated this year for the first time).

If you missed Vision or just didn't have the time to watch the presentations, all the sessions are available on demand at: www.messe-stuttgart.de/vision/en/on-demand.

Market update

As every Vision, the Chairman of VDMA Machine Vision gives a market update. This year, the German and European machine vision industry is expected to grow by 8% and growth prospects are positive for the coming years despite the overall economic uncertainty. "Machine vision is a key component for companies in the international automation race," said Mark Williamson, Chairman of the Board of VDMA Machine Vision.

This is a view shared by the International Federation of Robotics. When the World Robotics report was published on 13 October, Marina Bill, President of the IFR, stated: "The use of robotics and automation is growing at a breathtaking speed. Within six years, annual robot installations more than doubled. Installations grew strongly in 2021 in all major customer industries, although supply chain disruptions as well as different local or regional headwinds hampered production."

In 2021, an all-time high of 517,385 new industrial robots were installed in factories around the world. This represents a growth rate of 31% year-on-year and exceeds the pre-pandemic record of robot installation in 2018 by 22%.

Mastering uncertainty

VDMA Robotics and Automation ran an event for its members on 25 October titled: 'Mastering uncertainty – Robotics and automation in a new economic environment'. Today, companies must cope with a huge list of challenges: disrupted supply chains, rising energy prices, disruptive business models and rapid technological transformation. Dependencies are increasing as we are facing the threat of a decoupling of economic spheres of influence. How do we, as European companies, position ourselves in this rapidly changing world? How can we increase our resilience? How can we prepare ourselves for some of the tougher scenarios? This and more was discussed at the interactive event in Frankfurt.

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There were 6,505 visitors over the three days of the event

Market booming as industry gathers in Stuttgart

Greg Blackman reports from a packed Vision trade fair

In his opening address for this year's Vision show in Stuttgart at the beginning of October, Roland Bleinroth, President of Messe Stuttgart, praised the vision sector, saying that the two show halls "are packed with innovation".

This was undoubtedly the case, with AI, 3D vision, hyperspectral imaging and a host of other technology on display. Making use of CAD software was also highlighted, with Kitov.ai winning the Vision Award for its software that takes information from a CAD model and uses it to plan a robot inspection task, and Visometry, which won the best start-up for its augmented reality software that successfully tracks manufactured items via CAD models.

In his address to trade fair attendees at the start of the show, Mark Williamson, Chairman of the Board of VDMA Machine Vision, pointed to other growth trends taking place in the industry, including: extended wavelength imaging, into the shortwave infrared and the ultraviolet, thanks to sensors from Sony and new quantum dot sensors; embedded vision; and event-based imaging from the likes of Prophesee, winner of last year's Vision Award. Williamson said event-based vision was still very small in terms of market share but had good growth potential.

Revealing data from VDMA Machine Vision's market survey, Williamson said that the vision industry had grown by an impressive 16% in Germany in 2021, reaching a turnover of €3.1bn.

He said that this level of growth was unexpected – VDMA Machine Vision was predicting only 7% growth in 2021 this time last year – and was, to some extent, an indication of unpredictability in the market. One potential reason Williamson gave was that companies were stockpiling components in light of uncertainty in the market, around shortages in semiconductor components and supply chain issues.

VDMA Machine Vision is, however, remaining cautious for its estimate for this year, forecasting 8% growth to a turnover of €3.3bn.

Williamson warned that the challenge for machine vision businesses will be next year's market conditions, as it's still unclear what the effects of stockpiling will be and there remained a lot of uncertainty in the volatile global economy.

In a comment for Messe Stuttgart, Dr Dietmar Ley, CEO of Basler, said: "Currently the sector is subjected to powerful market dynamics. Past experience shows that decreased demand usually did not exceed 18 months. We are expecting the market →

Digital twin firm, Visometry, wins Vision start-up award

Visometry has won this year's start-up award at the Vision trade fair in Stuttgart for its industrial augmented reality solutions.

Harald Wuest, co-founder and CEO of Visometry, convinced the jury with his presentation about tracking manufactured items using CAD models.

Visometry's Twyn software is an AR platform for quality inspection. Users can annotate a CAD model against which the real part is compared. The annotations can be spatially located in AR at the exact position on the real component, and also combined with metadata such as the torque of a screw, production notes or the material properties of an object.

The award recognises the importance of digitisation in manufacturing, with production plants now using digital twins to help assemble parts. Along similar lines, the Vision Award, the prize for machine vision that also presented at the trade fair, went to Kitov.ai for its CAD-based planning software for robot inspection tasks.

The Start-Up World section at Vision Stuttgart hosted 20 young companies, with a number pitching their technology to the award jury on each of the three days of the show. Along with Visometry, the jury also recognised Saccade Vision for its MEMS-based 3D camera, which it launched at Automatica earlier in the year; Covision Quality, a spin-off of the computer vision and machine learning application centre Covision Lab, which licences its inspection software to manufacturing companies; the Japanese AI firm Hacarus; and Oculi for its take on an event-based vision sensor.

Oculi's sensing and processing unit (SPU) combines sensing and pre-processing in the pixel. The sensor offers microsecond latency, reduced bandwidth because only the relevant information is processed, 140dB of dynamic range, and milliwatt power consumption.

The sensor can switch from motion sensing to colour sensing, meaning the sensor can record data even when there is no movement in the scene.

Oculi's founder, Charbel Rizk, said he was interested in finding a partner at Vision Stuttgart for using the sensor in an industrial environment. The firm already has traction in the ITS and IoT markets.

Harald Wuest (centre) receiving the award from Anne Wendel, director of VMDA Machine Vision, and Messe Stuttgart's Florian Niethammer

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Vision was "packed with innovation"

Gpixel and Lumotive release next-gen lidar

Gpixel has partnered with Lumotive to release a design platform for developing lidar sensors.

The M30 reference design platform was announced at Vision Stuttgart at the beginning of October.

The platform comprises Lumotive's LM10 LCM beam steering chip and Gpixel's GTOF0503 time-of-flight sensor, and is designed to speed the adoption of next-generation 3D lidar sensors for mobility and industrial applications.

"Autonomy and automation are the future, and 3D sensing using lidar is a key enabler for both these megatrends," said Rakinder Grover, Vice President Strategy and Partnerships at Lumotive. "We are delighted to be working with Gpixel to deliver the industry's first-ever lidar 2.0 reference design based on our transformative optical semiconductor solutions for high-volume mobility and industrial products that require feature-rich, cost-effective, solid-state lidar capabilities."

Unlike traditional flash illumination solutions, lidar sensors based on LCM electronic beam steering have numerous advantages such as: excellent outdoor range performance; software-defined scan modes for increased and application-specific performance (range, field of view, frame rate, resolution); reduced multipath effects resulting in better point cloud quality; optimisation of illumination across the field of view in high ambient light levels and for varying levels of reflectivity; and improved interference mitigation from other sensors.

"The pairing of Gpixel's GTOF0503 indirect time-of-flight image sensor with Lumotive's LM10 beam steering chip provides an ideal solution for medium to long range 3D applications, and highlights both the precision and flexibility offered by Gpixel's sensor," said Wim Wuyts, Chief Commercial Officer at Gpixel. "We are especially excited about the performance enhancements possible for robot navigation in logistics environments, where Lumotive's lidar solution offers improved speed and accuracy."

The first version of the M30 reference design platform is currently being evaluated by a number of leading lidar systems developers, ToF camera makers, and industrial OEMs. The next generation of the platform with enhanced performance and optimised for volume manufacturing is expected to be available by mid-2023.

→ to recover in 2024 and the situation of the material markets of electronic components to improve within the course of 2023."

While sales into manufacturing is the largest customer sector for machine vision from Germany, with a market share of around 60%, manufacturing didn't grow much in 2021. The growth came from non-manufacturing markets, such as agriculture, medical and ITS, Williamson said.

Having said that, Williamson noted there is demand for machine vision in automotive and electronics, and that factories are being built for electric vehicle battery production.

Machine vision component suppliers generated 66% of their turnover abroad; system providers achieved 74% of their turnover on foreign markets. Exports of vision components to China increased by 20% in 2021, while exports of systems to China increased 16%. The largest growth market in the Asia region for vision components was India with a plus of 89%.

GigE gathers pace

A number of camera makers were promoting faster gigabit ethernet models, with 5GigE, 10GigE and even, in the case of Emergent Vision Technologies, 100GigE cameras on display at the show.

As higher resolution sensors become available, interfaces have to get faster to transfer all that data, and GigE is no exception. Basler and Teledyne were both showing 5GigE cameras, while Matrix Vision had a 10GigE camera on its stand. Lucid Vision Labs showed new models of its Atlas family, including a 10GigE version with

Some 378 companies exhibited at the show

Roland Bleinroth, President of Messe Stuttgart

'The growth came from non-manufacturing markets, such as agriculture, medical and ITS'

Gpixel's 65MP sensor, and a 25GigE version with an SFP28 interface to run the Pregius-S sensor at higher bit depths.

Marc Damhaut, CEO of Euresys, told *Imaging and Machine Vision Europe* at the show that Euresys is working with the GigE Vision committee to advance the standard to reach 25Gb/s. (Cameras from Lucid and Emergent reach 25GigE speeds, but this is proprietary technology.) Euresys' sister company, Sensor to Image, was showing an IP core with support for 25GigE Vision.

Damhaut said demand for higher GigE Vision speeds is needed in flat panel display inspection, for inspecting OLED displays, for instance. Euresys was also demonstrating faster Coaxpress frame grabbers, the higher speed also driven by demand in electronics and semiconductor inspection. Damhaut said that the next step in Coaxpress is Coaxpress-over-fibre to transfer data over a possible four lanes at 25Gb/s each.

Damhaut said Euresys was now receiving requests for high-resolution imaging outside of electronics production – in one case for installing a system in sports stadiums to acquire video at high resolution and fast frame rates. This obviously echoes Williamson's statement that interest in industrial vision technology is growing in non-industrial sectors.

Visitor numbers up

The trade fair recorded a total of 6,505 visitors over its three days, up from the 5,400 people who attended last year's show when some travel restrictions were still in place, but down on the 2018 show that had 11,106 visitors. There were 378 exhibiting companies, 60% of which came from abroad.

Overall, visitors from 60 countries were registered. The strongest presence was from Italy, Switzerland, the Netherlands, France, Austria, Belgium, Poland, Spain and the UK; there were also attendees from South Korea, Japan and the USA.

Messe Stuttgart said that, in addition to the classical client industries such as electrical engineering and electronics, mechanical engineering, and plant construction, as well as the automotive and automotive component supply industries, there was a significant share of visitors from non-industrial sectors present, including medical technology and pharmacology, agricultural industry, aerospace engineering, transport, and logistics. The organisers said that the interest in offers of non-industrial applications increased compared to the previous year. Turnkey machine vision systems also recorded increased visitor attention.

The next Vision trade fair will take place from 8 to 10 October 2024.

Kitov CAD robot planning tech wins Vision Award

We speak to Kitov.ai's **Adam Tabor** about the firm's CAD2Scan software

Kitov.ai has won this year's Vision Award at the Vision show in Stuttgart. The company's CAD2Scan software takes information from a CAD model, including geometric and component specifications and specific inspection requirements, and uses it to plan a robot inspection task.

Presenting the award, Christian Ripperda, VP at Interroll and a member of the judging panel, said: "What we found here [with Kitov.ai] is a holistic approach to bring expert knowledge from illumination, ray tracing and material interaction together with robot path planning and programming."

Speaking on a webinar *Imaging and Machine Vision Europe* organised to introduce the award shortlist, Dr Yossi Rubner, Kitov.ai's founder and CTO, explained the rationale behind the company's technology: "To perform an easy automated visual inspection, we need to deal with two issues: firstly, the need for systems that can handle complex geometries, deal with customised products, and with high-mix production lines. For this Kitov offers robotic inspection solutions. Secondly, the need for a fast and simple way to automate the generation of inspection plans directly from the CAD model. This is the power of CAD2Scan."

Adam Tabor, COO of Kitov, explained to *Imaging and Machine Vision Europe*, that Kitov's CAD2Scan software simplifies the setup of robotic inspection systems using CAD-based automated inspection planning. He said that all the user needs to do is mark the inspection requirements directly on the CAD software. CAD2Scan will then automatically generate an optimal inspection plan, including the optimal camera poses and imaging parameters for each inspection requirement, the best inspection algorithms, and the fastest robotic scan, giving full coverage of the inspected areas.

Kitov's semantic detectors include a surface detector, label detector, screw detector, existence detector, and so forth. In addition, Kitov's open software platform allows easy integration of third-party detectors.

Landesmesse Stuttgart GmbH

Kitov.ai's Corey Merchant (left) collecting the award

CAD2Scan is implemented as a plug-in to common CAD software; it is available for SolidWorks and Creo. It also supports the evolving quality information framework ISO standard and can parse visual inspection requirements embedded into it.

Tabor explained that CAD2Scan technology automatically deals with parts with complex 3D geometric shapes, such as metal moulding and CNC parts, which are difficult and time-consuming to inspect manually. It also analyses the part's material properties in order to determine the optimal illumination directions to maximise defect detection.

The main benefit of the software is to run quality inspection, but Tabor said that "customers can expect a reduction of the inspection time by a factor of two to four times, subject to the complexity of the product and the inspection requirements."

He said that additional benefits are the ability to automate inspection of complex products and those that are highly customised or manufactured in low volumes, as well as the digitisation of the inspection process.

Kitov's founders began by deploying its system for customised visual inspection projects. Following this, they decided to identify and automate the common needs for industrial inspection. Tabor said the initial market focus was on inspection of electronics parts. Later on, the capabilities were generalised to include complex parts in aerospace and automotive sectors. Tabor said that the software is a good fit for inspection lines where the takt time is between 20 and 30 seconds.

Collecting the award at the show on behalf Kitov, Dr Christoph Hofbeck, Managing Director of RSBG Ventures, a corporate venture capital firm, said: "We have invested in Kitov Systems since 2018, and since then we got to know Kitov as a rising star in the technology cluster around Tel Aviv in Israel, as a company with a passion for innovation, as a company with outstanding artificial intelligence developers, and as a company with the ability to work and cooperate well together with technology partners. The Vision Award for Kitov shows that the company is on the right track in developing its advanced software platform, to become a relevant technology company in the international automation industry."

Tabor said Kitov's focus is to further generalise its open software platform to handle any industrial automation environment. This is to include combinations of robots and mechanical automation, integrating into any control system, any MES/QMS system, and any inspection tool: "Kitov is pursuing partnerships with automation manufacturers that can integrate Kitov's automated planning and smart inspection capabilities. An example of such a partnership is our work with Mitutoyo to develop smart inspection solutions for joint visual inspection and metrology solutions."

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Fast processors advance 3D inspection

High-speed 3D cameras were in full force at Vision Stuttgart. **Alice Rolandini Jensen** explores the technology

Powerful processors, in the form of FPGAs or other chips, are opening up many more uses of vision technology, and this is especially the case with 3D imaging. A number of high-speed 3D smart cameras were being shown at the Vision trade fair in Stuttgart, including Teledyne Dalsa's Z-Trak2 5GigE 3D profile sensor for in-line applications, which can deliver scan speeds of up to 45,000 profiles per second, and Automation Technology's C6 laser triangulation sensor, able to reach a profile speed of 38kHz. Elsewhere, Nerian Vision, now owned by the TKH Group, which also owns 3D profiling provider LMI, was showing stereo vision cameras incorporating an FPGA for real-time 3D imaging.

Inder Kohli, Senior Product Manager of Vision Solutions at Teledyne Dalsa, explains that today's 3D vision technologies help solve several inspection challenges that are difficult, if not impossible for 2D imaging techniques. He cites the examples of "variation in height, defects caused by indentation or bubbling of laminate, measuring objects' thickness, coplanarity of adjoining surfaces, uniformity, or asymmetry of extruded parts."

Denise Müller, from Nerian Vision, adds: "If volumes or obstacles are to be detected, 2D image processing often reaches its limits. If you want to answer questions like: how far away is that obstacle? Or, find out if a package is really filled to the fill level, then 3D image processing technologies can be used wherever depth information is required for further automation steps."

Although 2D vision technology itself is still innovating, sometimes applying 3D vision can eliminate issues associated with the inherent limitations of 2D. For example, changes in illumination, or a lack of it, can cause problems for 2D vision systems, making images blurry or unclear. Here, 3D systems can step in as they can record depth information, generating a point cloud, and a more accurate, clear image.

In addition, "the biggest advantage of 3D scanning and processing over traditional 2D is the ability to perform measurements on low-contrasted parts, where most of the depth information would be lost if captured from a 2D sensor," says Kohli. "For example, measuring the depth of a drilled hole in a manufactured metal part is simply impossible to achieve using a 2D image. 3D image processing allows very high precision measurements on objects with many types and shapes."

However, creating a 3D image is much more data-heavy. Knowing when 3D vision needs to be applied, and when it doesn't, is key for industry. Collecting data just because you can is expensive in terms of computer time, storage, and energy.

Four key 3D technologies

It is not just knowing when 3D vision technology is needed, but also, which type. Müller explains that now, there are four key 3D technologies to take note of: the first is stereo vision, which is the most like human vision. Two cameras mimic human eyes and take 2D images of an object from different angles to extract depth information.

Secondly, there is laser triangulation or profiling, which measures the alteration of a laser beam when projected onto a moving object using a camera at an angle to the beam. The structured light technique known as a whole field method uses a light pattern projector to provide an entire 3D image of the object, and not just of a single cross-sectional line.

Mobile robots in agriculture are progressing thanks to 3D vision technology

Both stereo vision and laser triangulation or structured light techniques take measurements in the spatial domain. Time-of-flight (ToF) and lidar – light detection and ranging – are based in the time domain.

Time-of-flight sensors emit a light pulse, often in the infrared. Objects in the field of view reflect this light signal back to the sensor. The sensor measures the time of flight and uses this to create 3D images. "Large scenes can thus be recorded and scanned, which is especially relevant for

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'With ToF, we will see future developments to improve accuracy and precision'

volume measurements," explains Müller. "The sensors are also particularly compact. However, light pulses are susceptible to reflections and lighting conditions. High frame rates are achievable, but at moderate image resolutions."

Lidar also uses time-of-flight detection. It sends out a pulsed eye-safe laser to detect the environment and retrieve depth information. Müller notes: "A big advantage is that lidar can also offer rotation and thus 360° circular detection, which is a special requirement in applications for autonomous driving."

Here it is important to note that, when developing a machine vision system, understanding which technology to use depends on the application. In some cases, to get the machine to see what you want it to, you often need to apply a combination of techniques.

Human vision copycat

In mimicking human vision, one of the great advantages of stereo vision is that it has a passive mode of operation. As with our eyes, this form of machine vision does not require signals to be emitted to generate depth information. Müller notes that "this makes stereo vision technologies irreplaceable in outdoor applications." In addition, as it is not disturbed by other light signals, a 3D stereo camera can be used to supplement other 3D vision techniques.

However, stereo vision techniques are particularly computationally intensive, and Müller points out that "many manufacturers have to rely on additional computing power in the form of servers or graphics cards."

She says: "At Nerian, we pursue the innovative approach of implementing the image processing on the hardware side in a field-programmable gate array. This is very complex in terms of implementation and programming, but for the user, 3D image processing becomes possible in real time and without additional load on other computing units, even at high image resolutions."

Nerian's SceneScan stereo vision sensor has the processing power required for real- →

Nerian Vision's stereo vision cameras incorporate an FPGA for real-time 3D imaging

time stereo vision in challenging lighting conditions – in bright daylight or at long distances. It is also available in a small and energy-efficient system.

In an example of how vision systems can be integrated to fit different applications, Nerian's latest Ruby 3D depth camera is a hybrid solution of active illumination and passive stereo vision. It uses an infrared laser dot projector and integrates two monochrome sensors for depth perception with a colour sensor. This means it can act like a stereo vision camera, working well outdoors and sensing colour, but can also perform precise measurements on difficult surfaces.

When it comes to mobile robotics, the Ruby 3D can achieve solid obstacle and path detection and provides reliable 3D depth data to control autonomous vehicles or robots. It can generate reliable 3D depth and colour information giving it applications in agricultural robotics to check soil conditions and information on crop growth status. It can also detect challenging and bulk materials in bin-picking applications. In addition, Ruby 3D has an inertial sensor (IMU) and together with its robustness against dark and bright light conditions, this means it can be used on construction sites, for example, for navigation, mapping, and obstacle detection.

Profiling with precision

In contrast to stereo vision, laser profiling techniques generally require the objects they are seeing to be in continuous linear motion. This makes them an ideal technology for production lines where objects move along a conveyor belt. As laser light is monochromatic, detectors are calibrated to only detect light deflected from the laser and therefore these systems can be used in both dark and illuminated conditions.

"3D systems are becoming more reliable, and affordable, and are easier to deploy and maintain for factory applications that require 100% inline inspection," says Kohli. He introduces the Teledyne Dalsa Z-Trak2 3D profiler sensor as being "top of the range" for high-speed in-line measurement and inspection applications. "Its features include a high frame rate, single scan high dynamic range (HDR), and multiple automated optical inspection (AOI)." In addition, "Z-Trak2 offers the ability to combine multiple units to help expand the field of view without sacrificing aspects of resolution; it can remove occlusion and unwanted reflections or create a 360-degree view of the object."

With its ability to output both 3D data and 2D concurrently, Z-Trak2 also combines vision technologies to meet the needs of packaging, logistics, and identification applications. It offers a cost-effective solution, where "expensive" 3D data does not need to be collected and processed if not required. The factory calibrated Z-Trak2 also overcomes some of the key challenges that face laser profilers, including occlusion, spurious reflections, and laser speckles, which makes it easier to set up and maintain more attractive 3D options for factories.

Teledyne Dalsa's Z-Trak 3D profile sensor can reach scan speeds of 45,000 profiles per second

'When [AI is] combined with 3D vision technologies in the right way, this will open doors for many more applications'

Imaging at WARP speed

Athinodoros Klipfel from Automation Technology, another leader in 3D sensor tech, highlights that, "one of the key limitations with laser profiling is speed." Here, profiling with a laser can create millions of data points which limits processing times.

To tackle this issue, Automation Technology has developed a sensor chip for what it calls Widely Advanced Rapid Profiling (WARP). Klipfel notes that, "instead of transferring the complete image and all data points for processing, with WARP, only the region with the laser line is output and this vastly accelerates the frame rate and profile speed of the 3D sensor."

WARP allows the combination of high resolution and high-profile speed which leads to optimised surface inspection. In this case, smaller defects can be found at higher production speeds. Automation Technology's new C6 sensor is a 3D laser triangulation sensor that combines speed and resolution. The sensor chip incorporates WARP technology, allowing the camera to reach a profile speed of up to 38kHz at an image size of 3,072 x 201 pixels, and with a resolution of 3,072 points per profile. WARP technology is unique to Automation Technology, making them the global leader in high-res, high-speed profiling.

Klipfel adds: "WARP is revolutionising profiling, and is taking inspections in industries such as semiconductors, steel or transportation, to new levels."

The future of 3D

Time-of-flight and lidar technology are still in their nascent phases. They allow 3D images to be captured in real time and have potential applications in Industry 4.0, robotics, logistics, surveillance, intelligent traffic systems (ITS), mapping/building, and automated guided vehicles including drones.

But at present, ToF cameras are complex and often have low spatial resolution. To reach their full potential, further development in camera technology is needed, together with fluid computer software and system integration.

Kohli notes: "With ToF, we will see future developments to improve accuracy and precision. In combination, this will allow greater distance and reflectivity range, minimise the stray light effect, and enable systems to evolve autonomously and to take real-time decisions in complex conditions and changing environments."

Müller thinks it is important for the future of 3D technology that sensors become more reliable, faster, and more accurate. "Furthermore, there is a big trend towards AI through machine learning. When combined with 3D vision technologies in the right way, this will open doors for many more applications." She points to areas like agriculture and forestry automation, and in the emerging smart factories of Industry 4.0. She concludes: "In this way we can also ensure that the development of automation technology takes place in harmony with safety-relevant aspects and offers greater value to society."

More dimensions in Stuttgart

Optomotive presented a newly engineered 3D high-speed smart sensor series called LOM at the Vision trade fair. The LOM series consists of customisable and user-programmable high-speed laser triangulation sensors based on Optomotive's FPGA technology. The series can achieve inspection rates up to 10kHz. Excellent data of shiny and other challenging surfaces is generated by optimised optical design, in-camera Peak Detection and blue laser light.

The camera includes an Arm system-on-chip, combined with an industrial Ams image sensor and laser line projector. In-camera Peak Detection IP core processes images to produce profiles in 8-bit subpixel resolution.

Other 3D profile sensors released at the trade fair include SmartRay's Ecco X 25 3D sensor, offering 4,096 points of resolution and a scan rate of 40kHz. The Ecco X targets automated optical inspection in electronics and other challenging industries.

With a measurement range of 20mm and a stand-off distance of 65mm, the Ecco X 25 delivers a typical vertical resolution of 0.9 to 1.4µm and a typical vertical resolution of circa 5.0 to 7.0µm. The z-linearity is 0.005%, and z-repeatability is 0.2µm, targeting inspection of miniaturised electronics and precision-machined or 3D-printed mechanical parts. A scan at full field of view and 40kHz delivers up to 163 million points per second.

Vision Components launched the OEM laser profiler, VC PicoSmart 3D, with integrated processors for 3D profile data analysis. The profiler is made up of an embedded vision system with a 1MP image sensor, an FPGA pre-programmed for 3D computation, a high-end FPU processor, and a line laser module with a 130mW blue laser. The system is enclosed in an industrial-grade housing measuring 100 x 40 x 41mm.

Above: Vision Components' VC PicoSmart 3D laser profiler. Left: SmartRay's Ecco X sensor

Scanners for bin picking were also on display. Zivid announced the second member of its Zivid Two 3D camera family, the Zivid Two L100. The L100 has been developed to be able to tackle the larger, deeper bins typically seen in the manufacturing industry.

The camera has a focus distance of 100cm, a recommended working distance of 60 to 160cm, a field of view of 105 x 62cm at 100cm distance, and 2.3MP resolution. It has a spatial resolution of 0.56mm at 100cm distance, dynamic range of 90dB, and dimensional trueness of greater than 99.7%.

Zivid's VP of sales, Mikkel Orheim, told *Imaging and Machine Vision Europe* at Vision Stuttgart that trueness – is the camera both precise and accurate at producing 3D coordinates – is the real test for making the camera reliable enough for manufacturers to deploy them at scale. He said trueness in 3D cameras for bin picking is hard to find.

Zivid tests its cameras for use in industrial environments, making sure there's no drift in precision or accuracy over a temperature range of 0-45°C, and after being exposed to the kind of vibration and rapid acceleration commonly found when mounted on a robot arm.

Finally, MVTec showed a deep-learning bin-picking application based on its AnyPicker tool in Halcon software. In the demonstration, a robot system picked up arbitrary objects with unknown shapes with the help of Halcon.

The application combines 3D vision and deep learning for the first time with the aim of robustly detecting gripping surfaces. In contrast to typical bin-picking applications, there is no need to teach object surfaces – no prior knowledge about the objects is required. MVTec says that this enables typical applications, for instance in logistics, to be implemented in a shorter time and more cost-efficiently.

Programming choices: library or open-source?

Although open-source software is practically ubiquitous in the IT world, there will likely always be a place for proprietary machine vision offerings, finds Benjamin Skuse

Since the mid-1990s, developing machine-vision software for an industrial vision application has followed a predictable path: you invest in a professional machine-vision software package from an established supplier, pick the most appropriate solution within that package for your general requirements, and then develop your software with a little hand-holding from your supplier's technical support team. But, today, if you intend to develop a machine vision application, there is a new option: go open-source.

Looking to develop an imaging application? You can access a range of free solutions through open-source libraries such as AForge.NET, the Open Source Computer Vision Library (OpenCV), or Point Cloud Library. Aiming to execute targeted deep learning in a machine vision application? Investigate open-source frameworks such as TensorFlow, Caffe, or PyTorch.

These general-purpose libraries contain advanced interoperable software shared by developers at the bleeding edge of vision research, and anyone can access and use them for free. This includes the full source code, enabling you to tinker at the fundamental level, perform extensive software testing and implement new features. What's more, these libraries are supported by a large, global community of experts, keen to contribute new software, share ideas and updates, and collaborate in building new innovative solutions.

An example of the quality of free software on offer is PatchCore, an automated visual anomaly detection method freely available on Github – the largest source code host in the world – to anyone who wants to try and implement it on a GPU. Developed by University of Tübingen PhD student Karsten Roth during an internship, alongside expert collaborators at Amazon, PatchCore addresses the cold-start problem – where the software has to identify anomalies without having been given access to any negative examples or defects. It detects and localises these anomalies using a maximally representative memory bank of normal feature sets (images of non-defective items) and an outlier detection model.

The method has already been used in practice for anomaly detection on solar cell electroluminescence images, and a number of other real-world applications. "Intel's open-source OpenVino toolkit has this anomaly detection library that has reimplemented various collections of anomaly detection methods," says Roth. "Within this library, PatchCore is the best performing method on average, even

‘There is very much a growing interest in expanding and building on top of these open-source applications’

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though this library has more recent methods included as well.”

Talking more generally about how open-source machine vision software is starting to make a mark, Roth says: “Even individuals can start to build their own neural network-based applications – there is very much a growing interest in expanding and building on top of these open-source applications.”

Why then, are most machine vision and automation innovators still paying for professional libraries? “There is a pretty significant overhead that comes with developing your own set of tools that are specifically targeted to your problem at hand,” says Roth. “Obviously, if you have the money and you have the people to research and figure out which method to select and train for your specific problem, then – of course – you can do it, but there are those applications and use cases where it's hard to replace professional libraries.”

The value of libraries

Having been deeply involved in the industry since its inception, Pierantonio Boriero, Director of Product Management at Zebra Matrox Imaging, has a good handle on why clients still turn to Zebra’s portfolio of professional machine-vision software development tools: “Our users value working with software that's been rigorously professionally validated; knowing that they can have access to technical support and maintenance when they truly need it; and also that they have a certain peace of mind when it comes to intellectual property rights (there's no risk of hidden royalties, which would affect the cost basis for their particular product).”

Zebra Technologies, which acquired Matrox Imaging earlier in the year for $875m, offers the popular Matrox Imaging Library X (MIL X). MIL was first released in 1993 and initially focused on 2D algorithms and tools that work on monochrome images. Iterations over the years have increased MIL’s capabilities, allowing users to perform colour analysis in images, work on 3D data and, since 2018, leverage deep learning for inspection. It features functions for image capture, processing, analysis, annotation, display and archiving, and also includes MIL CoPilot, an interactive environment for experimentation, prototyping and code generation.

“We're continuing to add deep learning models to our library to provide users with more options to perform automated visual inspection using deep learning,” expands Boriero. Today, MIL X represents a comprehensive collection of ready-made tools or functions for developing machine vision, image analysis and medical imaging applications. “In MIL, we provide the tool, the environment needed to train the deep learning model for a specific use case and, obviously, perform the inference or prediction using that model,” says Boriero.

Alongside MIL X, which is designed for users with expert programmers on staff capable of developing machine-vision applications, Zebra also offers Matrox Design Assistant X. “MIL is really, first and foremost, aimed at original equipment manufacturers, whereas Design Assistant is aimed at systems integrators,” explains Boriero. “System integrators need an environment to accelerate their application development.” Design Assistant is an integrated development environment for Microsoft Windows where vision applications are created by constructing an intuitive flowchart instead of writing traditional program code, and where graphical web-based operator interfaces for the applications are designed.

Similarly, MVTec offers two products targeted at users with differing in-house machine-vision software development expertise: Halcon and Merlic (alongside MVTec’s Deep Learning Tool for easy image data labelling offered for free). First developed by researchers from the Munich University of Technology and adapted for industry by spin-off MVTec, Halcon was first released in 1996. Today, Halcon is a powerful toolkit featuring an integrated development environment (HDevelop), numerous interfaces and a range of deep-learning technologies. It serves all industries, with a library use in all areas of imaging, including blob analysis, morphology, matching, measuring and identification.

“It's a great, comprehensive product nowadays, with more than 2,100 operators,” says Maximilian Lückenhaus, MVTec Software Director Marketing and Business Development. “And it’s used in tens of thousands of applications worldwide.” One unusual application example was in a NASA robot for the International Space Station called Robonaut, where Halcon was wielded to allow the robot to track and grasp objects in zero gravity.

“Halcon is meant for programmers that want to have full control of everything,” explains Lückenhaus. “But we learned →

‘There's a bright future for professional libraries – there's always a need to help people do things quickly and easily’

Pierantonio Boriero, Zebra Matrox Imaging

Maximilian Lückenhaus, MVTec Software

→ that there are also other customers that don't have the time to program the whole solution for themselves, or customers that don't have knowledge about machine-vision technologies.” For these customers, MVTec built Merlic. Merlic provides access to the same library, but only contains preconfigured tools for typical tasks accessible through a graphical user interface, as Lückenhaus describes: “You take the tools, and drag and drop, and you can stitch them together – you need no programming knowledge.” As well as integrated PLC communication and image acquisition based on industry standards, all standard machine-vision tools, such as calibration, measuring, counting, checking, reading and position determination – as well as 3D vision with height images – are included.

With open-source software starting to build up basic technical support services and training to ease the development process, Lückenhaus sees the likes of OpenCV as competitors. However, he highlights two key drawbacks for customers thinking about opting for open-source development. “In many cases, it is not quite clear what the patent situation behind some of the algorithms is,” he says. “And, as long as you have a programming community that pushes some specific subjects, you have parts that are quite up-to-date and you have parts that are quite old. This is different for our library – we must keep all important parts of our library up to date because our industry customers demand it.

“A lot of machine vision and automation still is more a niche product, and you won't find so many open-source programmers for it,” he continues. “Smaller companies that are really quite closely working together with customers is where professional libraries will remain important from our point of view.”

Going with the flow

Another company offering specialised libraries of algorithms that can be used by developers to implement machine-vision applications is MathWorks. Its Deep Learning Toolbox is also a child of the 1990s (originally called the Neural Network Toolbox) and consists of deep-learning algorithms, techniques and models that provide a framework for designing and implementing deep neural networks, including those that can be used in industrial vision contexts. Users can also access several apps that help them through the network design, testing and evaluation process.

The Deep Learning Toolbox has been applied in a huge range of industries, from the development of a deep-learning system for real-time object detection at sea by maritime technology company Drass to improving automated visual inspection of sheet-shaped products on the production line for Mitsui Chemicals.

Much like MVTec, Zebra and others offering professional libraries, MathWorks has recently made it easier to use the various tools within the Deep Learning Toolbox, releasing higher level packages for non-experts “who are looking to solve a specific problem, whether it’s using deep learning or some other technique under the hood”, such as the Medical Imaging Toolbox. MathWorks also provides lower-level packages if users wish to customise further, such as the Computer Vision Toolbox and Lidar Toolbox.

Where MathWorks differs is in fully embracing the various vision software development platforms that exist today, including those that are open-source. For David Willingham, Principal Deep Learning Product Manager at MathWorks, it is important the company acknowledges the reality that product developers have their preferences and don’t necessarily want to be tied to a particular operating system, coding language or brand – interoperability is key.

“A few years ago, our community and the open-source community for deep learning had the same problem, and that was ‘how do we all coexist together, and how can we share the models that we've created with other platforms as freely as possible?’” says Willingham. “By having different interoperability techniques in the Deep Learning Toolbox, it enables users to mix and match which tools they might want to use in different parts of their workflow.”

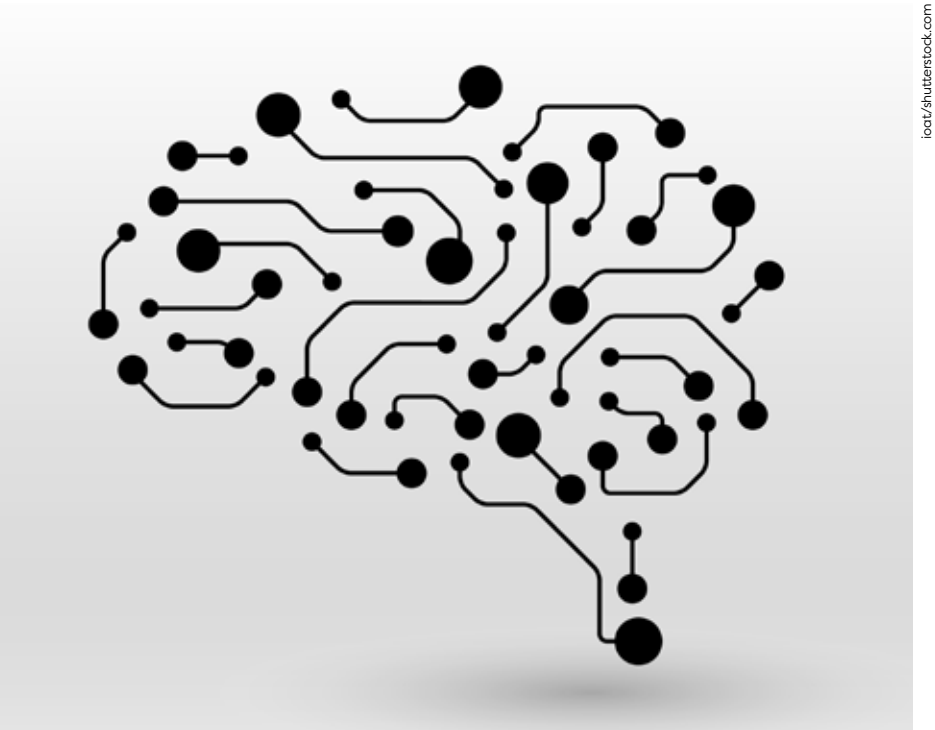
In Zebra’s MIL X and MVTec’s Halcon, users can choose from supplied, pre-defined deep-neural network architectures or import a compatible third-party open-source neural network model stored in the widely used Open Neural Network Exchange (ONNX) format. The Deep Learning Toolbox takes this a step further, providing import and export functions to ONNX, as well as popular, free and open-source platforms TensorFlow and PyTorch.

On top of this, MathWorks offers Matlab Coder and GPU Coder to expedite the deployment of imported networks – a unique offering for downstream product development. What this means is that users who have created a deep-learning model in, for example, TensorFlow can import into Matlab to automatically generate native embedded code for application in an FPGA, therefore simplifying and accelerating the process of integrating deep learning in a given product.

“While, in many cases, the latest research comes out in open-source, it's very difficult to take that research and get that onto a chip in a product that might go to mass market – it's a long lag time,” says Willingham. “We're focused on enabling engineers to take these techniques and make products out of them. That's why I say there's a bright future for professional libraries – there's always a need to help people do things quickly and easily and understand the value for their business.”

Accelerating AI with analogue computing

Tim Vehling at Mythic on the benefits of AI accelerators for industrial vision



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Chip companies dedicated to AI acceleration have been springing up over the past few years as AI processing becomes ever more important.

At Embedded World earlier in the year, AI accelerator chips were out in force, as running AI on an edge device at a high enough performance can still be challenging. The French firm, Dolphin Design, picked up an award for best start-up at Embedded World for its edge AI accelerator designed for sound and vision processing.

In industrial vision, the constraints of pure edge processing are sometimes less apparent, but nevertheless firms using AI for inspection or robot guidance still have to reach high levels of performance, and AI accelerators can offer benefits.

Tim Vehling, senior vice president at Mythic, a US-based AI accelerator chip start-up, listed industrial vision and robotics among Mythic's customers and potential customers, when he spoke to *Imaging and Machine Vision Europe*.

One of the cornerstones of Mythic's technology is its Analogue Compute Engine (ACE). It uses embedded flash both to store data and run computation concurrently – computation happens directly in the memory array. This means data doesn't have to move back and forth from memory, which reduces power and bandwidth requirements in the system.

Because it's using an analogue representation of the information, it's also a lot denser. This results in a single flash element that's about 50 times smaller than what would be used in SRAM.

The M1076 Analogue Matrix Processor, an array of 76 tiles, offers 25 TOPS performance, with a capacity for up to 80M on-chip weights. It provides low-latency deterministic execution of DNN models, with a typical power consumption running complex models of less than 3W.

The company also uses mature 40nm CMOS technology, because it is so much more cost effective and storage efficient with its technology.

Vehling says that plugging the chip into an NXP processor will give a 10 times or more increase in performance, while it will improve the performance of an Nvidia Jetson Xavier NX by two or three times.

He adds that most industrial architectures are based on an Intel system and, from a hardware point of view, it's just a case of plugging in one of Mythic's cards.

"Most of the customers we deal with are not doing AI from scratch," Vehling says. "They've already got some level of AI expertise, and what they're running into is system limitations.

"Two or three years ago, it was less known about how to deploy AI in the industrial sector," he adds. "Now people know how to deploy it; now it's what is the best solution to get the best results."

Vehling recalls that Mythic had some customers at Embedded World that were very clear what they were looking for – normally they weren't getting the performance when running a certain model on a certain platform, which is why they needed an accelerator. "The knowledge of what people are looking for has advanced quite a bit," he says.

> **'Most of the customers we deal with are not doing AI from scratch… and what they're running into is system limitations'**

Mythic has raised $165m in venture funding and now has 150 employees worldwide. Vehling says the focus for the company involves getting designs finalised to start shipping production chips next year. Mythic is also working on its next-generation architecture, from which Vehling is expecting to see some significant performance improvements, of the order of eight to 10 times improvement.

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Spectral cameras offer window into Alzheimer's

Investigations are underway into using hyperspectral imaging to screen for a host of medical conditions, as **Abigail Williams** finds out

Hyperspectral imaging (HSI) is emerging as a key underlying technology for a number of next-generation medical systems in applications ranging from protein detection for screening and diagnosing Alzheimer's disease, to oxygen monitoring and tissue-type identification.

One frontrunner in the development of HSI technology for use in medical applications is the Leuven, Belgium-based institute Imec, which is working closely with medical experts in a variety of fields to develop new instruments, or to upgrade existing tools with added functionalities enabled by HSI. As Wouter Charle, Hyperspectral Imaging Technology Manager at Imec, explains, initially, these solutions can have a supportive function, but will eventually evolve into solutions that "can offer assistance for increased precision and efficiency, or even perform repetitive, routine tasks".

"With hyperspectral cameras becoming more and more compact, opportunities to integrate them onto various medical tools can be found everywhere," he says.

One project Imec has been working on is focused on real-time video detection of proteins or oxygen levels in blood. In the past decade, it has become clear that blood will show different signals depending on levels of oxygen saturation, which can be detected through HSI – both in post-processing, and in real-time. According to Charle, the first start-ups offering the necessary algorithms to provide real-time oxygenation, blood volume and true-colour RGB imaging to surgeons are currently emerging in the market.

"Current miniaturised and integrated surgical cameras can only show black-and-white real-time images, which provides less information about the tissues surgeons are looking at, and gives them less means to navigate the body," he says. "We have been working with medical researchers to integrate our machine vision chips and cameras on existing optical instruments.

"This backwards compatible approach is more cost-efficient, as we're starting from existing platforms and adding new features onto them; whether it be a new type of sensor or specific filters. We can scale down sensor chips and cameras to fit onto the tip of an endoscope camera, for example – not just to inspect and perform surgery on kidneys, but also on lungs," he adds.

According to Charle, other areas where HSI can play a part include exoscopy – optical systems outside the body that give surgeons an extra pair of eyes – laparoscopy for abdominal interventions, and oral cavity scanning to detect cancer in the mouth or throat, or for dentistry. "The next step would be to develop cameras that can distinguish different types of healthy tissue, such as muscles, ligaments, bones and organs – to ultimately detect cancerous tissue. The more accurately cameras can detect unhealthy tissue, the more precisely surgeons will be able to remove growths, with minimal damage to healthy tissue. Realising such precision with hyperspectral cameras will be the holy grail," he adds.

Screening for Alzheimer's

Imec has also collaborated with the Flemish research organisation Vito, as well as university KU Leuven and UZ Leuven hospital on retinal imaging for the detection of certain proteins that are indicative of Alzheimer's disease. Even though Alzheimer's is a neurological disease, the eyes can give clues to help with diagnosis.

"We've developed a snapshot camera that can detect accumulation of two proteins – amyloid-beta (Aβ) and Tau – in the eyes in a very early stage of disease development. In the next phase of our collaboration, we are making a few practical improvements to the camera: creating a new optical instrument to provide a larger field of view and enable imaging at lower-light intensities, and adding a more recent chip with wider bands and higher spectral contrast to detect the proteins more accurately," says Charle.

As Lies De Groef, Assistant Professor at KU Leuven, explains, the retina is an integral part of the central nervous system (CNS), and thus "closely related to the brain and spinal cord". Thanks to the transparent ocular media and the availability of an array of non-invasive,

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high-resolution retinal imaging techniques, the eye provides what she describes as a "unique window into the CNS".

As such, retinal imaging may be used to understand what disease processes are ongoing in the brain, and retinal biomarkers have become a field of intensive research. One application of retinal biomarkers is their use for non-invasive diagnosis of Alzheimer's disease. There is accumulating evidence, both from animal studies and in Alzheimer's patients, for the presence of Alzheimer's disease hallmarks in the retina – and De Groef and colleagues are exploring the use of different imaging techniques, including hyperspectral retinal imaging, to detect the retinal changes related to neurodegeneration and protein (amyloid, tau) aggregation in vivo.

"Post-mortem studies in both animal and human retinas, and in vivo studies in rodents, have shown that hyperspectral retinal imaging can detect spectral changes in the 460-570nm range that seem to be caused by the presence of retinal amyloid aggregates. A second important biomarker for Alzheimer's in the eye is thinning of the retinal nerve fibre layer. This can be studied by optical coherence tomography (OCT), and is a sign of neurodegeneration," says De Groef.

'The signal caused by the Alzheimer's biomarker is very small… We will need AI to analyse the data'

"The current belief is that by combining multiple biomarkers that each cover different hallmarks of the disease – in this case hyperspectral imaging to measure amyloid aggregation, and OCT as a read-out for neurodegeneration – one may come to a multimodal approach for improved diagnosing and monitoring of Alzheimer's disease," she adds.

Pilot study

In 2019, De Groef and colleagues ran a pilot study with 17 clinically probable Alzheimer's patients, seven biomarker-proven Alzheimer's cases and 22 controls. The study was performed at the Ophthalmology Department of the University Hospital UZ Leuven, in collaboration with the UZ Leuven Memory Clinic. The team found that classification models integrating HSI and OCT data could discriminate between Alzheimer's subjects and controls with an accuracy of approximately 75% in a nested leave-one-out cross-validation.

"The hyperspectral information was the main driver for this classification result, yet classification accuracy improved by including OCT data," says →

‘The hyperspectral information was the main driver… yet classification accuracy improved by including OCT data’

Imec/KU Leuven

Set-up of combined hyperspectral and fundus camera at Peter Stalmans’ lab at KU Leuven

→ De Groef. In parallel, researchers in the Biology Department at KU Leuven also investigated the use of HSI in preclinical research of Alzheimer’s mouse models – and demonstrated that hyperspectral imaging can also be used to quantify retinal amyloid in animal models and post mortem tissues, underscoring its potential as a biomarker for Alzheimer’s diagnosis and monitoring.

“Retinal imaging techniques thus offer unique opportunities for drug discovery and fundamental research into Alzheimer’s disease, and have a high translational value given that the same technologies can be used in mice and humans,” says De Groef.

More generally speaking, De Groef reveals that HSI technology is also currently being used for several other medical applications, including in ophthalmology – where an HSI-based technique called retinal oximetry is used to measure blood oxygenation in the retinal vessels, providing valuable information in the diagnosis and monitoring of ocular diseases such as diabetic retinopathy, age-related macular degeneration and glaucoma. Other medical applications include perioperative support (helping to delineate the field of surgery), measurements of cytochrome-c, cholesterol, melanin and haemoglobin, and the detection of neoplasms.

“As hyperspectral imaging is a label-free technique, it holds great potential for in vivo applications. However, it may also be used in pathology research, where it would then circumvent the use of antibodies, tracers and other labelling techniques, and thereby increase speed and cost efficiency,” explains De Groef.

Snapshot camera

Another interesting example is a snapshot hyperspectral camera developed by Sweden-based Mantis Photonics for use in a range of ophthalmology applications. As Diego Guénot, Co-Founder and Chief Technology Officer at Mantis Photonics, explains, the eye is in constant motion – particularly the retina at the back of the eye – so ophthalmologists need to capture images of it “extremely quickly”. The technology can be used for the diagnosis of several eye diseases – including glaucoma and diabetic retinopathy – but also to diagnose neurodegenerative diseases such as Alzheimer’s.

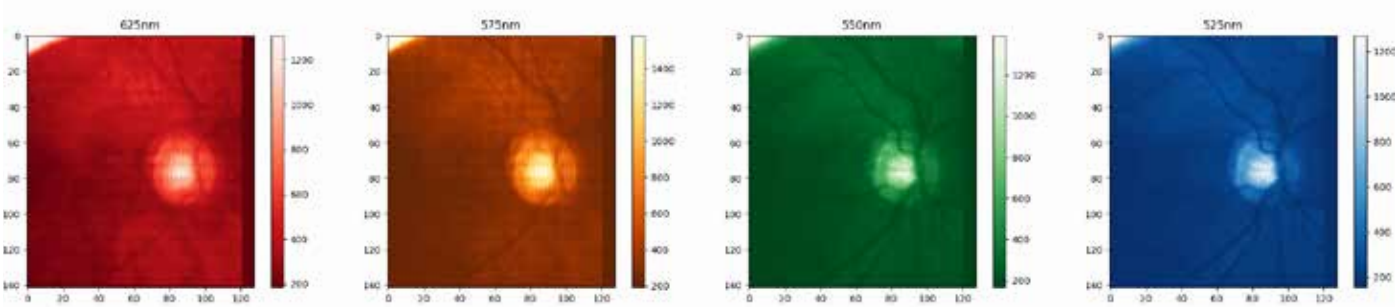
“We are about to start two clinical trials, one with patients affected by glaucoma, and another one with patients affected by Alzheimer’s,” says Guénot.

“For glaucoma, our aim is to measure the blood oxygenation by analysing the reflected spectrum of the eye veins and arteries. Blood oxygenation is an indicator of the disease.

“For Alzheimer’s, we aim to distinguish a small spectral shift between healthy patients and patients affected by the disease. This spectral shift is believed to be caused by the presence of amyloid beta, which is an early biomarker of Alzheimer’s,” he adds.

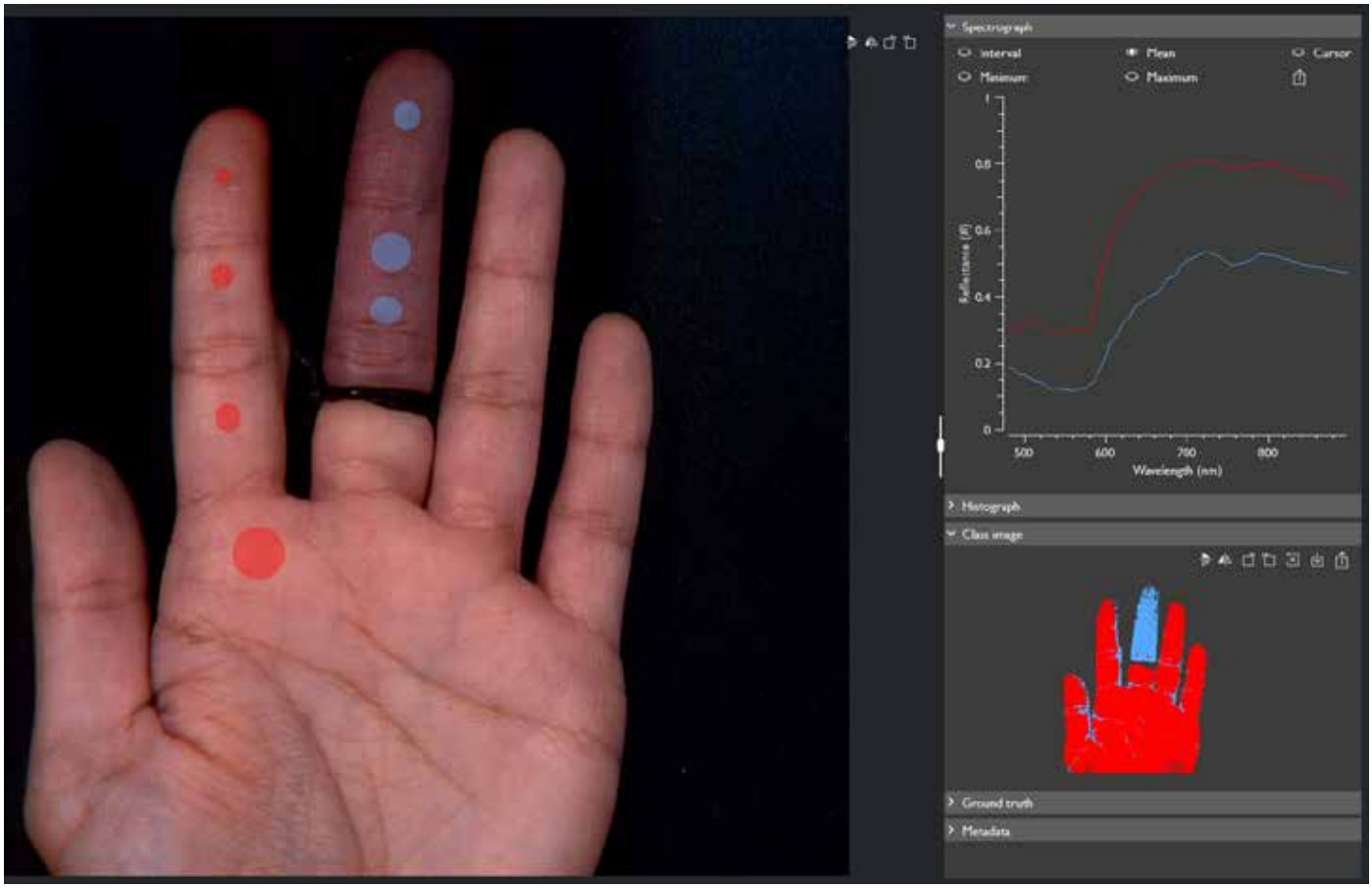
The camera works by shining a light on an object – here, a retina – and the filtering and reflecting of the light using a collimating element. A grating and a spectrometer are then used in combination to disperse and focus the light onto a CMOS sensor.

“In this way, the incoming spectrum is displayed for each microlens. From this, we can either reconstruct the images for



Mantis Photonics

Diego Guénot’s retina imaged at different wavelengths with a Mantis Photonics camera



Imec

A snapscan VNIR camera shows oxygenation levels of a hand with one tied finger

each wavelength – or, at a single point, we can extract the spectrum and, for example, measure blood oxygenation," says Guénot.

More generally speaking, Guénot observes that, although the use of hyperspectral imaging technology in medical and healthcare applications is not yet commonplace, it continues to generate a great deal of interest. "To the best of our knowledge, hyperspectral imaging is not yet an established technique in medicine, but there is an ever-increasing interest in it. More and more groups are investigating it for a large number of conditions," he says.

"Broadly speaking, hyperspectral imaging is used to measure functional changes, as opposed to the structural changes seen by standard cameras or other imaging techniques. In practice, the main application is for skin imaging, and more specifically detecting skin cancer."

Moving forward, Guénot believes that AI has a major role to play in hyperspectral imaging, "since it is not a type of data that the human brain is adapted to interpret".

"More and more people are combining AI with hyperspectral imaging in many applications – in medicine, but also in agriculture or industrial sorting," he says.

"In the case of Mantis Photonics, the signal caused by the Alzheimer's biomarker is very small, while the variation in the retina varies a lot from one patient to another. We will therefore need AI to analyse the data."

Artificial intelligence

Moving forward, De Groef reveals that the next steps in her and her colleagues' research include a larger, multi-centre, longitudinal clinical trial with Alzheimer's patients in different stages of the disease. Through this study, the Leuven team wants to clarify whether hyperspectral imaging may also be used to diagnose Alzheimer's in the very early, presymptomatic stage of the disease, and thereby open up an earlier time window for effective treatment.

The Leuven-based research group is also conducting a series of experiments in cellular and animal models with different neurodegenerative diseases, to assess the specificity of the HSI signature. This will clarify what forms of amyloid are being measured by HIS, and whether it may also be used to detect other protein aggregates found in other neurodegenerative diseases, such as tau and alfa-synuclein.

"Given the complexity and the vast amount of data that we gather via HSI, we are looking at AI to improve our diagnostic models. One of our future goals is to further expand our multimodal approach and include more biomarkers of Alzheimer's in one classification model. AI technologies can really help maximise information extraction and force breakthroughs in this field," she says.

Meanwhile Charle reveals that, in order to enable application research, Imec has CE-certified its snapscan VNIR camera to allow integration on surgical microscopes, which will be useful for clinical research surgery. By pairing the data from high-resolution recording of surgeries with traditional analyses by medical specialists, he explains that the Imec team can train AI systems to detect cancer in HSI data.

"And of course, HSI cameras create an enormous amount of data, which will need AI to interpret and translate into useful information," he says.

Bridging two worlds

The key challenge in all of this is bridging the two worlds of engineering and medical expertise. Translating the range of medical needs to technical solutions has been one of the more intensive aspects of developing new medical instruments. It's a challenge that continues. Cross-disciplinary involvement is a must to develop a sensor ecosystem for robots, or even cobots, that will allow better healthcare, he adds.

Breaking hyperspectral barriers

Reducing the cost and size of hyperspectral cameras is opening up many more applications, as **Keely Portway** finds out

Unispectral's solutions allow for a smaller, lower-cost system that can be used in any application for which hyperspectral imaging is desired

Hyperspectral imaging is used to analyse a wide spectrum of light instead of just assigning primary colours to each pixel. The light striking each pixel is broken down into many different spectral bands to provide more information on the subject of the image.

Hyperspectral imaging was developed in the 1970s by NASA's Jet Propulsion Laboratory, and in the early 1980s the organisation recorded its first hyperspectral image using an aerosol imaging spectrometer (AIS-1). Today, hyperspectral imaging is used in applications such as astronomy, agriculture, molecular biology, biomedical imaging, geosciences, physics and surveillance, waste sorting and recycling, eye care and environmental monitoring. There is also increasing interest in agri-tech and other industrial use cases where it may not be possible for the human eye to detect discrepancies between images.

Reducing waste

The European Commission has committed to scaling-up European Union member countries' contributions to the global target of halving food waste by 2030 as part of the Farm to Fork Strategy. Dan Dariel, VP of Marketing and Product Management at Unispectral, explains that the quality of food needs to be determined in order to help reduce waste. "If the quality is beyond selling but still edible, it can be given away," he says.

Likewise, the use of chemicals in agriculture is coming under scrutiny, particularly in the EU. Under the same strategy, the European Commission has also committed to cutting the use of chemical pesticides in half by 2030. But fruit and vegetables from non-member countries are not always subject to the same scrutiny, and so there needs to be a way to determine the amount of fertiliser, pesticide and insecticide chemicals within these foods, which is where hyperspectral imaging can help.

Tomato plant classification

Another example is in the detection of T-virus in tomato plant classification. Dariel continues: "When you look at a healthy plant and a sick plant using your eyes, they will look similar, so it is difficult to distinguish which is healthy and which has a virus. The virus can spread and damage healthy plants if it is not identified and eradicated. A hyperspectral camera can identify the difference between a healthy and a sick leaf."

This is because, with hyperspectral imaging, the images are taken in different bands of the leaf itself, so the spectral response of the leaf will behave differently between two different materials, which look exactly the same to the human eye. The first step is to grab several images of the same object in different bands; the optimised band should be defined to differentiate sick from healthy leaves. The next step is to create an extensive database of images on which the software or modelling must be trained to differentiate between healthy and sick plants, after which there is a model in place that is capable of developing an application which will know what to do next time by itself.

Similarly, hyperspectral imaging can be used to quantify the quality of meat. Dariel elaborates: "Images can be taken of meat, and if different meats have different water percentages and different proteins, these parameters will be different in different bands. So, by taking many, many images, it is possible to distinguish between a meat which has 10% water or meat which has 20% water, or if there is antibiotic inside the meat itself. This is important in agriculture because, between the first phase of an animal reaching an abattoir to when it reaches the store, there are about 10 different merchants in the chain. At each one of these points the quality of the meat should be quantified in the same way so the merchants and vendors agree on the quality in order to agree how much to pay."

It's clear, therefore, that there is a real use case for hyperspectral imaging across many different applications in the agri-tech industry. However, for many organisations, there have been a number of barriers to entry. Dariel explains: "Up until now, hyperspectral imaging cameras have been very expensive, in the sense that a single camera can cost between $10,000 and $100,000 for the visible and near infrared, and considerably more for specialised hyperspectral cameras operating in the thermal IR region. They can also be very big and bulky. So, in many cases, you can find these cameras in static environments, such as scientific labs or universities, but there have been fewer use cases in industrial or precise agri-tech locations by standard users or integrators because of the high price and the bulkiness of the product."

A helping hand

Unispectral has developed a range of hyperspectral products, allowing for a smaller, cheaper system that can be used in any application for which hyperspectral imaging is desired. The solution is based on the Fabry-Pérot proven hyperspectral technology, in which an optical cavity is made from two parallel reflecting surfaces. Optical waves can pass through the cavity only when they are in resonance with it.

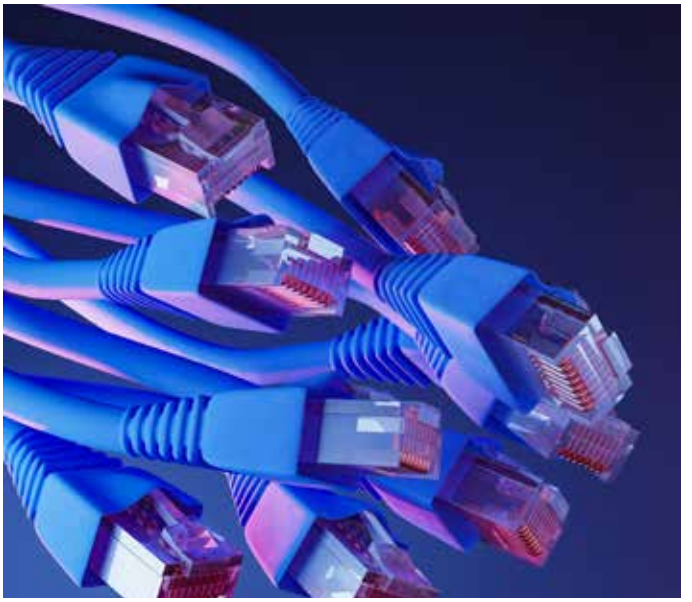
The company's ColorIR NIR Tunable Fabry-Pérot MEMS filter was designed to control the voltage of the upper mirror, causing it to move up and down and, in turn, change the central wavelength of the filter itself. It is designed to enable a unispectral NIR image to be captured, using a standard IR micro camera, and can be applied to any micro IR camera to convert it into a multi-spectral authentication, detection and inspection device.

Alongside the filter, the company closely collaborated with partner camera manufacturers to develop a camera. The result is the Monarch II, a portable, tunable hyperspectral IR camera for agriculture, industrial, scientific, and commercial use. The Monarch II is designed to capture in-field or on-site spectral images in a simple and inexpensive way, with no need for expensive, bulky or sensitive equipment. It benefits from a high-speed lens and a 680-940nm spectral range, but it measures only 6.0 x 4.5cm. Analysis and decision-making is possible through an AI application that provides diagnostics of produce, merchandise, humans, or medical processes. The camera can be connected to a mobile phone or can also be embedded in sorting robotics, machine vision platforms, manufacturing lines, QA systems and biometric authentication terminals. It can connect to real-time analysis, inspection and control systems through a PC interface. In order to simplify and shorten time of development, Unispectral provides its hyperspectral camera with an Applications and a SDK library, allowing the developer a smooth and short development process. Unispectral's camera SDK is available for Windows, Android and Linux.

'Eventually, we predict that a mobile phone company will be able to take the 3.4mm filter… [to turn a] mobile phone [into] a hyperspectral camera'

David Gibson, Managing Director of Photon Lines, Unispectral's partner in the UK and Ireland, states: "The whole of the Photon Lines Group has been heavily invested in hyperspectral imaging since it first became commercially viable. We have sold systems for our partners Resonon and Telops in a number of applications such as land-based and marine-based remote sensing, and have delivered bespoke systems for quality control in the food industry. When Unispectral introduced themselves to us earlier this year and showed us their novel, compact solutions we saw it as a real opportunity to help them find and exploit new, low-cost, volume applications."

In developing this solution, Unispectral has opened up the possibility to make hyperspectral smaller and more cost-effective in the future. With the addition of the filter to any CMOS camera, an inexpensive hyperspectral camera can be created. Dariel reveals: "This is a contrast to the way that other companies are implementing the technology, and why our solution is much more cost effective. Eventually, we predict that a mobile phone company will be able to take the 3.4mm filter and assemble it on a standard camera inside their product, and thus use the mobile phone as a hyperspectral camera – just think how much further the cost could be reduced for users."



A. Solano/Shutterstock.com

Up to standard

A GigE Vision round-up with a look at some of the latest technology

GigE Vision is a global camera interface standard that was first developed in 2006, by a group of 12 companies, for high-performance industrial cameras. It was designed to provide a framework for the fast transmission of images using low-cost standard cables.

One of the key benefits of GigE Vision is that it allows multiple cameras to be controlled and synchronised on a 24-hour basis from a remote location. Since its introduction, the committee has grown to more than 50 members, and the standard's administration and ongoing development is now overseen by A3 the Association for Advancing Automation. There have been a number of updates since the standard's inception, the most recent of which was in June, when it was updated from version 2.1 to 2.2. Primary enhancements include GenDC streaming and multi-event data.

Commercial products

There are many new GigE products on the market – not all will necessarily be GigE Vision compliant – including those from Basler, JAI, Teledyne Flir, and Lucid Vision Labs. All of these firms now offer a 5GigE portfolio using Sony Pregius global shutter CMOS sensors. **Basler**'s Ace 2 Basic cameras, Teledyne Flir's Forge area scan camera family, and cameras in **JAI**'s Go-X series now include models with resolutions ranging from 5 to 24MP.

Teledyne Flir's Forge will be available in Q4. In addition to supporting link speeds of 1, 2.5, and 5GigE, Forge offers burst mode to capture images at speeds up to 10Gb/s into memory. This, combined with a 500MB image buffer, allows engineers to capture information in bursts for high-speed applications. The camera's reliability framework gives engineers tools to develop reliable systems faster.

The latest Atlas models from **Lucid Vision Labs** with the 5GBase-T interface include 2.8, 8.9 and 12.3MP versions using Sony Pregius sensors. The Atlas Factory Tough camera line is designed for industrial applications requiring high bandwidth and high resolution in a robust IP67-rated housing. It features active sensor alignment for superior optical performance, a compact 60 x 60mm size, M12 Ethernet and M8 general purpose I/O connectors for robust connection resistant to shock and vibration, industrial EMC immunity, and a wide ambient temperature range of -20°C to 55°C. The Atlas IP67 models feature C-mount lenses and are compatible with the standard IP67 lens tubes from the Triton cameras.

IDS now offers 10GigE uEye Warp10 cameras, also based on Sony Pregius sensors (5, 8.9, and 12MP), while **Optomotive** has released Smilodon, a customisable and user-programmable FPGA-based high-speed smart camera featuring a Xilinx Zynq FPGA. It

JAI's Go-X series

Sensor to Image Featured product

Sensor to Image (S2i) offers a set of IP cores and a development framework to build FPGA-based products using the GigE Vision interface. GigE Vision cores are compatible with Xilinx 7 Series devices (and higher) and Intel/Altera Cyclone V devices (and higher).

S2i offers a complete suite of functions and tools to ease the implementation of the protocol. These include: A top level design; vendor specific framebuffer; working reference design, offering top performance and the smallest footprint; video acquisition module source code; GigE packet composer; software and hardware toolkits, including application samples, and access to the FPGA integrated CPU.

More information:
www.euresys.com/en/Products/IP-Cores/Vision-Standard-IP-Cores-for-FPGA/GigE-Vision-IP-Core-(2)

Allied Vision Featured product

Allied Vision's Alvium platform now includes industrial vision cameras with a GigE Vision interface. Alvium G1 camera series comes in a future-proof package with a comprehensive feature set including a broad selection of the most popular sensors in machine vision. Alvium G5 cameras with 5GigE Vision interface offer all the advantages of the GigE Vision standard while providing more bandwidth for applications, where resolution and frame rate are critical.

The Alvium G5 camera series enables an easy upgrade of existing systems (USB3 Vision or GigE Vision) and offers backwards compatibility with GigE solutions. The models cover a broad spectral range including UV, visible light, NIR, and SWIR. With superior image quality through FPNC, DPC, Active Sensor Alignment, and industrial standard hardware, both Alvium G1 and Alvium G5 cameras provide future-proof reliability for vision applications. The new series increase the flexibility of the Alvium platform concept and offer the user even more options to choose from.

More information:
www.alliedvision.com/en/alvium-gige-cameras/

IDS Featured product

Like a webcam, but for industry

IDS Imaging Development Systems recently launched the webcam-like 13 MP autofocus camera uEye XC, which closes the market gap between industrial cameras and webcams. Setting up and operating only requires a cable connection. After that, the autofocus camera immediately delivers high-resolution, detailed images and videos. It can easily handle changing object distances.

With the optionally available, quickly exchangeable macro lens, users can easily shorten the minimum object distance of the camera. This makes it also suitable for close-up applications. Unlike consumer webcams, the uEye XC camera is especially designed for industrial use. Its components score with long availability – a must for industrial applications. Useful features such as 24x digital zoom, auto white balance and colour correction ensure that it can capture all details perfectly. uEye XC is suitable for kiosk systems. It can also be used for quality control, logistics automation and medical technology.

More information:
https://en.ids-imaging.com/ueye-xc-autofocus-camera.html

includes Arm system-on-chip technology, combined with Gpixel sensors available from 5 to 25MP, and a 1 or 10 Gigabit Ethernet interface. Targeted for applications in laser triangulation, motion capture, process automation and quality control, Smilodon 10G Evo has a user-programmable open-reference design.

Newly available from **E-con Systems** is the RouteCam_CU20, an HDR GigE ultra-low light camera with network synchronisation capability. It is an OEM HDR camera based on the Sony Starvis IMX462 sensor that comes with low light and NIR performance. The camera can be easily integrated with all image processing platforms including X86 processors and Arm processors.

Matrox Imaging recently released Matrox GevIQ, a smart network interface card (NIC) offering generic GigE Vision acquisition offload at speeds up to 25Gb/s per port, without any packet loss. It is designed to provide a more versatile and widely compatible alternative to proprietary 10+ GigE acquisition solutions.

The boards pair readily with currently available GigE Vision cameras, delivering transmission rates up to dual 25GbE with very little host CPU usage. The NIC boards pair with Matrox Imaging Library X software and include both Matrox Gecho – a logging utility that records events generated by the Matrox GevIQ device driver and saves these to a JSON or CSV file for viewing in Google Perfetto – and Matrox Capture Works, a utility that allows users to rapidly evaluate the performance and functionality of virtually any GigE Vision-compliant camera or 3D sensor.

Pleora Technologies offers a software solution, eBus Edge, that converts embedded platforms, sensors, and cameras into GigE Vision devices. For 3D inspection, designing eBus Edge into imaging devices can help manufacturers overcome multi-part data support and interoperability challenges that traditionally add cost and complexity. It converts 3D images and data into GigE Vision- and GenICam-compliant time-stamped data that is transmitted with associated metadata over low-latency Ethernet cabling.

Data from multiple sensors, including 1D and 2D images, can be synchronised and transported in parallel using multiple streams.

This is not an exhaustive list. If you provide GigE Vision-compliant products and technology, and you'd like your company to be included, please email: editor.imaging@europascience.com.

Products

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

Embedded vision

Optimom Mipi CSI-2 modules

Teledyne e2v has released the 2MP Optimom, the first in a range of Mipi CSI-2 optical modules. Optimom 2M features a native Mipi CSI-2 protocol and standard FPC connector to link with embedded processing boards. Integration is through a dedicated development kit, which includes both an adapter board for hardware integration and Linux drivers for software integration with Nvidia Jetson or NXP i.MX solutions.

These optical modules are built with the same compact 25mm square outline, enabling a single mechanical design that can fit into constrained mechanical systems. The modules are available with monochrome or RGB sensors, and three lens options: a multi-focus lens, a fixed-focus lens, or without a lens. The lens is supplied already installed and focused.

All Optimom 2M models are powered by Teledyne e2v's 2MP low-noise, global shutter image sensor. The multi-focus version of Optimom 2M combines a broad working distance and wide aperture in one solution by using focus adjustment technology.
https://imaging.teledyne-e2v.com/

Modular embedded ecosystem

Stemmer Imaging is presenting a new embedded vision concept, called Modular Embedded. The core of the system is Stemmer Imaging's Modular Embedded carrier board coupled with the company's generic driver stack. The board enables manufacturer-independent camera use. It is based on Nvidia Jetson hardware and offers plug-and-play efficiency for developing embedded vision and AI projects.

On the software side, Common Vision Blox, Stemmer Imaging's software library, offers flexibility and performance for image acquisition and processing.

GenICam-compatible and equipped with a number of 10GigE, USB3 and Mipi interfaces, the Embedded ecosystem's hardware modules are suitable for demanding vision applications supporting a high bandwidth and multiple simultaneous cameras.

Hardware I/O and a separate GigE interface provide communication with an automation controller or a connected host PC. The integrated M2 interface allows access to a wide range of peripheral hardware.

A comprehensive and flexible range of service packages round off the Modular Embedded ecosystem. These range from feasibility studies, assistance to select the right products, along with support through product training and consulting services followed up by lifecycle management services.
www.stemmer-imaging.com

Frame grabbers

Claxon Fiber

BitFlow has introduced its first Coaxpress-over-fibre (CXPoF) frame grabber, the Claxon Fiber. The frame grabber is a PCIe Gen3 x8 CXPoF board configured with a single port for QSFP+ hot-swappable, parallel fibre-optical/copper transceiver modules.

Equipping the Claxon Fiber with a QSFP+ module provides the flexibility of running multi-mode fibre cable up to 150 metres between cameras and the PC, or running single-mode fibre cables a maximum of 40km. Complex, expensive repeaters are not needed in long-distance fibre optic installations, as they are when using copper cables, therefore driving down overall system costs while removing potential points of failure.

The frame grabber can accommodate high-bandwidth applications ranging from multiple line scan cameras inspecting colour print materials or semiconductor wafers, to area scan cameras deployed in 3D video scientific analysis or OLED defect detection. Immunity to electromagnetic interference also makes the Claxon Fiber an excellent choice for manufacturing or medical facilities subject to high levels of EMC.
www.bitflow.com

Industrial computers

Matrox 4Sight EV7

Matrox Imaging has updated its Design Assistant software and launched Matrox 4Sight EV7, the next iteration of its 4Sight series of industrial computers. With an integrated twelve-core Intel Core processor, the 4Sight EV7 has the processing power necessary to handle both traditional machine vision workloads and those using deep learning to classify or segment images for inspection.

The computer is compatible with both Matrox Imaging Library X and Matrox Design Assistant X software. It contains four 2.5 Gigabit Ethernet ports and four USB ports.

The company has also released version 22H2 of Matrox Design Assistant X with new deep neural networks for classification and segmentation; updated MIL CoPilot companion application for simplified deep learning training; 3D data display in the operator view; and support for IEEE 1588 precision time protocol timestamps for GigE Vision acquisition.
www.matrox.com

Software

Halcon 22.11

MVTec Software's latest version of Halcon (22.11) features a toolbox with more than 2,100 operators. The new 3D Gripping Point Detection technology is a highlight of Halcon 22.11. It can be used to detect surfaces suitable for gripping with suction. In contrast to classic bin-picking applications, this new technology eliminates the need to train object surfaces. This means that no prior knowledge of the specific object is required.

Halcon 22.11 also introduces a new data type called memory block, which can be used to store and transfer binary data in Halcon as well as process it with other applications. This increases the software's compatibility with machine communication protocols, such as OPC UA, or image acquisition interfaces, for example for storing camera configuration files. Furthermore, there is the option to encrypt all data that can be serialised, which significantly increases data security. In this way, trained deep learning models can now also be protected.

Another new feature, the Guided GradCam, gives a heat map as to which regions of the image a deep learning network has used to make a decision. Halcon 22.11 also now supports Hailo AI acceleration hardware, which can be used via a plug-in to execute deep learning inferences quickly.

www.mvtec.com

Real-time video denoiser

Visionary.ai, a developer of image processing software, has launched a real-time video denoiser that improves video image quality. It can be applied to extend the operating conditions for the majority of the approximately seven billion image sensors manufactured each year.

AI for noise reduction has so far mainly been used for still images, but Visionary.ai algorithms can run in real time, at the edge.

The denoiser has been benchmarked against other approaches to noise reduction. The only alternative with comparable denoising performance (Restormer) required considerable computer processing power and took 212 times longer to execute, thus eliminating it as a potential solution for real-time vision. Furthermore, the Visionary.ai de-noising performance does not come at the expense of image sharpness.

The new denoiser uses the image sensor's raw output data, which has not been compressed or degraded by any post processing. It has been designed to work alongside the company's other core technology, a software image signal processor to create a solid foundation for an evolving suite of image enhancement features.

www.visionary.ai

Eigen software tools

The Canadian company, Eigen Innovations, has introduced five software tools and cloud services to make vision system development, deployment, and operation more efficient.

Eigen Vision Twin is a design tool that helps vision system integrators determine which cameras and lenses will produce the best results. It also automatically calculates the optimal placement of the camera(s). The tool creates a digital blueprint of a vision system to allow for more seamless implementation across multiple sites.

Eigen Image Twin merges raw image data and creates a virtual and normalised image dataset, regardless of the variation in the camera location. In this way defects can be detected more reliably and machine learning models can be trained with a larger volume of data collected across multiple sources.

Eigen Product Twin creates 3D part records that combine real image data captured during inspection with original part CAD data, while Eigen Cloud allows manufacturers to converge vision data across machines, lines, and factories into one central place and augment it with other data from their manufacturing processes. Eigen Edge provides the interface between the production lines and Eigen Cloud.

https://eigen.io/

Deep learning OCR

Zebra Technologies has unveiled a deep learning optical character recognition software tool. The solution supports manufacturers and warehouse operators.

The new industrial-quality OCR tool is an add-on to Zebra Aurora software. DL-OCR comes with a ready-to-use neural network that is pre-trained using thousands of different image samples. It can deliver accurate results straight out of the box, even when dealing with very difficult cases. Users can create robust OCR applications in just a few simple steps.

www.zebra.com

Cameras

Chip-on-tip borescope

Canon Medical Systems has launched a chip-on-tip video borescope camera for inspection applications in extremely tight spaces. The SV-2000 provides full-colour, high-resolution video or still image capture. Rugged and flexible, the CMOS video scope is offered in three configurations: 1.6mm x 1.9m, 400 x 400-pixel resolution; 1.05mm x 1.2m, 200 x 200-pixel resolution; and 0.89 mm x 1.2m, 400 x 400-pixel resolution.

Each video scope features 120° field of view and an integrated LED light for illumination within the flexible shaft. They are water resistant (IPX7 rated) for disinfection tasks or other uses in wet environments.

There are two camera control unit options, both with HDMI and USB 3.0 outputs: one with a tablet console, and a second with an external display. Other system features include manual and automatic brightness control, white balance and calibration functions, firmware updates via USB, and multi-sensor compatibility.

https://us.medical.canon

Illumination

JWL150 camera-to-light series

New from Smart Vision Lights is the JWL150, the first in the company's Camera-to-Light (CTL) series. The JWL150 delivers an intense, compact light source with an integrated camera mount.

Compatible with most major machine vision cameras, the JWL150 can be directly connected and controlled through the camera's trigger output.

The IP65-rated bright field light features a working distance of 500mm up to 2,000mm; 10-, 14-, and 30-degree lens options; and built-in Multi-Drive technology, which offers both continuous operation and overdrive mode.

In continuous operation mode, the JWL150 can provide constant light or be triggered following the camera's exposure signal. Overdrive mode delivers up to six times the continuous power with a low-latency response and fast strobe durations down to 10µs.

The product features a batwing design that illuminates a larger area than built-in lighting systems, and produces a greater light output to combine with polarisers, diffusers, and other optical elements that reduce light output.

https://smartvisionlights.com/

Power Flash series of LEDs

CCS has expanded its PF (Power Flash) series of LED lighting with 28 new models in various form factors and colours. Combined with existing products, the lineup offers 10 series with 76 models.

The PF series is a line of bright LED lighting and power supplies designed exclusively for strobe illumination. It is ideal for high-speed image processing inspection because of its high-power strobing in steps of 0.1µs. It has a peak illuminance of 15.5 million lux.

The PF series now includes flat dome lights (four sizes), coaxial lights for high-resolution cameras (two sizes), flat lights (three sizes), and low-angle square lights (two sizes). Small sizes of bar lights and diffused ring lights have also been added for precision inspections. Each model is available in red and white LED emission colours.

www.ccs-grp.com

Cobra HyperSpec SWIR line light

The new Cobra HyperSpec SWIR 2.0 line light from ProPhotonix offers a fuller and flatter spectrum with 11 wavelengths filling the band from 950nm to 1,750nm, and a peak-to-valley ratio of less than 1.5. The Cobra platform uses adjustable optics to give spectral uniformity, along with a variety of diffuser options.

The hyperspectral shortwave infrared line light uses chip-on-board LED technology, and users can optimise the spectrum to maximise contrast, compensate for camera sensitivity, and deliver clearer, higher resolution images. The LED line light incorporates a user-friendly GUI, allowing users to fine-tune the performance of their system.

www.prophotonix.com

Corona II combined tube light

Chromasens has launched an LED illumination solution that combines tube light, bright field and dark field techniques into one compact module.

The module delivers tube light brightness levels of up to 1.2 MLux with white LEDs, 12,000 cd/m² for bright field, and 800 kLux for dark field by leveraging Chromasen's reflector focusing technology. Fan, passive or water cooling options are available to maximise LED service life. In complex applications, a vision system must distinguish different types of flaws, therefore requiring different lighting techniques. Until now, to perform these complex inspection tasks required manufacturers to employ three expensive illumination modules and three line scan cameras in different inspection stations.

The Corona II module overcomes these limitations in a single, economical unit using only one camera.

Customers can choose from a range of LED colours including white (5,500K or 3,500K), red/green/blue, or infrared (850nm or 940nm).

https://chromasens.de

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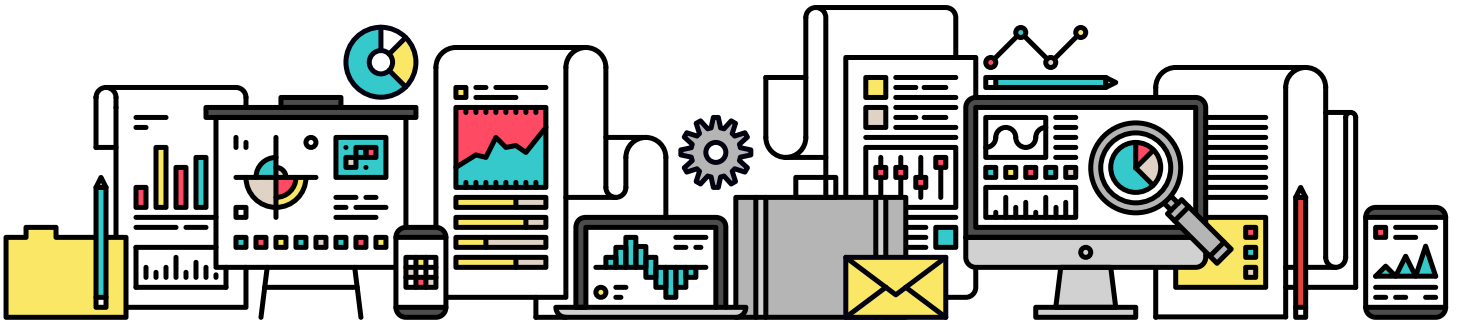

Accessible hyperspectral imaging: how can it be achieved?

PHOTON LINES, UNISPECTRAL

This white paper details how advances in camera and filter technology from Unispectral have opened up more applications in hyperspectral imaging across industrial and agricultural use cases

Hack your imaging system

EDMUND OPTICS

Specifying an imaging system and getting the best performance out of a setup can sometimes feel like a minefield. This white paper reveals a few "hacks" to keep in mind when thinking about specifying a new setup or adjusting an existing one.

Vision Platform Approach – Rethinking Line Scan Systems

CHROMASENS

The selection of optimal components for a line scan camera system is a complex task requiring extensive knowledge about cameras, optics and lighting.

C6 Series: The next generation of 3D sensors

AUTOMATION TECHNOLOGY

The new C6 series of 3D sensors from AT - Automation Technology is based on a new sensor platform that supports the latest technology trends such as GenICam 3D.

Industrial camera interface guide

TELEDYNE DALSA

There are many types of cables and connectors used with today's industrial cameras. This white paper explores and provides an understanding of the available interfaces within the industrial and scientific area scan camera market.

Triton Edge: The promise of industrial embedded vision systems

LUCID VISION LABS

This white paper will discuss in detail how Lucid's Triton Edge camera helps vision application designers reduce their time-to-market while integrating their own IP into a compact vision system.

www.imveurope.com/white-papers

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Opto Engineering®
Theia Technologies

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AT – Automation Technology GmbH
Basler AG
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Matrox Imaging
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Complete vision systems
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Speakers

Armin Jehle

Armin Jehle, senior business development and key account manager at Automation Technology, will discuss the new C6-3070 3D sensor, how it can achieve such high speeds, and what it means for 3D image processing.

Armin is an expert in sensing technology, with decades of industry experience under his belt, including senior positions at organisations such as SmartRay, AIT Goehner, Cognex Corporation and di-soric.

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