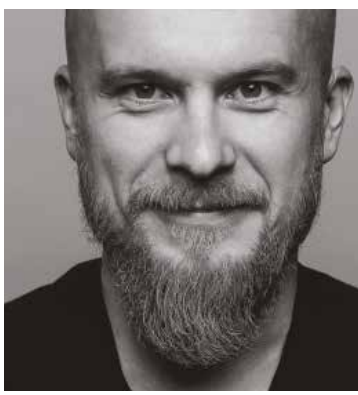
Visionaries 2026

The most innovative integrators in imaging and machine vision









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visionaries

Editor's letter

What a year! Looking back over the past 12 months – a year in which I took the reins as Editor of Imaging & Machine Vision Europe and already find myself putting together my first yearbook editor's letter. I've interviewed some of the best and brightest of the machine vision world, from big name suppliers to up-and-coming start-ups and even bedroom enthusiasts.

The knowledge and the passion of those in our vision community never fails to astound me! And yet it's always matched by their patience, walking me through their latest research or development project.

It's that willingness to share that makes the Vision family so great to be a part of, and it's getting bigger all the time. From first-stage research to end-user products, from factory to farm, across land, sea, air and space, the spaces occupied by machine vision are growing fast.

This yearbook is a chance to look back at some of the highlights. You'll find the best of our Visionaries series, which profiles the rock-star integrators making vision systems work in the real world, alongside business insights from suppliers and a round-up of the year's biggest events.

Talking of events, how could we publish a yearbook weeks before VISION and not help you get ready for it?

'Failing to plan is planning to fail', or so it says on a t-shirt somewhere.

But whether you're visiting VISION as an integrator to compare technologies, meeting vendors as a distributor or presenting your wares and catching up with clients as a vendor yourself, start your plan with our VISION 2026 Guide.

Before you travel to Stuttgart, make sure that this bumper issue is on your packing list. There's plenty here to help you make the most of the show, whether you're there with a carefully planned itinerary or just following your feet from hall to hall.

And if you're going to be at VISION 2026, let me know what you're up to. I'll be there too, and I'd love to hear what you've been working on, what you're looking for and what's caught your eye.

James Wormald

Three-year machine vision slump over, claim suppliers, after VDMA growth forecast

The figures from the VDMA's Annual Markets Survey may suggest Europe is on the way out of its three-year slump, but **James Wormald** asks European vision business leaders what the data really says about the future of the market

After three consecutive years of contraction, the European machine vision industry will return to growth in 2026. This is according to the 2026 Annual Markets Survey from the VDMA, which cites recovering component demand as a key driver of its forecasted figure of 3% turnover growth by the end of the year, up from a 2% decline in 2025.

According to Daniel Seiler, Chairman of VDMA Machine Vision and CEO of AT-Automation Technology, strong 2025 figures from outside the region, including 9% growth in North America and 3% in Asia, are a good sign for Europe.

"Demand outside Europe was already positive in 2025," said Seiler, "and as willingness to invest increases, the European market is following suit."

But with European sales falling 6% in 2025, is 2026 growth a realistic prediction?

Seiler's optimism is shared across the industry, although it still comes wrapped in a note of caution. MVTec Software's Managing Director Olaf Munkelt agreed with Seiler up to a point, saying: "We've come out of the darkness and can see a little brightness on the horizon."

But the numbers only tell part of the story, said Munkelt, as he also warned it would take time to recover the ground lost over the previous three years.

A recovery, not a return

The industry's recent performance is particularly striking when compared with the decade that preceded the downturn. Between 2012 and 2022, European machine vision recorded a compound annual growth rate (CAGR) of 9%. It then contracted for three consecutive years, something Seiler described as unprecedented.

That experience has exposed a fundamental weakness in the European

Messe Stuttgart

Vision industry leaders Martin Klenke, Teledyne (centre, left); Kai Ströder, Basler (centre, right) and Olaf Munkelt, MVTec Software (far right) took part in a panel discussion moderated by Daniel Seiler, CEO of Automation Technology and Chairman of the VDMA (left) at Messe Stuttgart

market: its dependence on manufacturing. Almost two-thirds of machine vision sales in Europe come from manufacturing, said Seiler, and almost 60% of the manufacturing sector's total turnover comes from companies in Europe. Therefore, when European manufacturers reduce investment, the effects spread rapidly through the vision supply chain.

One possible route could be diversification, and industry leaders identified multiple areas including logistics, agriculture, recycling, food processing and other application areas where automation remains relatively underdeveloped.

"We are component providers," said Teledyne Market Development Leader Martin Klenke, "but it's not enough just to think about components; you need to consider what customers are doing with them."

For example, figures presented during a recent industry discussion suggest that less than a fifth (18%) of logistics processes are fully automated, said Klenke, and 50% remain largely untouched by automation technologies.

Messe Stuttgart

Daniel Seiler presented the VDMA's 2026 Annual Markets Survey report at Messe Stuttgart ahead of VISION 2026

From products to problems

One of the strongest themes to emerge from the discussions was that the downturn has changed what customers expect from suppliers. Because products are becoming increasingly similar, Jan Hartmann, Managing Partner at IDS Imaging, said software and customer service are both becoming more important differentiators.

Basler CTO Kai Ströder agreed, revealing that, rather than simply selling them hardware, Basler engineers are being sent out to visit customers to understand their applications and problems first, before offering a solution.

"If you can help customers reduce the complexity of design-in phases, you can help them reduce time to market," he said. "Then you're really solving problems."

This shift is even beginning to change how machine vision is bought, from owning the hardware outright to the operational expenditure models some smaller companies are experimenting with.

"It's a question between CapEx and OpEx," said Klenke. "Our industry is still more CapEx oriented, (but) OpEx trends (are) emerging."

The implication here is that future growth may depend less on selling units and more on taking greater responsibility for the outcome those units deliver.

"We've come out of the darkness and can see a little brightness on the horizon"

Does AI bring opportunity or pressure?

With any future change to industrial operational practices, artificial intelligence (AI) is likely to be found at the centre. While the technology continues to raise the sophistication level of vision systems, a fully efficient AI model's demand for data and computing power are still not being met.

"We have a lack of data in various areas in the AI," said Munkelt, who explained that, as industrial data remains largely with production companies, access to the datasets needed to develop and train the AI systems is limited.

"Most of the data we're processing is not ours," agreed Klenke, "it belongs to our customers." So incoming data sharing regulations and standards could be as important to the industry's future as the underlying AI technology itself.

While initiatives from the VDMA to create legal frameworks that make industrial data sharing possible by monitoring it would "be good for our industry", said Munkelt, the administrative burden is significant.

"It's an enormous task to work out what data we can give away, what data we can't give away and what data we need to keep and what data we need to give back," said Klenke.

Does Europe still have the advantage?

The rise of Asian competitors and the arrival of technology giants such as Google, Microsoft and Nvidia into the industrial AI and machine vision market might cause concern for some European machine vision companies, but the industry leaders I spoke to were confident in Europe's ability to retain its advantage.

The continent already has the technological capabilities it needs "in (its own) hands," said Munkelt, adding that "our strength lies in understanding what the customer wants".

And that pre-existing market knowledge will become more valuable as we move into less mature markets. "We need to go further into our customers' niches," said Klenke, "and we need to solve problems there, on an intimate level."

Proceed with caution

Even if the VDMA's 3% 2026 growth forecast is realised, a return to the pre-slump heights of 9% CAGR is still some way off. While the forecast is a welcome change after three years of contraction, economic uncertainty, geopolitical tensions, competition from China and continuing supply chain pressures all remain.

However, for European suppliers with pre-existing market knowledge and the ability to adapt, a greater demand for integrated systems across a wider range of applications means opportunities are still there to be found. **IMVE**

Thomas Lübkemeier's thoughts on the data sharing standards and regulations coming soon to the European machine vision market can be found in the EMVA column overleaf on page 6.

EMVA at VISION 2026

News from the EMVA
By **Thomas Lübkemeier**

Just a few months after the successful European Machine Vision Association (EMVA) Business Conference 2026 in Stockholm, Sweden, in June, which drew more than 100 participants, the EMVA is gearing up for the next highlight on the machine vision industry's calendar: the VISION trade show, which will take place in Stuttgart from 6 to 8 October.

On the eve of the trade show, the EMVA will again host the International VISION Night for the 15th time, bringing the machine vision community together for a pleasant evening in a casual setting for networking, exchanging market intelligence and getting in the right mood for three days at the world´s leading trade show for machine vision.

Exhibitors, as well as visitors, at VISION 2026 are welcome to join that exciting and informative event, which is sponsored by Messe Stuttgart and the US-based company Headwall. Details about the event and how to register for the International VISION Night can be found at www.vision-night-emva.org.

Focus on standards

At the trade show, the EMVA once again is the leading organiser of the International Machine Vision Standards booth. Machine vision experts will present the most commonly used hardware and software interface standards in the industry in their current versions in Hall 8 at Booth 8E46. Take advantage of these experts' know-how to learn about the technical details and benefits of the interfaces that are available on the market. This will help you establish a solid basis for deciding which interface is best suited for your upcoming machine vision project.

2026 marks a special year for the GenICam interface standard: the Generic Interface for Cameras standard is the base for plug-and-play handling of cameras and devices, and has been invented and introduced in 2006. The EMVA will celebrate the 20th GenICam anniversary at VISION 2026.

Cyber Resilience Act coming up

One of the most important issues currently facing the industry is the Cyber Resilience Act (CRA), which was introduced by the European Union. It will have far-reaching implications for the entire machine vision community, and 11 December 2027 is a key deadline for all companies manufacturing or distributing products with digital elements. If components or systems do not comply with the requirements of the extended CE marking, they will no longer be permitted to be distributed in Europe, without exception.

The GenICam software standard, which has been managed by the EMVA from the very beginning, is among the technologies that are affected by the CRA. As a result, the association must ensure that the transition of GenICam in accordance with the CRA requirements is completed on time. According to EMVA President Dr. Chris Yates, the technical experts who are responsible for this within the GenICam Working Group are already working intensively on a practical solution that will meet the needs of all affected players in the vision industry.

> "The EMVA must ensure the transition of GenICam is in accordance with Cyber Resilience Act requirements, and is completed on time"

New EMVA members

The EMVA is still growing: 13 further companies have decided to become EMVA members since the beginning of this year. Since May alone, five companies have joined the EMVA. They are:

Eleven Dynamics Deutschland – a German subsidiary of Eleven Dynamics. It is an industrial automation and precision metrology pioneer specialising in inline/atline measurement software and robotics integration. Headquartered in Rosenheim, Germany, it supports the group's development, distribution and technical services.

The Fraunhofer Institute for Material Flow and Logistics IML in Germany is considered the top address for integrated logistics research, and works in all fields of internal and external logistics. In line with the Fraunhofer idea, solutions are developed for direct use by companies, but pre-competitive research lasting two to five years – and, in some cases, longer – is also carried out.

Delta Optical Thin Film in Denmark is a privately owned manufacturer of advanced optical thin film components and focuses entirely on designing and manufacturing custom parts for its global OEM customers. The company is one of the pioneers in the optical thin film coating industry.

Vision Research in the US develops high-speed cameras that empower R&D teams, engineers and researchers worldwide in ballistics, automotive, aerospace, biometrics, materials science and academia, optimising designs, solving complex challenges and pushing the boundaries of what's possible.

Evopro is a German company whose expertise and passion lies in the development of customised industrial solutions, especially in the field of automation and testing technology, paired with machine vision and software solutions. **IMVE**

Year in review

Looking back at the 10 biggest industrial machine vision exhibitions, conferences and shows from 2025 and 2026

From Birmingham to Stuttgart, Stockholm to Chicago, the past 12 months have provided plenty of opportunities to see machine vision in action, explore the technologies behind it and debate where the industry is heading. **James Wormald** takes a look back at 10 of the biggest exhibitions, conferences and industry gatherings of the past year, and where they'll be next

IMHX 2025
9-11 Sep 2025 – NEC Birmingham, UK

IMHX 2025 brought together logistics and automation technologies at the National Exhibition Centre (NEC) in Birmingham. With machine vision becoming increasingly central to robotics applications, the exhibition provided a chance to see vision tech operate outside traditional factory environments, including autonomous mobile robots (AMRs), tracking, automated picking and warehouse navigation.

As logistics systems become more data-driven, IMHX provides machine vision specialists with insights into the practical requirements of high-volume, dynamic environments, and how imaging technology will contribute to the next generation of warehouse automation.

Next date: 14-16 Sep 2027 – NEC Birmingham, UK
https://www.imhx.net

PPMA 2025
23-25 Sep 2025 – NEC Birmingham, UK

One of the UK's major meeting points for processing, packaging, robotics and industrial vision specialists, the pull of the PPMA Show is to see imaging and inspection technologies as a key part of operational production systems. Live demonstrations provided useful technical context that can be difficult to gain from standard tech expos.

The 2025 show also highlighted one of the major challenges for the UK's engineering and automation sector: the skills shortage.

Alongside the new technology demos, seminars and initiatives that addressed the need for training and apprenticeships made PPMA a useful forum to understand the market as a whole.

Next date: 22-24 Sep 2026 – NEC Birmingham, UK
https://www.ppmashow.co.uk >

PPMA Show

A bottling demo at PPMA 2023

IMHX

IMHX 2025 exhibition floor

SPIE

Product demonstrations took place at exhibition booths at Photonics West 2026

Image Sensors Europe

Experts and innovators gathered at Image Sensory Europe to discuss future vision trends

Photonics West 2026
17-22 Jan 2026 – San Francisco, USA

Although it's held outside Europe and covers the wider photonics industry, Photonics West has become an important event in the calendar of any European machine vision specialist. That's because its strength lies in the breadth of technology on display. Optics, spectroscopy, 3D imaging, SWIR and AI vision are all covered in detail, and the 2026 introduction of the Vision Tech Expo gave machine vision a more prominent presence during the week. Alongside a substantial technical conference programme, the event offered a broad view of the technologies that will underpin modern vision systems for years to come.

Next date: 30 Jan-4 Feb 2027 – San Francisco, USA

https://spie.org/conferences-and-exhibitions/photonics-west

Image Sensors Europe 2026
17-18 Mar 2026 – London, UK

Image Sensors Europe marked its 20th edition in 2026, bringing together more than 250 specialists from across the digital imaging supply chain.

The appeal of the long-running meet-up comes from venturing beneath the camera, looking at the sensing technologies that ultimately determine system performance.

The conference provides a concentrated forum for understanding developments in image sensors, sensor architectures, processing and other emerging imaging technologies. With contributions from sensor manufacturers, semiconductor specialists, researchers and system developers, the event offers a technically focused view of where industrial imaging technology is headed.

Next date: 17-18 Mar 2027 – London, UK

https://www.image-sensors.com/image-sensors-europe

International Vision Standards Meeting (IVSM) 2026
13-17 Apr 2026 – Prague, Czech Republic

The International Vision Standards Meeting (IVSM) is one of the machine vision industry's most technically focused gatherings, bringing together experts working directly on the standards that underpin modern vision systems.

Organised by the EMVA, the 2026 spring meeting in Prague brought together working groups covering major machine vision hardware and software standards, and tested their interoperability in practice.

Developments in interfaces, communication, software and hardware interoperability can have a long-term impact on system architecture and vision integration. IVSM offers an opportunity to understand not just how these systems work, but how the industry is working to make them work together.

Next dates:
Oct 2026 – Hosted by A3 in Ottawa, Canada
Apr 2027 – Hosted by JIIA in Fukuoka, Japan

https://www.automate.org/vision/vision-standards/ivsm-fall-2026

MACH 2026
20-24 April 2026 – NEC Birmingham, UK

MACH 2026 demonstrated how deeply machine vision is becoming embedded in modern manufacturing. More than 26,000 visitors and 500 exhibitors filled five halls at the NEC, covering machine tools, robotics, metrology, additive manufacturing, software and automation, with imaging

EMVA

The IVSM Plugfest brought groups together to test the interoperability of systems

UKIVA

Laurie Barnes, CTO of Automate UK, spoke at the UKIVA Conference 2026, the latest manufacturing innovations with the UK's biggest experts

technology appearing across many of these areas rather than being confined to specialist inspection applications.

The event offered integrators the opportunity to see component suppliers' products in a wider manufacturing context, with AI inspection, 3D measurement, robotic automation and smart manufacturing all heavily featured in engineered demo systems.

Next date: 3-7 Apr 2028 – NEC Birmingham, UK

https://machexhibition.com

UKIVA Conference 2026
17 Jun 2026 – Schneider Electric, Coventry, UK

UKIVA's annual conference provides one of the UK's most focused meet-ups for machine vision specialists to exchange technical knowledge and discuss the direction of the industry. The 2026 programme combined presentations on robotics, AI, industrial automation and machine vision, alongside analysis of current market trends.

With sessions examining technology development and robotics, and discussions surrounding integration and standards, the concentrated format provided a specialist audience with the opportunity to hear directly from experienced practitioners in an advanced manufacturing setting.

Next date: 28-30 Sep 2027 – Birmingham, UK (part of Automate UK Week)

https://www.automate-uk.com/what-we-do/events-exhibitions/automate-uk-week-2027

EMVA Business Conference 2026
18-20 Jun 2026 – Stockholm, Sweden

The EMVA Business Conference combines technical presentations with open discussions on the industry's wider issues. The 2026 Conference in Stockholm highlighted the growing importance of regulations, with the EU Cyber Resilience Act a major topic.

Alongside industry perspective presentations and discussions, another talking point at the 2026 Conference was the EMVA Young Professional Award, presented to Vanessa Staderini from the AIT Austrian Institute of Technology for research into optimising robotic visual inspection.

Further details from the 2026 EMVA Business Conference can be found in the column from EMVA General Manager Thomas Lübkeimeir on page 6.

Next date: Apr 2027 – Nice, France

https://www.emva.org

MTA

MACH 2026 combined the latest manufacturing innovations with the UK's biggest experts

>

Uli Regenscheit / Messe Stuttgart

VISION 2026 will take place at Messe Stuttgart 6-8 October

EMVA

EMVA President Chris Yates (left), Young Professional Award winner Vanessa Staderini and Marco Diani (EMVA board member)

> **Automate 2026**
> **22-25 Jun 2026 – Chicago, USA**

As one of the world's major industrial automation events, Automate US is well attended by both European machine vision companies and professionals. One of the main focuses of the 2026 event was the evolution from rule-based to AI-assisted inspection systems, with deep learning, synthetic data, edge computing and 3D vision all covered in the programme.

Another opportunity to see vision technology working alongside scaled robotics and automation systems, Automate 2026 demonstrated systems including AI-driven inspection, robotic guidance, autonomous navigation and the perception of difficult objects, detailing the emerging hardware and software that will direct the next generation of industrial machine vision.

Next date: 10-13 May 2027 – Las Vegas, USA
https://www.automateshow.com

A3

Automate 2026 took place 22-25 June in Chicago, Illinois

VISION 2026
6-8 Oct 2026 – Stuttgart, Germany

No annual machine vision round-up would be complete without VISION, the industry's principal dedicated international exhibition. With around 500 exhibitors expected in Stuttgart and, according to organisers, more than 20% new to the show, the event offers an opportunity to survey the entire industry in one place, from cameras, optics and lighting to AI, 3D imaging and complete inspection systems.

As usual, the 2026 programme will feature the Industrial and Scientific Vision Days presentations, alongside guided tours and a new Synthetic Data Symposium, all covering a range of application areas including automotive, electronics and semiconductor manufacturing.

Turn to Imaging & Machine Vision Europe's detailed editor's guide to VISION 2026 on page 10 to plan your week in Stuttgart!

Next date: Oct 2028 – Stuttgart, Germany
https://www.messe-stuttgart.de/vision

The dates, locations and focus of these events are subject to change, please check the official websites for up-to-date information.* **IMVE

Messe Stuttgart

VISION 2026 event guide:
What to look out for in Stuttgart

With new exhibitors, new programme features and machine vision technology continuing to evolve rapidly, VISION 2026 promises plenty to discover. Our comprehensive nine-page guide highlights the companies, products, talks and areas worth seeking out at this year's show

VISION 2026 arrives at Messe Stuttgart at a time when machine vision is changing rapidly. AI is reshaping what vision systems can detect and how they can be deployed, while other advances in imaging technology, software and data are opening up new possibilities across industrial applications.

That evolution is reflected in this year's exhibition, which Messe Stuttgart's VISION Project Manager Florian Niethammer says will feature more than 20% new exhibitors, and record participation numbers are expected, especially from further afield.

"We're seeing strong participation from companies from China," says Niethammer. "We saw that at the last edition, and maybe this might reach the next level this year as there are lots of new, high-quality players."

While reflective of a growing industry, the sheer scale and scope of the VISION show can present a challenge to visitors looking to capture it all.

Step in, Imaging & Machine Vision Europe to guide you through.

Across the following pages, we present our curated selection of some of the most intriguing, groundbreaking and innovative highlights of the week, from 3D vision to AI-enabled inspection systems and complete machine vision solutions, these are some of the developments worth making time for as you work your way around the halls.

Separate OK from NOK

VISION is just as much conference as it is exhibition, of course, and with more than 70 talks, discussions, pitches and presentations at the Industrial VISION Days stage, cutting-edge technology lectures at the Scientific VISION Days stage and insights from leading experts at the new Synthetic Data Symposium, there's plenty to learn.

There are also new ways to explore the exhibition itself. Specialised guided tours organised with the VDMA will focus on aerospace and defence, automotive and battery manufacturing and electronics and semiconductor production, bringing visitors to selected exhibitors while providing a practical introduction to the role of machine vision in each sector.

The next generation of the industry will also get plenty of attention, with the return of Start-up World, featuring around 30 emerging companies, and a new Start-up Happy Hour creating opportunities for start-ups to connect with established suppliers. Looking even further to the future, the Vision Makeathon, supported by the VDMA and ITQ, invites students and young engineers to work with industry experts to tackle practical machine vision challenges.

The VISION Award will, once again, provide a showcase for some of the most interesting applications and innovations on display.

This year, representatives from shortlisted companies, the Austrian Institute of Technology (AIT), Lidwave, Medabsy, photonicSENS and Singular Photonics will pitch it out on the Industrial VISION Days stage to see who takes home the top prize.

And finally, we've selected a collection of new products from VISION exhibitors, providing a quick way to see some of the latest cameras, sensors, software, lighting and other machine vision technologies arriving on the market.

So read on for Imaging & Machine Vision Europe's handy VISION Guide, helping you navigate the exhibition, learn from the conference and, hopefully, find something you might otherwise have missed. **IMVE**

Booth highlights: what to look out for

Austrian Institute of Technology (AIT)
Hall 8, Booth 8C50

Under the theme 'From Vision to Action', AIT will demonstrate ICI (Inline Computational Imaging) for the simultaneous 2D/3D inspection of moving objects, photometry for ultrafast inline inspection and the VISION Award-nominated portable motion-robust surface inspection platform, PHOTODEX. AIT will also show a robotic inspection platform that automatically plans workflows from CAD models, and SLAM for real-time 3D environment perception, localisation and mapping.

AT Sensors
Hall 10, Booth 10E55

AT Sensors will demonstrate two new C7 portfolio products that use 5GigE to simultaneously transmit 3D profile, intensity and reflection data. Sending loss-free data in real time has "limited inline inspection for years", says the company, and "now (it's been) solved in a single acquisition step". Live demonstrations at the AT Sensors booth will include applications that inspect tyres, beverages and electrical components, and one that combines 3D imaging with infrared sensing to inspect smartphone components.

Edmund Optics
Hall 8, Booth 8C30

Edmund Optics will be demonstrating a custom-optics drone application and a showcase of optical solutions engineered for harsh environments, alongside a range of other applications. Under the theme 'Your Trusted Partner for Imaging Solutions', the company promises to showcase how close collaboration between customers and its engineering, design and manufacturing teams results in "practical optical solutions".

EFFILUX
Hall 10, Booth 10E54

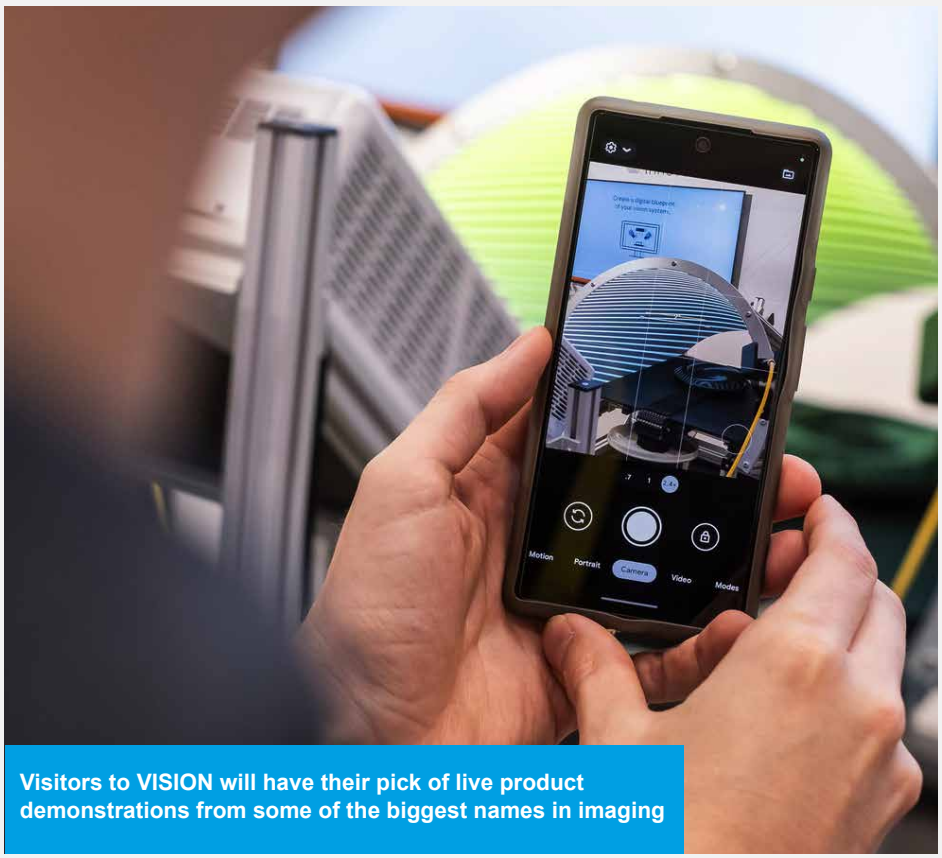
EFFILUX will demonstrate how its tailored lighting products can be integrated for dimensional measurements, cap and fill-level inspection, colour and surface inspection, SWIR imaging and QR/Data Matrix reading applications on a live conveyor, and a dedicated logistics portal will showcase further identification, traceability and automated material handling applications. Sharing a booth with familial group companies CCS and Gardasoft, EFFILUX says it will "address the most demanding industrial challenges, from logistics to space technologies".

EVT EyeVision Technology
Hall 10, Booth 10G57

Demonstrating how its EyeVision software takes manufacturers from concept to application, live demonstrations at the EVT booth will feature both 2D and 3D sensors, in applications such as robot pick-and-place and 3D solder-paste inspection systems, as well as the EyeSorter Checkbox, which uses one-click teaching to identify, orient and pass or reject small parts in feeding systems. According to EVT, visitors will be able to try the software tools out to understand how their own production challenges could be addressed.

Exosens
Hall 8, Booth 8C33

At the Exosens booth you'll find imaging technologies ranging from UV to LWIR. There will also be with live demonstrations of the following: industrial inspection applications such as detecting contaminants and defects in food; identifying and sorting different materials for improved recycling efficiency; thermal imaging and analysis to enhance wafer inspection in semiconductor manufacturing; UV dark-field imaging for improved defect detection; and SWIR imaging applications enabled by quantum dot technology.



Messe Stuttgart

Visitors to VISION will have their pick of live product demonstrations from some of the biggest names in imaging

HAIP Solutions
Hall 10, Booth 10E70.8

A complete hyperspectral imaging workflow will be demonstrated by HAIP, using industrial inspection and sorting applications in the food and recycling industries as examples. Its BlackIndustry SWIR and RGB cameras will join forces with its BlackBright illumination systems and BlackStudio software to handle data acquisition, visualisation, analysis and classification, in a full demonstration of the BlackIndustry Station scanning system.

JAI
Hall 10, Booth 10C18

With 11 live demonstrations covering food, electronics, pharmaceutical, medical and print inspection applications as well as semiconductor manufacturing, recycling and material sorting, JAI's booth could be one of the busies. Highlights include prism-based RGB/NIR multispectral imaging, UV imaging, cooled SWIR 400-1700nm cameras and SWIR line scan technology, as well as high-res line and area scan cameras with CoaXPress.

Lidwave
Hall 8, Booth 8E60

Lidwave will demonstrate its Odem sensor, which, it says, is the world's first single-chip coherent 4D lidar, designed to provide both range and per-pixel velocity in a single frame for robotics, drone, automotive and industrial automation applications. Based on the company's patented Finite Coherent Ranging technology, the system puts the optical engine onto a single silicon photonics chip in a monostatic design, which enables calibration-free, wafer-scale production and high-speed perception, even in challenging conditions such as glare, rain, fog, dust and snow.

LUCID Vision Labs
Hall 10, Booth 10E40

New GigE Vision cameras spanning high-res line scan, NIR, low-light and RGB-D imaging will be demonstrated by LUCID Vision Labs. The Triton, Triton 2 and Triton 10 models all feature Sony's STARVIS and STARVIS 2 sensors for applications including automated optical inspection, material sorting and grading, print and surface inspection, food sorting, automated logistics, barcode reading and robotics. The company's Helios 2 Chroma cameras, which, it claims, improve spatial awareness and material handling for robotics and outdoor 3D imaging applications, will also be on show.

MVTec Software
Hall 8, Booth 8C56

MVTec Software will show how AI is extending machine vision beyond traditional image processing techniques. Highlighting the AI Vision Solver, a prototype product that uses AI agents to generate vision applications from prompts, MVTec says it will present a glimpse into the future of product development. Visitors to the booth will also get to see hardware accelerators from Qualcomm, Nvidia, Intel and AMD running deep learning systems and preview new software features from HALCON and MERLIC.

Optotune
Hall 10, Booth 10G25

Using a robotic arm/turntable application, Optotune will demonstrate electronically focus-tunable lens modules (ELMs), showing how liquid lens technology can add flexibility to machine vision systems and a combined ELM/adaptive mirror will also show how field-of-view can be expanded for dynamic barcode reading in logistics applications. According to Optotune, visitors will learn how technologies such as liquid tunable prisms and adaptive mirrors can be applied to optical image stabilisation, lidar and free-space communications.

Messe Stuttgart

Demonstrations will include machine vision systems that power robotics cells for industrial automation

photonicSENS
Hall 10, Booth 10C33

photonicSENS will demonstrate its VISION Award-shortlisted industrial light-field cameras, which capture a full 2D image and 3D depth map simultaneously in a single shot, without structured light or scanning. Live demonstrations will include applications such as wire-bond inspection, telecentric-lens 2D measurement and XYZ stitching for larger 3D parts. The company will also introduce its new apiCAM EDGE+ global-shutter module, which doubles the working range of its standard EDGE camera, reducing captures and inspection cycle times.

Pleora
Hall 8, Booth 8B02

Pleora will showcase new connectivity solutions including Camera Link-to-GigE Vision 10GigE and RoCEv2 frame grabbers, as well as an SDI-to-GigE Vision frame grabber and a GigE Vision-to-Thunderbolt model. But the company's key demonstration will feature its Multisensor Edge Integration Platform, which brings cameras together with lidar, ToF and other sensors into a unified perception pipeline. According to Pleora, the approach reduces software complexity, improving interoperability for applications such as industrial automation, robotics and medical imaging.

Sightwise
Hall 8, Booth 8C05

Used for synthetic data generation and AI model development, Sightwise's flagship SightHub platform will be the main focus of its booth, where visitors will be able to see the company's latest approach to obtaining synthetic training data from 3D CAD models and generative AI. Aimed at reducing the time and manual effort spent on image annotation and dataset preparation tasks, Sightwise says SightHub makes it easier to scale inspection tasks across larger product portfolios, shortening time-to-value and improving model performance.

Singular Photonics
Hall 8, Booth 8D47

The star of the Singular Photonics booth will no doubt be the VISION Award-shortlisted image sensor Litavis. With High Dynamic Range, Single Photon Counting and Lidar/ToF modes, Singular will highlight the SPAD-based sensor's configurable sensing architecture and in-pixel processing. The company says Litavis moves SPAD technology beyond conventional photon counting and towards more flexible, time-resolved computational imaging. Visitors to the live demonstrations will get to see for themselves.

Spectricity
Hall 10, Booth 10G63

At Spectricity's booth, you'll see the company's new S1-A Evaluation Kit for multispectral imaging. According to the developers, the upgraded device is available in one of two packages: the Discover package supports handheld capture for Android devices, capture and analysis with Spectricity's GUI for Windows and Mac and automated acquisition via Python. The Develop package is for users to produce their own mobile applications, with access to the Android SDK and application examples. The company will also show its Chromatope SC-400 for Colorimetry. For more information please turn to page 18.

Teledyne Vision Solutions
Hall 8, Booth 8B10

Two particular highlights from Teledyne will be a live demonstration of its 100Gb/s imaging platform that combines a Sony CMOS image sensor in a Teledyne camera with a frame grabber and CoaXPress interface, and a 5D camera that synchronises 2D imaging with 3D depth data using a single CMOS sensor. Visitors will also be able to explore its SWIR, global-shutter BSI, 3D laser profiler and compact thermal imaging portfolio for applications such as semiconductor, battery and print inspection, as well as robotics, food processing, logistics, metrology, automotive, aerospace, medical and life sciences.

Vision & Control
Hall 10, Booth 10B87

Vision & Control produces integrated photonics solutions that combine optics, illumination and image processing, and these will be on show with two live demonstrations focusing on complex-surface defect detection and high-speed vision for accurate inspection at high production speeds. The telecentric illumination system, for precision measurements and inspections, will also be on display, alongside custom-designed optical systems. **IMVE**

Selected vision talks

Beyond the exhibition halls, VISION 2026 will offer visitors of all experience levels a wide-ranging conference programme designed to help them make sense of the latest technologies, trends and terms in machine vision.

Lecture Forums: With three different perspectives, the event's headline Lecture Forums include Industrial VISION Days: presentations, discussions and start-up pitches on the latest developments and application; Scientific VISION Days: more specialised presentations from researchers and technicians in areas such as 3D vision, computational imaging, deep learning and machine vision testing; and the new-for-2026 Synthetic Data Symposium: this details how, with a shortage of real-world training data, synthetic data can be used to train vision systems by simulating production environments. **See my pick of Lecture Forums from both Industrial VISION Days and Scientific VISION Days here. >>>**

Theme Parks: Providing useful focal points on the show floor, the VISION Integration Area allows system integrators and collaborative suppliers to present their application-ready inspection, robotic guidance and quality control solutions; Start-up World allows emerging companies and technologies to take centre stage and the BMWE Joint Stand showcases innovative German small-to-medium enterprises and newcomers.

Special Shows: With the opportunity for more active engagement, these Special Shows include the VISION Makeathon, which brings interdisciplinary teams together to tackle practical image-processing challenges (in smart farming and the circular economy for 2026), International Machine Vision Standards dives into the standards that underpin the development of new products, and the Career Centre + Job Board will offer industry-specific career advice and connections between companies and potential recruits.

Guided Tours: With more than 500 exhibitors expected in Stuttgart, the idea of covering it all in detail is the stuff of nightmares, so the event organisers also offer a series of Guided Tours that concentrate on three major sectors: Electronics & Semiconductors, Aerospace & Defence and Automotive & Battery. Each tour takes visitors to selected exhibitors working on the particular imaging and inspection challenges those industries face.

Overview

06 Oct: 09.10-09.20: Industrial VISION Days (8C70): VISION 2026 Opening and Market Update – Anne Wendel, VDMA Machine Vision

Food/logistics

6 Oct: 12.40-13.00: Industrial VISION Days (8C70): How Multispectral Vision Transforms Food Inspection – James Cameron, Global Segment Director, Food, JAI

6 Oct: 13.00-13.20: Industrial VISION Days (8C70): Hygienic Machine Vision: Three Essential Design Principles – Povilas Dailies – Product Manager, Exaktera

6 Oct: 13.20-13.40: From Farm to Fork(lift) – End-to-end Food Inspection and Automation – Brian Cha, Product Manager, LUCID Vision Labs

Lighting

06 Oct: 14.20-14.40: Industrial VISION Days (8C70): Illumination Techniques for High-Speed PhotometricStereo Using FPGA/GPU/CPU – Michael Stelzl (Visionary/P100) Managing Director, MSTVision

06 Oct: 14.40-15.00: Industrial VISION Days (8C70): High Contrast Edges Thanks to the Shadow-Casting Principle: Telecentr.Light – Claudia Link, Senior Engineer Optical Systems, Vision & Control

08 Oct: 10.20-10.40: Industrial VISION Days (8C70): LED Current Control for Reproducible High-Speed Machine Vision – Georg Schaffer, Sales Engineer, GEFASOFT Automatisierung und Software

Robotic guidance

06 Oct: 13.00-13.20: Scientific VISION Days (8C50): Plan-Once, Place-Anywhere: a CAD-Centric Framework for Adaptive Robotic Inspection – Vanessa Staderini, AIT Austrian Institute of Technology

08 Oct: 11.20-11.40: Industrial VISION Days (8C70): AI-Powered 3D Robotic Guidance for Sustainable Robotic Painting – Michael Beising, CEO, EVT

08 Oct: 15.20-15.40: Industrial VISION Days (8C70): From Images to Depth: When Sensors Drive Robotic Intelligence – Marie-Charlotte Leclerc, Product Manager, Industrial & IoT Sensors, STMicroelectronics

Inspection

07 Oct: 14.20-14.40: Industrial VISION Days (8C70): Solving High-Speed 3D inspection with the World's Fastest Laser Profilers – Marcu Brucculeri – Sales Manager Northern Europe, AT Sensors

08 Oct: 10.40-11.00: Scientific VISION Days (8C50): Precision in Motion: High-Speed Microscopy for Miniaturised Component Inspection – Caroline Girmen, Fraunhofer IPT

08 Oct: 11.40-12.00: Industrial VISION Days (8C70): SPEAR: Drones for Infrastructure Inspection and Complex Terrain Monitoring – Paul Tenfjord, Biodrone

Semiconductor inspection

06 Oct: 10.20-10.40: Industrial VISION Days (8C70): 32k for Wafer Scale Imaging – Matt Moser, Director Product Development, Teledyne DALSA

08 Oct: 13.20-13.40: Industrial VISION Days (8C70): 32k Line Scan Imaging for High-throughput Semiconductor Inspection – Robin Ziegler, Product Manager Line Scan, Allied Vision Konstanz

08 Oct: 16.40-17.00: Industrial VISION Days (8C70): Single-Shot 12-Inch Wafer Inspection: Solving Coaxial Uniformity for AI AOI – Victor Wei, VICO Imaging

AI / Synthetic Data

07 Oct: 11.00-11.20: Scientific VISION Days (8C50): Efficient and Robust Training of Foundational Vision AI Models Using GenAI – Dr Sven Wanner, Artificial Pixels

07 Oct: 15.20-15.40: Industrial VISION Days (8C70): From Hype to Hands On: Practical Deep Learning for Industrial Vision – Christian Eckstein, Product Manager Deep Learning Tool, MVTex Software

07 Oct: 16.00-16.20: Industrial VISION Days (8C70): AI-assisted Development and Configuration of Industrial Vision Systems – Thies Moeller, Chief Engineer R&D, Basler

Hyperspectral/multispectral

08 Oct: 14.00-14.20: Industrial VISION Days (8C70): Why Industrial Spectral Imaging is Finally Taking Off – Tobias Kreklow, CEO, HAIP Solutions

08 Oct: 14.20-14.40: Industrial VISION Days (8C70): Beyond Visible: Unlocking Industrial Intelligence with UV, SWIR and LWIR – Sarah Montella, Director of Marketing, Advanced Imaging, Exosens

08 Oct: 16.20-16.40: Industrial VISION Days (8C70): Integrated Filter-Switching Lens for Automated Multispectral Inspection – Kai Masberg, Image & Information Technology Division Group Manager, CBC Europe

Discussions

07 Oct: 14.40-15.00: AI and 3D Machine Vision for the World's Biggest Workforce – the Frontline – Jason Harvey, VP AI and Automation, Zebra Technologies & Svorad Stolc, CTO, Photoneo

2026 VISION Award: The finalists

Austrian Institute of Technology

Five shortlisted companies will compete for the 2026 VISION Award. From coherent 4D sensing to configurable SPAD architectures, the nominees and their work reflect the wealth and breadth of approaches pushing industrial vision beyond conventional 2D and 3D imaging.

Held during a live presentation at Industrial VISION Days (Hall 8, Booth 8D90), the 2026 VISION Award celebrates the excellence and innovation of the imaging and machine vision industry, with a total of 75 entries having already been whittled down to five nominees by a judging panel including Christian Ripperda, CEO of BN Automation; Jens Michael Carstensen, CEO of Videometer; Michael Engel, founder of Vision Components; Chris Yates, Managing Partner at Vision Ventures; Dr Ronald Muller, CEO of Vision Markets and Martin Wäny, CEO of Technologies MW.

Ranging from plenoptic imaging and coherent 4D sensing to photometric stereo, sensor virtualisation and configurable SPAD architectures, representatives from the five shortlisted companies will present their innovations to a VISION audience at a live session, moderated by Warren Clark, Chief Executive of Imaging & Machine Vision Europe publisher Europa Science. Jury member Martin Wäny, will announce the winners of the €3,000 prize. Here, we take an in-depth look at the five finalists, and the innovations that have put them in contention for the main prize.

Austrian Institute of Technology AIT
PHOTODEX: a mobile inspection system for intelligent, robust industrial surface analysis

PHOTODEX, developed by the Austrian Institute of Technology (AIT), is a portable industrial inspection system that enables high-resolution surface inspection during continuous handheld or robotic operation.

Its key innovation is the combination of motion-robust, quasi- single-shot photometric stereo and automatic CAD-based localisation in a single portable system. As a result, manufacturers can perform reliable high-resolution inspection without motion artefacts, while every detected defect is automatically registered to its exact position on the digital twin. This helps manufacturers detect surface defects faster, reduce inspection costs, minimise scrap and rework, and generate standardised, spatially referenced AI-ready ground-truth datasets.

Unlike conventional inspection systems, PHOTODEX maintains full spatial resolution during continuous scanning, making it ideal for inspecting large or difficult-to-access components. By automatically registering every detected defect to its exact CAD model position, the system creates structured inspection data that integrates directly into digital engineering and quality management workflows.

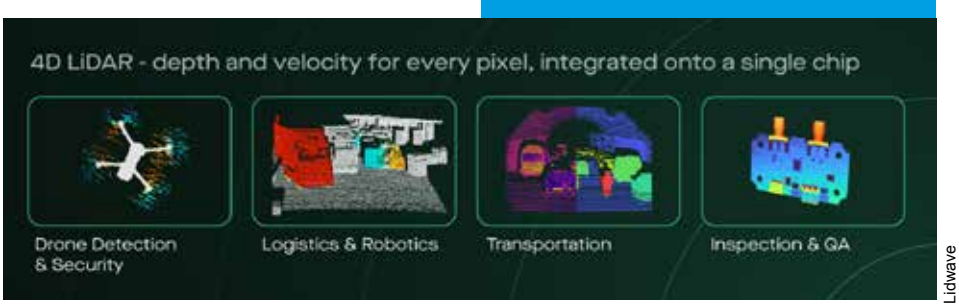
This unified workflow for surface characterisation, defect localisation, and digital quality assurance enables applications in the automotive, die-casting, battery manufacturing and aerospace industries, improving productivity, defect traceability, root-cause analysis and AI-driven quality assurance.

Lidwave
Odem: 4D coherent vision on a single chip

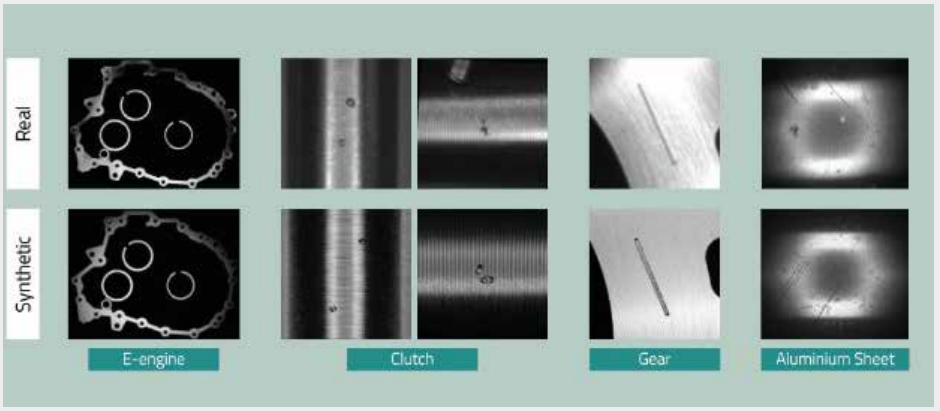
Odem is the world's first and only single-chip 4D lidar – the perception layer for physical AI. It gives robotics and drone makers, automotive OEMs and Tier-1s, industrial-automation firms, and smart-city and security operators one sensor that measures range and per-pixel velocity together, in a single frame and in any condition.

That turns perception from reactive to predictive: not only where objects are, but how fast and where they move – separating moving hazards from static clutter instantly, with total immunity to sun glare, ambient light and cross-talk, as well as clear vision through rain, fog, dust and snow.

The breakthrough is Lidwave's patented finite coherent ranging (FCR), reading the coherence of light rather than its speed. This puts the whole optical engine on one silicon photonics chip in a true monostatic design: calibration-free, built at wafer scale, and streaming millions of points per second over hundreds of metres.



Lidwave



Medabsy

Medabsy
Virtualising machine vision

The software enables users to virtually design complete machine vision systems using real, commercially available cameras, lenses, lighting and other hardware. These virtual designs can be then used to generate photorealistic synthetic training datasets with pixel-perfect annotations.

Unlike synthetic data solutions that rely on generative AI, the platform uses physically accurate light transport simulation and mathematical models of textures and defects to create every image. This approach ensures full physical accuracy, complete controllability and realistic sensor behaviour, while enabling users to systematically generate edge cases and apply domain randomisation.

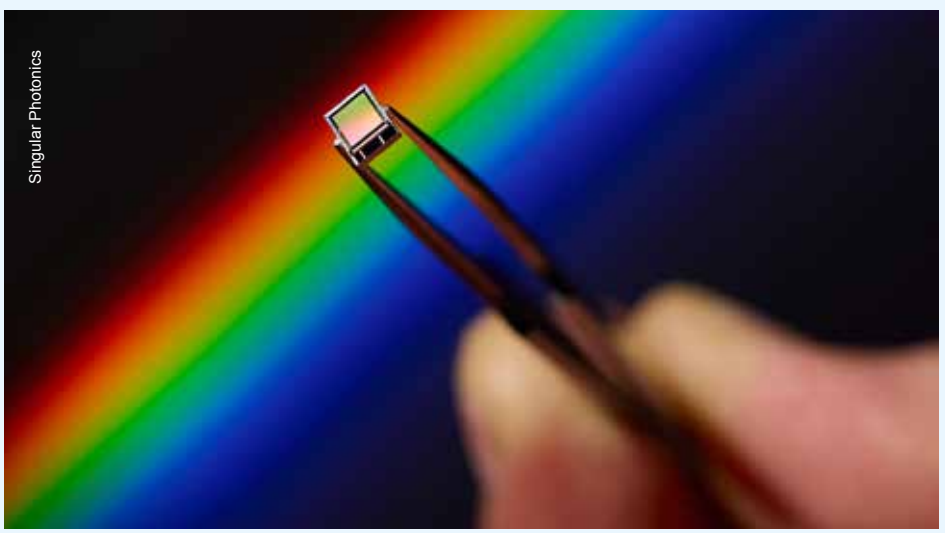
The result is high-quality synthetic data that supports the development, validation and optimisation of machine vision systems with greater confidence, reduced cost, and faster time to deployment.

Singular Photonics
Litavis: a software-configurable SPAD image sensor

Coming soon from Singular Photonics, Litavis is a next-generation single-photon avalanche diode (SPAD) image sensor that brings unprecedented flexibility and intelligence to advanced imaging and machine vision.

Unlike conventional sensors, which are typically designed for a single operating mode, Litavis features a software-configurable architecture that combines high-sensitivity photon-counting imaging, programmable time gating and advanced photon timing on a scalable SPAD platform. By integrating embedded digital photon processing directly on the sensor, it enables simultaneous photon-counting and time-resolved sensing for applications including machine vision and lidar, while allowing sensor functionality to be reconfigured in software without hardware redesign.

Processing photon events on-chip dramatically reduces data transfer requirements, enabling lower latency, reduced power consumption and faster real-time decision-making. The software-defined approach transforms image sensors into intelligent sensing platforms that extract meaningful information directly at the focal plane, accelerating application development while reducing system complexity and opening new possibilities for computational imaging.



Singular Photonics

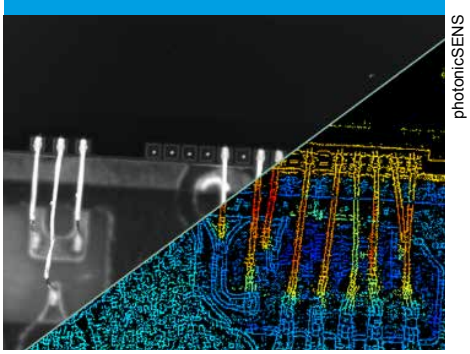
photonicSENS
From plenoptic research to industrial 3D vision

photonicSENS has turned plenoptic (light field) imaging, understood in theory for more than a century, into a manufacturable industrial technology. Its apiCAM platform captures a full 2D image and a calibrated, per-pixel 3D depth map simultaneously, from a single sensor, in a single shot, with no projector, no scan axis and no on-site calibration.

A Micro-Lens Array between lens and sensor captures multiple angular perspectives in one frame. A proprietary algorithm then extracts genuine, measured depth in real time, including on specular metallic surfaces and transparent substrates that challenge structured light, laser triangulation and stereo vision.

Manufactured at industrial scale using a proprietary automated alignment process in photonicSENS' own cleanroom in Valencia, Spain, the portfolio now spans more than 50 off-the-shelf camera designs, with depth precision reaching less than 0.5 µm at the high end and up to the millimetre range at the other.

Light field imaging has been discussed in machine vision for two decades. photonicSENS is the company that made it a product.



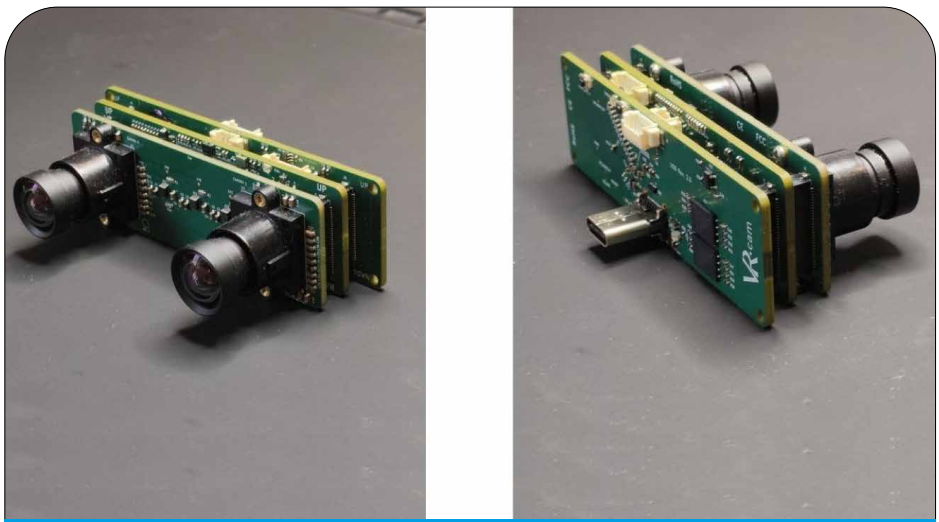
photonicSENS

The 2026 VISION Award is sponsored by Imaging and Machine Vision Europe. "Imaging and Machine Vision Europe has been the VISION Award sponsor for more than 20 years and we're very proud to continue that tradition into 2026," said Warren Clark. "With its focus on innovation and driving intelligent vision forward, the VISION Award is aligned with our own values, particularly our Visionaries series of imaging innovators and integrators." The five nominees will present their products during a one-hour session at **11.00-12.00** on the Industrial VISION Days stage (**Hall 8, Booth D90**).

2026 VISION products

All of the following product manufacturers can be found at VISION 2026

To submit your new product release for inclusion, please send details and images to james.wormald@europascience.com

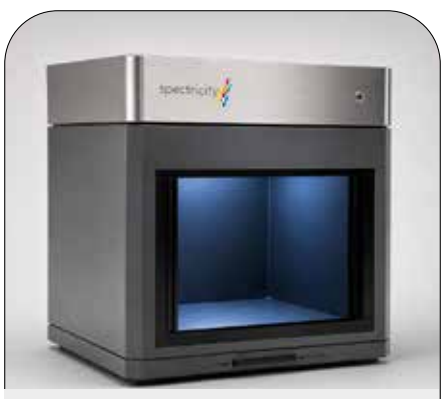


Efinix
(Hall 8, Booth 8A56)
VR.cam03 from VR.cam

Built on the processing power of Efinix's titanium FPGA silicon platform, the VR.cam03 from edge AI application developer VR.cam, which supplies AR/VR solutions to Meta, Apple and Samsung, streams side-by-side 4K video at 60fps and 8K at 30fps via a USB-C interface at up to 20Gbps. The device's planned software roadmap includes on-camera machine-learning inference, event detection up to 1,000fps, ToF depth-sensing, real-time point cloud streaming and 4D Gaussian splatting for 3D scene reconstruction.

IDS Imaging
(Hall 8, Booth 8C60)
uEye FA camera series

The uEye FA industrial camera series has been expanded with new models featuring Sony's STARVIS 2 rolling shutter sensors ranging from two-to- 12.5MP resolution. All models are GigE Vision-compliant, offer near-infrared sensitivity, low noise, clear HDR for extended dynamic range and asynchronous exposure triggering. According to IDS, the cameras' IP69K-rated protective housing, lens tube and cabling allow for high-pressure cleaning, dust and operational temperatures down to -20ºC.



Spectricity
(Hall 10, Booth 10G63)
Chromatope SC-400 colorimeter

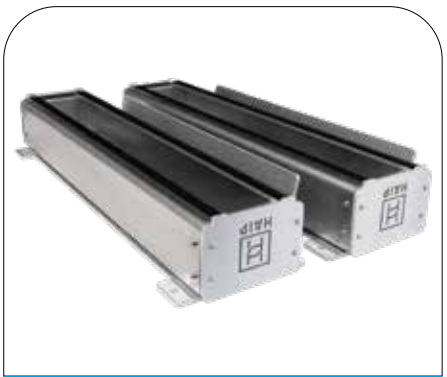
Chromatope SC-400 is a computational spectral imaging colorimeter built by on the back of Spectricity's S1 sensor. Designed for diffuse reflection samples with flat surfaces, uneven colour distribution, irregular shapes and granular textures, the company says the box captures measurement areas up to 420mm x 340mm in a single, non-contact acquisition with colour-difference heat maps, and features ≤0.15 ΔE00 repeatability, ≤0.2 stability over one month, ≤0.2 instrument-to-instrument agreement and an integration-ready SDK for custom development.

Beckhoff Automation
(Hall 10, Booth 10F10)
Vision Unit Illuminated series

Sixteen new devices have been added to Beckhoff's Vision Unit Illuminated (VUI) series, each combining a camera, illumination and liquid lens-focusable optics in a single unit. Using Sony Pregius S image sensors with resolutions of 5.1, 8.1 and 12.4MP, the units are available with crossed polarising filters to suppress surface reflections through glass, plastic or water, and integrate with Beckhoff's EtherCAT and TwinCAT automation platforms for synchronised control of both machine and vision.

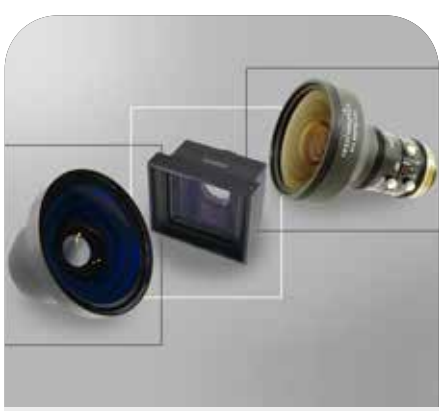
Basler
(Hall 8, Booth 8D50)
Stereo mini camera

Measuring just 90mm x 25mm x 30mm and weighing 97g, the compact Stereo mini camera from Basler uses two synchronised image sensors to generate depth maps and 3D point clouds via passive or actively-supported stereo vision. Designed for AGV, AMR and robotic arm platforms, the camera integrates with Basler's pylon SDK, supports C++, C# and Python APIs and meets IP5x, IP65 and IP67 protection standards, with interface options including USB 3.0, GigE (up to 100m) and GMSL2 (up to 15m).



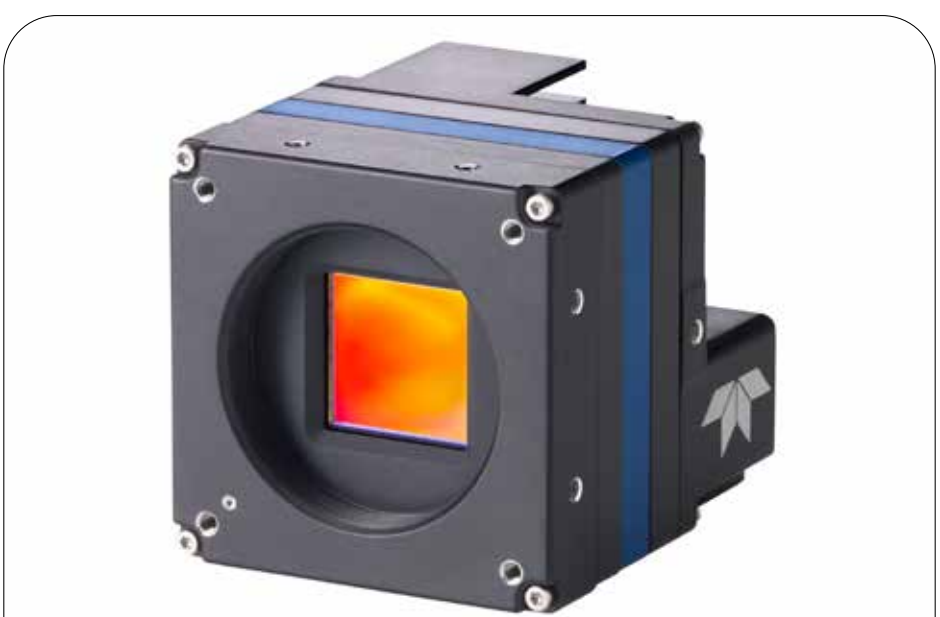
HAIP Solutions
(Hall 10, Booth 10E70.8)
BlackBright RGB LED bar

Part of HAIP's BlackIndustry station, the BlackBright RGB LED Bar is a ready-to-use illumination unit for industrial image acquisition. Designed for applications such as sorting, food inspection and quality control, the light bar has an advertised lifetime of up to 50,000 hours, passive dust-resistant cooling, a UL-optimised design rated less than 100W per unit and is available up to 1.4m in length.



Resolve Optics
(Hall 10, Booth 10G44)
Lens adapters

A new range of specialist lens adapters has been released by Resolve Optics, designed to change the field of view (FOV) or image format of specific lenses, while maintaining resolution and minimising distortion. The company says its Model 287 wide-angle lens adapter, for example, doubles the FOV of any zoom camera's operating range, addressing the typical compromises in distortion and resolution that come with off-the-shelf adapters designed for wider use.



Teledyne DALSA
(Hall 8, Booth 8B10 as Teledyne Vision Solutions)
Falcon4-CLHS area scan camera

Built on Teledyne e2v's Emerald 67MP CMOS sensor, the Falcon4-CLHS M8200-Scientific is a 67MP area scan camera from Teledyne DALSA. Featuring up to 64dB dynamic range, 2.5µm pixels, 3e (electronic noise), 70% quantum efficiency at 550nm and operation up to 65fps, the camera is intended for applications such as whole-slide imaging, genomics, fluorescence microscopy, high-content screening, precision metrology and semiconductor inspection.

visionaries

Edge intelligence can overcome inspection failures to build systems manufacturers can trust

Why do so many automated inspection projects fall short of expectation, and how can holistically engineered edge hardware restore operational trust on the factory floor? **Christian Pennygate**, Managing Director of machine vision integrator Soldel Group, details the factors that drive deployment success in industrial environments

Imaging & Machine Vision Europe: Tell us about Soldel Group. What kind of systems do you build and in which markets?

Christian Pennycate: Soldel Group designs and delivers advanced vision-based systems that combine imaging hardware, edge computing and intelligent software. The "group" part of the name reflects the evolution of the business into product-led platforms – most notably our Tempest range – rather than a single integration offering.

Our focus is building robust, production-ready platforms that operate reliably in real-world industrial environments.

We began working in vision systems almost 20 years ago, initially developing specialist platforms for military applications where deterministic performance and reliability were non-negotiable. More than a decade ago, that foundation evolved into applying advanced AI to video – not as a marketing term, but as a practical means of extracting useful metadata and operational insight.

We have always been edge-based. Running systems close to the sensor has shaped how we engineer software: efficient, performance-focused and tightly integrated with the underlying hardware. Over the years we've delivered everything from racing car video platforms to pipe inspection systems and large-scale AI-driven surveillance infrastructure.

In the past two years we have pivoted our surveillance platform toward industrial machine vision. Our current platform operates under the Tempest MV name. We engineer complete systems – cameras, lighting, compute and software – with strong emphasis on performance transparency, remote management and long-term maintainability.

We are a team of 10 experienced, hands-on engineers and have shipped thousands of vision-enabled products over the lifetime of the group. Reliability is designed in from the outset. We are clear about achievable outcomes and equally open about potential pitfalls.

Full remote access and control is standard across all deployments. Inspection data, system metrics and trend analysis can be surfaced from factory floor to boardroom. Full traceability is built in: every analysed item, image and decision can be recorded and recalled, reinforcing trust in both the data and the system.

The result is not just a vision algorithm,

but a supported, scalable platform that integrates cleanly into operational workflows and continues to deliver value long after installation.

IMVE: But you still work on bespoke projects? Tell me about some of your recent use cases.

CP: There are two recent projects I can talk about that capture the type of work we now deliver.

The first was for a roofing tile manufacturer seeking automated inspection and, critically, visibility of production quality trends.

The project had previously been attempted without success.

The solution we implemented used our Tempest MV platform with two industrial HikRobot GigE cameras, carefully configured lighting, polarising filters and matched optics under a protective shroud. After capturing representative footage, the system was trained on site and rapidly began localising each tile and performing anomaly detection at line speed.

The stated goal was defect detection; the unstated goal was confidence and direction of travel.

With full traceability built in, every tile, every decision and every image could be reviewed historically, giving management both operational control and board-level visibility of trends.

The outcome was reduced manual inspections, improved consistency and data they could act upon.

The second project involved inspecting materials as they were wound onto rolls before shipment. This, too, had seen earlier attempts that had failed to deliver consistent results. The view was constant, removing the need for localisation, but the anomaly detection challenge remained. By tightly controlling lighting and edge performance, and by exposing clear metrics, we delivered reliable detection in a system the customer could interrogate and trust.

In both cases, we were engaged after prior efforts had not met expectations, Disciplined engineering and transparency proved just as important as the AI itself.

IMVE: How typical are those issues and how do you overcome them?

CP: The challenges described above are extremely common in machine vision projects. The most frequent pain points include inconsistent lighting, mechanical variability, unclear acceptance criteria and unrealistic assumptions about AI capability.

Another recurring issue is performance transparency. Many systems are assumed to "just work," yet there is often limited transparency around what they are actually doing. Stakeholders cannot always articulate frame rates, latency, false positive rates or long-term drift, and some so-called "AI smart cameras" are effectively closed appliances with fixed computational limits defined at the point of design. In practice, that ceiling may already be reached before the application has fully evolved. Without measurable baselines, open performance visibility and the ability to scale beyond embedded constraints, it becomes difficult to judge success objectively – or to improve it over time.

We address these challenges by designing systems holistically. Lighting geometry is treated as seriously as model training. Performance metrics are exposed and monitored. Remote access is built in from the outset, allowing us to diagnose and optimise systems without unnecessary site visits. Ultimately, disciplined engineering and clear communication reduce surprises later in the lifecycle.

IMVE: On the subject of clients with unrealistic expectations, is there still a mismatch or is AI fluency improving?

CP: There can still be a gap between expectation and reality, particularly where AI is involved. Marketing narratives often imply that vision systems can solve almost any problem with minimal set-up. In practice, performance depends heavily on data quality, lighting control and clearly defined objectives.

Our background has always required close collaboration with customers. We operate in a straightforward manner: we are clear about what we know, clear about what we are building and clear about what success looks like. The primary objective is solving the customer's problem in a measurable, reliable way.

IMVE: How do you dampen client expectations without losing business?

CP: We manage expectations by being transparent from the outset. We define what "good" looks like in measurable terms – detection rate, throughput, tolerance bands – and we validate against real production footage wherever possible. We explain what is achievable now, what can be improved iteratively and what would require structural changes.

If we do not believe we can genuinely solve the problem, we will say so. That clarity protects both sides. To date, that approach has meant we have not had to walk away. This discipline, combined with comprehensive remote support and tight integration into wider factory systems, builds trust and tends to strengthen long-term commercial relationships.

IMVE: Do you tend to focus on a particular market?

CP: We focus on industrial manufacturing environments where quality assurance and process visibility directly impact profitability – and we deliberately take on the harder problems first. High-performance

"Disciplined engineering and transparency proved just as important as the AI itself"

inspection, anomaly detection at speed, subtle surface defects and reliable, real-time on-site processing are areas where there is rarely a clear market leader. Trend analysis and quality direction naturally follow from doing inspection properly, and we see that as a fundamental part of the value rather than an optional add-on.

That suits us. We repeatedly solve these challenges and have built a platform that now allows even non-technical users to train robust anomaly detection models on site. Onboarding our Tempest MV platform can be done in as little as 30 minutes – faster than getting an operator onboarded.

Industrial settings reward a full-stack approach. When hardware, lighting and software are engineered together, performance is predictable and scalable.

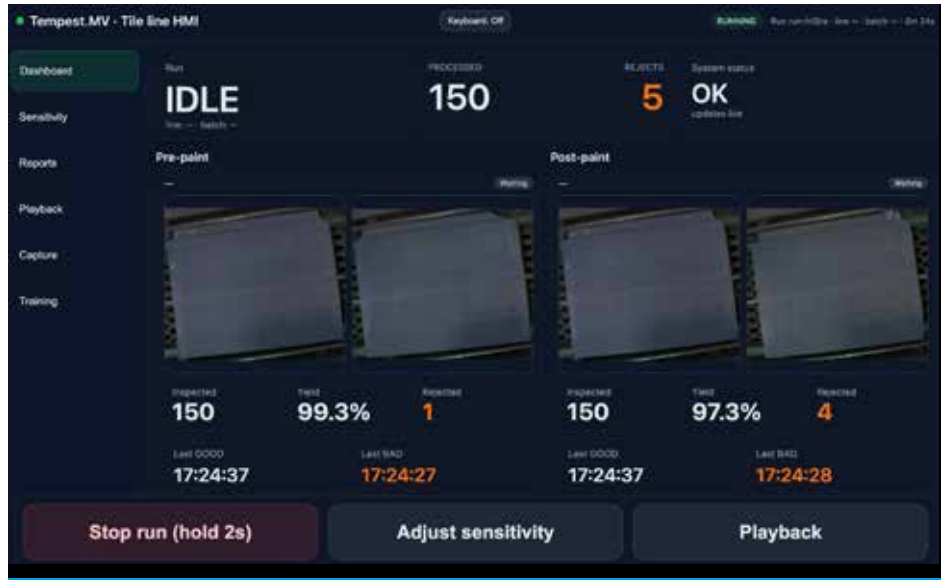
Our next focus is pushing anomaly detection to even higher speeds, including demanding applications such as tray seal integrity in food production, where reliability and throughput are non-negotiable.

The underlying Tempest MV platform is highly extensible. The same architectural principles apply whether inspecting manufactured components or packaging materials – and we are now operating in structured 3D environments, interfacing directly with robotics. For us, that is the natural progression: from inspection, to understanding, to action.

IMVE: As an integrator, much of your work relies on the components themselves. What makes a good component vendor, in your opinion?

CP: A strong vision component vendor provides more than specifications. Clear documentation, stable firmware, long product lifecycles and responsive technical support are essential. Consistency is also particularly valuable. When a camera or lighting product behaves predictably across batches and over time, it reduces integration risk dramatically.

> **"When hardware, lighting and software are engineered together, performance becomes predictable and scalable"**



Inspection data and trend analysis is generated by Soldel Group's Tempest MV system to provide full traceability from the factory floor to board level

IMVE: Are there any specific areas you'd like to see vendor improvements?

CP: One area for improvement across the industry is transparency around performance characteristics in real-world conditions. Published specifications are useful, but integrators benefit greatly from deeper insight into thermal behaviour, long-term stability and integration constraints. Vendors who collaborate closely with integrators ultimately help create better end systems.

IMVE: Where do you discover new business opportunities?

CP: Opportunities tend to arise through a combination of industry networks, referrals and direct engagement with engineering teams facing specific operational challenges. We also work closely with a number of system integrators across Europe – including the UK – who bring us into projects where advanced vision capability is required.

We find that demonstrating measurable capability – for example, through pilot deployments or proof-of-concept work – is one of the most effective ways to open new conversations. Integrators, in particular, value platforms that are reliable, well-documented and straightforward to deploy within wider automation projects.

In technical markets, credibility is built through performance, delivery and long-term support rather than volume marketing alone.

IMVE: How competitive is the vision integrator market? And what are the main ways your products differentiate themselves from others?

CP: The machine vision integration market is highly competitive, with many capable providers. Differentiation often comes down to execution discipline rather than headline claims.

We differentiate through performance transparency, remote manageability and a platform-based architecture that allows systems to evolve over time. Our focus is not simply deploying a model, but delivering an operational asset that can be monitored, tuned and supported throughout its lifecycle.

Clients increasingly value systems that can be maintained and improved without constant on-site intervention.

IMVE: Where are you seeing growth right now in machine vision, and how does that influence your strategy for the next few years?

CP: Growth is particularly strong in sectors where automation, labour constraints and quality traceability intersect.

Manufacturers are under pressure to increase throughput while reducing waste and maintaining consistent standards, and that aligns closely with our strategy.

We focus on use cases where measurable return on investment can be demonstrated and where intelligent edge processing provides an operational advantage.

Rather than chasing every possible application, we prioritise verticals where disciplined engineering and long-term system ownership serve to create sustained value.

We are also investing heavily in extending our capabilities into structured 3D vision and spatial understanding, which we see as the natural next step in bridging inspection and automation. **IMVE**

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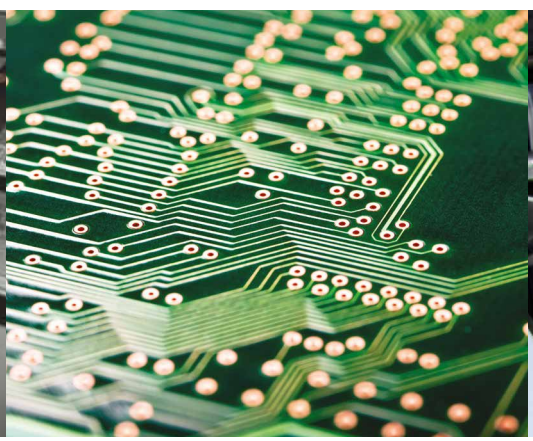


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Industrial Vision Solutions

visionaries

‘The challenge is bridging the gap between the desire for AI-driven imaging and its commercial viability’

42 Technology Director of Industrial Instrumentation, **Jamie Jeffs**, tells **James Wormald** how the vision system integrator blends imaging with AI for bespoke, yet scalable, solutions

Imaging & Machine Vision Europe: Tell us about 42 Technology. How do you integrate imaging components or technologies into bespoke solutions?
Jamie Jeffs: 42T is a broad-range technical consultancy providing clients with solutions that require a science and engineering approach. We work extensively across industries to solve complex problems by developing bespoke sensing solutions, often involving the integration of vision and image acquisition systems within a wider system-engineered solution. This involves working collaboratively with vision system providers to integrate commercially available components, through to the full design and development of a complete optical system.

IMVE: Could you take us through some of the recent projects where you’ve applied imaging technology in an innovative way? What was the outcome?
JJ: With our recent collaboration with Balluff, Synaptics and Arcturus Networks, we identified an opportunity to leverage Synaptics’ Astra range of edge AI devices to address issues with automated line clearance checks in pharmaceutical production processes. The challenge of scaling an automated vision system to provide AI-driven object detection involves balancing cost with performance.

By designing an integrated system that couples Balluff’s industrial image acquisition systems with Astra’s capability for edge image processing, we developed a platform from which cost-effective automated line clearance can be deployed on the edge, that balances the required IoT workloads with an automated imaging system with a commercially viable approach. The application is designed for manufacturers of high-volume/low-cost products that need multiple inspection points on multiple lines.

The system addresses a number of challenges which are barriers to deployment. By working with Arcturus Networks to deploy the data analytics at the edge, the system avoids the need for cloud connectivity and the associated data management costs and data security concerns.

The Arcturus deep learning models are able to provide on-premises model training, which further reduces the need for operators’ data to leave site, and the open development environment provided by Synaptics enables the system to be customised for different processes in a quicker and less restrictive way compared with other solutions.

The system was designed with integration – alongside existing PLC and plant-wide automation systems – in mind, providing the capability to integrate with existing infrastructure but also adaptable enough to be implemented by machine builders or incorporated into a wider suite of software solutions. While focused on pharmaceutical line clearance, this platform can be adapted to address a wide range

of manufacturing processes that support defect or anomaly detection such as in the chemical, food and beverage and consumer health sectors.

Elsewhere, we have supported the integration of custom vision systems into large-scale digital printing applications, high-speed cameras in transportation sectors and imaging systems for neonatal eye inspection to detect cataracts.

IMVE: When working with new clients, how do you deal with expectation management in terms of what a vision system can (or can't) do?

JJ: In our experience, managing these expectations is all about establishing the requirements in a structured way early on, creating a set of defined specifications that consider the actual deployment of the system in the application.

Although it can be tempting to do some quick experimentation and prototyping of vision systems, unless you have properly understood the processes the system will monitor and the challenges it needs to overcome, it can often lead to re-engineering down the line, or in the worst cases, having an end system design that doesn't achieve the users' expectations.

This is particularly true with AI integration where the deployment is used to automate a process. Without fully understanding the role operators play in performing manual tasks – visual inspection, for example – implementing an automated solution can fall short of the full range of tasks performed manually, and leave operators still requiring the manual inputs they sought to remove.

IMVE: What are your pain points when sourcing vision components and designing systems?

JJ: Common challenges in system design often centre around the interconnectivity of commercially-available hardware and the restrictive development environments of data processing solutions, particularly in industrial applications. While many OEMs provide a wide range of industrial comms, the complexity and associated costs of integrating bespoke solutions into existing PLC/DCS systems can often make scaling these solutions to multiple monitoring locations or across multiple manufacturing plants challenging.

Equally, some of the AI-driven solutions, either integrated into existing image acquisition systems or available as edge compute solutions, force users into restrictive development environments, locking them into system architecture with a limited development environment and relatively high costs of ownership, which can be a barrier to adoption.

While this can be attractive for ease of configuration and use, the requirement in many cases is to transfer live streamed data directly into PLC systems or a standalone IT infrastructure for processing, which puts a further strain on the operator's internal data management solutions.

.42 Technology

Synaptics' AI-powered line clearance solution

IMVE: What types of optical components do you buy?

JJ: At 42T we typically work on complex technical challenges that require bespoke solutions. As such, we are able to individually consider the right approach for each project. This could include anything from designing and developing our own optical components right through to working collaboratively with existing vendors of complete image acquisition systems, and everything in between.

IMVE: In terms of how vendors can support you, what represents good customer service?

JJ: Vendors can support our needs, and the needs of our clients, by providing open platforms for rapid development. Along with the core requirements of responsiveness and high-quality technical support, the values we look for in vendors are less restrictive development environments to integrate their equipment.

IMVE: In what other areas might vendors improve?

JJ: A more open approach to pricing and subscription models for the products and services provided would help users understand the true cost of ownership.

IMVE: How do you set about finding new business opportunities?

JJ: We work with clients across the long-term, so provide support to a group of core clients across a wide range of science and engineering projects. We attract new clients by being actively engaged in these cross-industry challenges and defining ways in which we can help solve them. We also exhibit and attend events, publish articles and case studies and often receive referrals from current or former clients.

IMVE: How do you differentiate yourselves from your competitors?

JJ: With our experience in both solving complex challenges in industrial processes and developing new products for use within these industrial applications, we provide an insight to both process operators and OEMs that our clients find highly valuable. Our ability to understand the processes we are supporting with sensing and instrumentation solutions is a combination that sets us apart from many of our competitors.

IMVE: Which sectors are showing the most growth in machine vision, and why do you think this is?

JJ: We see significant growth across all the sectors we work in including industrial, MedTech and consumer. The drive for AI-based solutions to improve automation, process efficiency and quality control, in manufacturing in particular, requires data captured from sensing solutions such as machine vision. As OEMs and operators further explore real-world applications for IoT within their processes and/or products, the demand for commercially-viable machine vision systems will continue to grow.

IMVE: What do you think the next 12-24 months will hold for machine vision?

JJ: We see the emergence of more cost-effective and scalable edge computing solutions powering native AI solutions embedded close-to-the-sensor as a catalyst for further evolution of machine vision, addressing the current cybersecurity and data management barriers that prevent adoption in certain industries that use cloud-only solutions. The advantages of lower power consumption, reduced latency and increased compute power for edge devices, coupled with advances in machine learning capabilities, will increase the demand for automation, further driving partnerships and collaborations with OEMs seeking complete scalable, and commercially viable, solutions. **IMVE**

Matta AI

visionaries

Training a vision system in five minutes

Doug Brion (left), CEO of Matta AI, explains why manufacturing stands to be the biggest beneficiary of real-world AI. From self-supervised inspection to global operational analytics, he tells **James Wormald** how the company combines simple yet robust hardware with unsupervised AI learning and data to improve manufacturing saying: "If you can't measure something, you can't make it"

Imaging & Machine Vision Europe: Tell us about Matta AI, what kind of markets you're in and how the company started?
Doug Brion: I've always played in the software/hardware interface. I spent most of my childhood building robots, as you do! I built a full humanoid robot when I was 15 because, if you don't have friends, you learn how to make them (laughs).

I studied computing and electronics at Imperial College, played with a few start-ups for a bit, then got my PhD at the University of Cambridge in AI for control using vision – so cameras that could watch something and figure out what's going wrong, why it's going wrong and what action needs to be taken to stop it going wrong.

I decided to apply it to the manufacturing environment because it's messy, it's hard, it's real-world and because I love manufacturing.

We wanted to use that research to make a real-world impact, so we spun out Matta AI about two-and-a-half years ago. The reason we chose manufacturing is it's the best place to add value if you want to make a difference.

All the revolutions we're now seeing in AI, for example, are only possible because in 2012 we were able to manufacture silicon chips capable of enough parallel calculations to run these models. If you're going to make an impact, manufacturing is where you can have the biggest effect.

Our goal at Matta AI is to target the know-how. Everyone in the AI space is obsessing over the 'sexy' applications right now, such as AI for new materials or CAD, but it's often a distraction. It's all well and good for a computer in an office to design a new crystal material, but if no one can manufacture it at scale, it's useless. We discovered graphene 20 years ago, yet nothing is made of it today. I guarantee that in another 20 years, we still won't see it in mass production.

The hard part is production. Our goal is to capture the know-how that spans the full lifecycle – from design, through engineering and building, to quality control before leaving the factory. The entire stack. We believe the only way to master the whole stack is from the bottom up. That means learning about the physics of the factory floor first, then passing that on to the next stage.

Matta AI says all its Blue-1 system requires is an industrial camera and a MattaBox to connect it to the cloud

That's why we're starting with vision; all our first products are based around measurement and inspection because, if you can't measure something, you can't make it.

We take off-the-shelf commodity cameras from our partners at Basler and just strap them anywhere, on any line. It could be manual assembly, a conveyor, a robot or inside a machine, and in any sector.

We're doing projects in food and drink, electronics, automotive and aero; it doesn't matter what it is, the camera sits there and just watches production and figures out what it thinks "good" is using unsupervised or self-supervised learning. That means you don't need to show it "bad". It can spot problems it has never seen before, doesn't require any work from the factory operators and, after two weeks, can usually perform a task, such as detecting scratches, even though you've never specifically told it how to do that.

Our system allows for multiple models to run simultaneously on a single camera. We've developed distinct AI modules for varied industrial needs: one for anomaly detection – identifying scratches or assembly errors; one for measurement, which consistently locates and verifies specific points on an object; one for counting via video or still frames; and another for OCR and barcode processing. Because these functions are defined in software, they all operate on the same hardware footprint. The true power of this architecture is scalability: in a facility with 100 cameras, our global platform connects every unit into a single, cohesive intelligence layer across the factory.

We provide pinpoint local solutions, addressing specific visual tasks such as "did that bolt go in properly?". If the answer is no, the system generates a heat map to identify the root cause. Beyond inspection, we offer real-time parts tracking, giving you visibility into the location of every object, alongside cycle times and yields for every station on a global scale. We've even integrated a Large Language Model (LLM) so you can query the platform directly. You can ask it to "show the recent errors on line three from the past two weeks when Dave was on shift", and instantly see how that compares with the same period last year.

IMVE: So, the platform itself can be used by companies of any scale, from the smallest independent manufacturer to the largest multi-national corporations?

DB: Yes, exactly. There are three things our customers really like compared with traditional vision systems. One is robustness. You don't need perfect lighting, the part doesn't need to be in a specific position, and you don't need to show it all the ways that it can go wrong beforehand. It's also hard to do "vibes-based" automation with classic systems – where an AI has to understand the context within a manufacturing task such as "is that scuff an error or not?" – and we can learn these things very robustly.

So, robustness is big, but so, too, is this combination of local and global. We provide vision tasks, but also an intelligent layer that joins every camera together into a global platform. Many customers have vision systems already, but they operate in a vacuum – they don't know how many parts are being rejected globally or the root causes behind them. Not having that unified data means they can't compare different lines or drive continuous improvement across the whole factory. Our platform creates that high-level analytics layer, with dashboards and a chat interface that acts as a source of truth for the entire factory.

Then the third thing is we do the whole task for them. We install cameras on-site, normally in less than a day. Then we integrate the hardware, software, data collection, training, deployment and maintenance. You don't need to get a camera from Keyence, get another system integrator to integrate it, and someone else to hook it all up. There's none of that. Just tell us the problem; we'll tell you the solution. We can go from that first "hello" to a working system in a month.

IMVE: Sounds quick and easy… are there any previous use cases you can tell me about specifically?

DB: One recent case was with Bowers & Wilkins, the speaker and headphone manufacturer. It used to spend 20 minutes using callipers to measure all the curved surfaces on a single speaker. Even then, the same operator might get a different measurement for the same part. Now, they simply place it under a camera, and it gives all the measurements to 50µm in less than 10 seconds, despite the natural variations in wood grain. The challenge with these speakers is, when you get to the end of the line and try to attach the speaker, if it doesn't fit it means you've wasted all that production time.

What they do now is capture an image of the speaker for immediate measurement. Our AI model identifies specific points and performs "virtual fixturing". You no longer need physical fixtures that are more >

Matta's AI vision-based quality control system detects defects as part of the manufacturing process

"We found graphene 20 years ago, but nothing is made of graphene now. I guarantee, in 20 years' time, still nothing will be made of graphene"

The MattaOS accesses the livestream from the MattaBox, so production quality can be monitored from anywhere on site

Matta says its system can place items under a camera and identify scratches just by rocking them back and forth

accurate than the measurements themselves; even if the speaker is slightly out of position, we can handle it.

Traditional systems struggle with wood grain and warping, but our system handles those edge cases robustly. You can also export the data to track trends, such as standard deviation, or receive notifications when measurements start to drift, which might suggest an issue you need to fix with the tooling.

That's a measurement example, but we also handled anomaly detection for an SME casting company where parts had tiny surface pores or scratches. Previously screened manually, these castings can now be placed on a tabletop with cameras to identify imperfections. Crucially, the AI ignores differences in shape, size and colour without requiring manual labelling or a library of "bad" parts. Building on that "global" aspect, we also enabled them to count parts per station per day, and log data over time to define what a "good month" looks like.

We've also applied this to continuous processes, such as polymer production. The customer previously had five people that were dedicated to staring at white polymer sheets to find errors. Now, they use two cameras and a box.

In that instance, the AI watched for just five minutes to learn what "good" looked like. With that tiny data set, it could pick up smudges barely visible to the naked eye.

IMVE: It all sounds very simple to set up, but are there any challenges you typically need to work through when you set up a new project?

DB: The hardest bit is hilariously often the dumbest bit, such as attaching the camera so that "Dave" doesn't knock it, or whatever. We've been going for two-and-a-half years now, but our first factory install was just less than a year ago, and the first few were a real baptism of fire. We had a lot of learning to do along the way.

Potentially, right at the beginning, it was down to hardware underestimation. We had cheaper cameras and would have, basically, a camera dangling from a stick, not thinking at all about the likelihood of someone knocking it out of focus. It's really obvious in hindsight – and the industry knows it already – but it made the task of AI development infinitely harder.

However, that "failure mode" was, I think, the best thing that could have happened to us because it forced us to operationalise everything. We are now in a place of total control over the environment. We've figured out the lighting, we've locked down the hardware rigs to be incredibly robust and we've made the systems industrial-grade and securely hardened.

We moved from "camera on a stick" to a locked-down, professional deployment that can survive the messiest factory environments.

We also still had to do a ton of stuff on the AI side. We still do our own research and build our own AI models, and at first, they required a lot of data, which could take weeks or even months to collect. That is a huge barrier in manual production where you might only see 20 units a day. We've put a lot of work into reducing that data requirement and eliminating the need for manual labelling altogether. Now, we can get nearly any task up and running in just two weeks, and our fastest deployment to date used only five minutes of data to learn the baseline.

Then there is the coordination side. At Matta AI, we highly value our customers and pride ourselves on the deep relationships and service we provide; it's never just a 'drop-and-go' hardware install. We work closely with clients to uncover those subtle, subjective 'vibes-based' rules that aren't always written in a manual, ensuring the AI aligns perfectly with their expert human know-how. Managing that level of detail – alongside the orchestration of software, AI, procurement and safety – is like conducting an orchestra.

Currently, we've intentionally limited ourselves to two new factory installs a month to guarantee that every new deployment gets our full engineering attention and our services are world-class. However, with hundreds of factories now in our pipeline, our primary focus is learning how to scale that orchestration. We are building the systems to automate the administrative friction of coordination so we can deploy at a much higher frequency while still providing the same dedicated partnership our early customers rely on.

IMVE: So, the clients you work with… are these projects typically their first venture into vision systems, or are you improving on platforms they're already using?

DB: Yes and no. A lot of companies might have some Keyence systems already, but find they have a task that's too nuanced for a

classic vision system to solve. One project we're doing is with a bottling company that previously used old-school cameras, but they found those cameras couldn't handle multiple tasks at once. They might have had one camera dedicated solely to checking the heat shrinking for sleeving, for example, whereas we can install a single camera that inspects the whole bottle. It can verify the correct label, check its position, ensure the text is legible, look for scuffs and confirm the heat shrink has worked – all in one go. Plus, it handles all the data storage and analytics simultaneously.

So, it depends. A provider such as Keyence offers a huge range of excellent, specialised hardware. In contrast, we standardise everything: we use the same camera and the same hardware for every single task. The reason is scalability. Rather than stocking 10 different expensive cameras for spares, a factory just needs one standard unit on the shelf that works for every Matta AI station in the building.

That makes maintenance significantly easier. It shifts the complexity from the hardware – which is hard to change – to the software, where we can deploy state-of-the-art AI to solve problems traditional vision simply can't touch.

IMVE: On the subject of AI… do mismatches between clients' AI expectations and what's actually possible still exist? Or is reality catching up with ambition?

DB: There's a lot of hype in marketing right now – you'll see traditional companies claiming a camera is "AI-powered" just because it has autofocus. We prefer to let the tech speak for itself. When we go to trade shows, we bring live demos and encourage people to try to "break" them by shining phone torches directly into the lens. They spend five or 10 minutes, getting their phone torch out and shining it directly on the object and asking, does it still work? The reaction is always the same: they're blown away by how tangible and robust the system is in real-world conditions.

I think the reality of AI is catching up, but part of our job is helping customers understand the "magic". Because our demos are so advanced, we take the time to ground expectations in what's physically possible, ensuring the final solution is both revolutionary and reliable.

One of our greatest strengths is helping customers through the scoping process. For many, this is their first step into advanced automation, so we act as partners in defining their technical standards. Often, the AI acts as a "source of truth" – it identifies where human bias may have unknowingly drifted away from original specs. By bringing this level of objectivity to the line, we help our customers replace inconsistency with a new, gold-standard benchmark. We aren't just giving them a camera; we're giving them the data and the confidence to redefine excellence in their production process.

IMVE: You exclusively use Basler cameras. What went into that decision?

DB: Choosing the camera (vendor) was actually really tough because we first tried going direct to China and sourcing low-cost cameras. However, there was a significant problem with reliability and consistency between batches.

We decided we wanted something more local that wasn't an exceptionally high cost. The idea was that the "smarts" would be in the AI models rather than the hardware itself. That said, since they are used for industrial applications, they still need to be robust, with 10-year-plus lifetimes. Basler hit that sweet spot with their low-cost cameras, which are in the hundreds of pounds. They also have a broad ecosystem, and we met their UK sales rep, whom we got on with really well and who has been super helpful, so it seemed like a natural fit.

Because they are a camera manufacturer and not a solution provider, we aren't in competition; we didn't feel like they were trying to do our job for us. Plus, if we do well, they get to sell more cameras – it's a win-win. **IMVE**

visionaries

‘No BS’ machine vision: ‘AI doesn’t change the laws of physics’

Peter Jelf (left) has built a reputation on straight-talking machine vision integration. Here, the founder of UK-based Visicon and self-styled ‘No BS Machine Vision Expert’ tells **James Wormald** how he manages customer expectations in the age of AI, why reliability still trumps novelty and looks at some common pitfalls

Imaging & Machine Vision Europe: Tell us about Visicon.
Peter Jelf: I’ve been in machine vision for about 26 years, so none of it’s new to me – although they keep trying to dress up old things as new by sticking ‘AI’ in front and hoping nobody notices. I specialise in taking proven technology and deploying it in robust and reliable solutions where it’s going to work.

I’m not at the cutting edge, I’m not trying to set the world on fire, that’s not really my bag. While I do use deep learning and AI, I’m not developing things that no one has ever tried before. I’m the guy you come to when you don’t want to have problems in six months’ time.

My LinkedIn tagline is ‘the No BS Machine Vision Expert’ and that’s always been my brand. I’m not a university-trained engineer, I’m more of a hands-on, apprenticeship-trained engineer. I’ve spent my time on production lines, making things work. There’s more than one way to solve every problem, but my approach has always been that the best solution is one that’s going to work reliably.

I think what my customers enjoy most about working with me is the fact that there’s no fluff. If I’m asked a question or I’m shown an application, you get my honest feedback.

And, if I don’t think it’s going to work, I’ll say it. I don’t want to sell a system that’s not going to work well to anyone. That’s why I have a good reputation, but don’t have millions in the bank.

IMVE: On the subject of client relations and this raw honesty style of yours, is there still a mismatch between what clients expect a modern vision system to be capable of and what the reality is?
PJ: Initially there is, yes. But it’s an integrator’s job to manage expectations, to give them a reality check. If we believed

everything we saw robots doing in online videos, we'd think we were six months away from an 'iRobot' situation with a robot in every home, but that's just not where we're at.

There are systems being talked about where a video feed goes into an AI system that does quality checks, but that's not what we're being brought in to deploy on production lines. We're doing the same things we've always done, just with newer tools. We're still inspecting part quality, still reading 'best before' dates, still counting bolts on engine housings and still giving locations to robots to pick things up. The jobs haven't changed, it's just the number we can actually solve has got bigger. It's about making sure customers realise that.

I had a customer the other day, for example, who said one of the requirements was to measure a certain gap on the inside of an injection-moulded part. It couldn't be seen from any outer area of the part, so it wasn't possible unless they were thinking of X-raying it or something similar. But, at that point, you start going down the forging new paths route and that's not me.

I said to them: "We can measure your part. This is what we can measure. But I can't measure that internal lip that you can't physically see." Sometimes you have to bring people back down to Earth and explain that all this AI stuff is great, but it doesn't change the laws of physics. Light still behaves in the same way it's always done, lensing is the same and fields of view and resolution haven't changed just because AI came along.

IMVE: Do you have any techniques on dampening those expectations without losing the business entirely, or is there a certain point where you need to just cut your losses and just say we're not going to be able to do this?

PJ: I try to give the customer what they need. Which isn't always the same as giving them what they want. They tend to come in with a Christmas list, and although most things are achievable, there's always a cost involved. So, we need to understand what they actually need. What I often get from conversations is that the actual pain points are the first two things they mention. The next eight things they've just thrown in to try to get more value from the system, but all it does is make the first two solutions to the real problems less reliable. If I don't think something will work, I say I don't think it will work. I think customers respect you more when you say you can't do something than if you take it on and make a hash of it.

We don't employ sales people, only engineers. The reason for that is that I'm not trying to sell to anyone. All I'm doing is solving problems. That means I don't have any sales targets to meet. It's about coming up with solutions and, if I don't think I can do it, I won't do it.

IMVE: Is there a particular market sector you tend to focus on?

PJ: No, I wish there was. It would be nice to standardise, but no. We can check the seals on bags of food and we can check the seals on bags of cement. We've looked at electronics components, we've looked at pharmaceuticals, we work with most of the automotive manufacturers. In any given month we'll work in around six-to-eight different industries.

But I see that as an advantage, because if we're working in injection moulding, let's say, the people who work in injection moulding are those who have always worked in injection moulding, so they don't know how someone in pharmaceuticals would solve a similar problem. However, I've seen it in pharmaceuticals, so I can advise them on things they wouldn't have considered.

IMVE: So, the solutions aren't the same but there can be cross-over when a solution in one industry informs or inspires one in another?

PJ: Absolutely. Whether you're looking at bags of sugar or bags of cement, it's the same application in a different environment. We talk about vision falling into four different categories: guidance, inspection, gauging and identification. It doesn't matter what it is you're doing, it will fall into one of those four camps.

Everyone seems to think their process is unique. It is to them, of course, but it's not that different in reality. If you've inspected milk bottles, you can inspect coffee jars. It's the same primary inspection. It's just applied slightly differently.

IMVE: So, drawing on your knowledge and experience gives you an advantage when solving new challenges, what kind of problems do you tend to come up against time and time again?

PJ: Hopefully the time when we have to think on our feet to solve a problem, the problem isn't with one of our systems. We often work with manufacturers who have previously installed camera systems that just aren't fit for purpose. They may have been using it for five years even, but it's not reliable, it's not repeatable and it gives them quite a few headaches.

Inevitably it tends to be one of three problems: either the lighting's wrong, the lensing is wrong or the software set-up is wrong. And, sometimes, it's all three. But sometimes it's about just coming in and saying: "No. You don't need to rip it all out, you don't need to spend thousands on a new camera system, you just need to change that light."

As an example, there was one project where the client had an application to depalletise boxes. The machine builders had previously put together a whole robot cell, so they were competent people, >

"You don't always need to spend thousands on a new system. Sometimes you just need to change a light"

With two bar lights pointed at the top of a box, the system couldn't pick up the box corners reliably because it couldn't see them

but vision isn't like programming a robot, it's half physics, half art. They approached it in what they thought was the right way: they had two bar lights pointed at the top of a box and it resulted in a beautiful image of a white box with text on it, sitting next to other white boxes with text on. But, because the boxes were pushed tightly together, when it tried to pick up the corners it couldn't see them.

So I looked at their software. And it turned out they'd used one tool to try to do it, but that didn't work too well so they applied another to counter the first tool, then they had to add another tool to fix that one. So they had this cascading list of tools applied, and it turned out to be this behemoth of a job file.

All we did to fix the thing was make it a lot simpler. We got rid of the two bar lights, then put a spotlight in one corner at 45º to completely wash out the top the box. The top was bright white, and we had created this huge shadow down the side of it. We'd created a black background for this white box to sit in.

We knew if we could find one corner we could find the other three because they're connected so we used two edge tools to find the sides, joined them together to find the intersection point and, hey presto, we found the box.

They were suffering with up to three hours of downtime a day on this system because it was struggling to find the boxes. After we changed one light and spent a day on site, they had zero downtime over the next six months. They could have saved themselves a lot of hassle if they'd got a vision integrator involved at the beginning rather than trying to do it themselves.

IMVE: You're a partner system integrator with Cognex. Do you exclusively use Cognex components?

PJ: For around 1% of the work we do we use a PC-based platform with Cognex's Designer and VisionPro softwares, but that's only the odd job. The rest is all smart camera-based, so we work with Cognex's In-Sight platform.

The In-Sight range covers everything from little vision sensors up to high-res AI-based camera systems, so it gives us almost everything we need. Other than that, we also recently became the UK and Ireland distributor for Mech-Mind Robotics. That's for 3D robot guidance systems, which was a hole within the Cognex product portfolio.

IMVE: What went into that decision to work with Cognex? What advantage does it give you?

PJ: When I started Visicon 14 years ago my plan was to integrate whatever seemed best for the application. So although (as a partner system integrator) we're not required to be exclusive to Cognex, the reality was that I'd been working with Cognex kit for 11 years before that, so it was inevitable that I'd gravitate towards their products. It's very good kit and very good for smart cameras. It's very adaptable and it allows you to do things you can't always do with competitors' smart camera products.

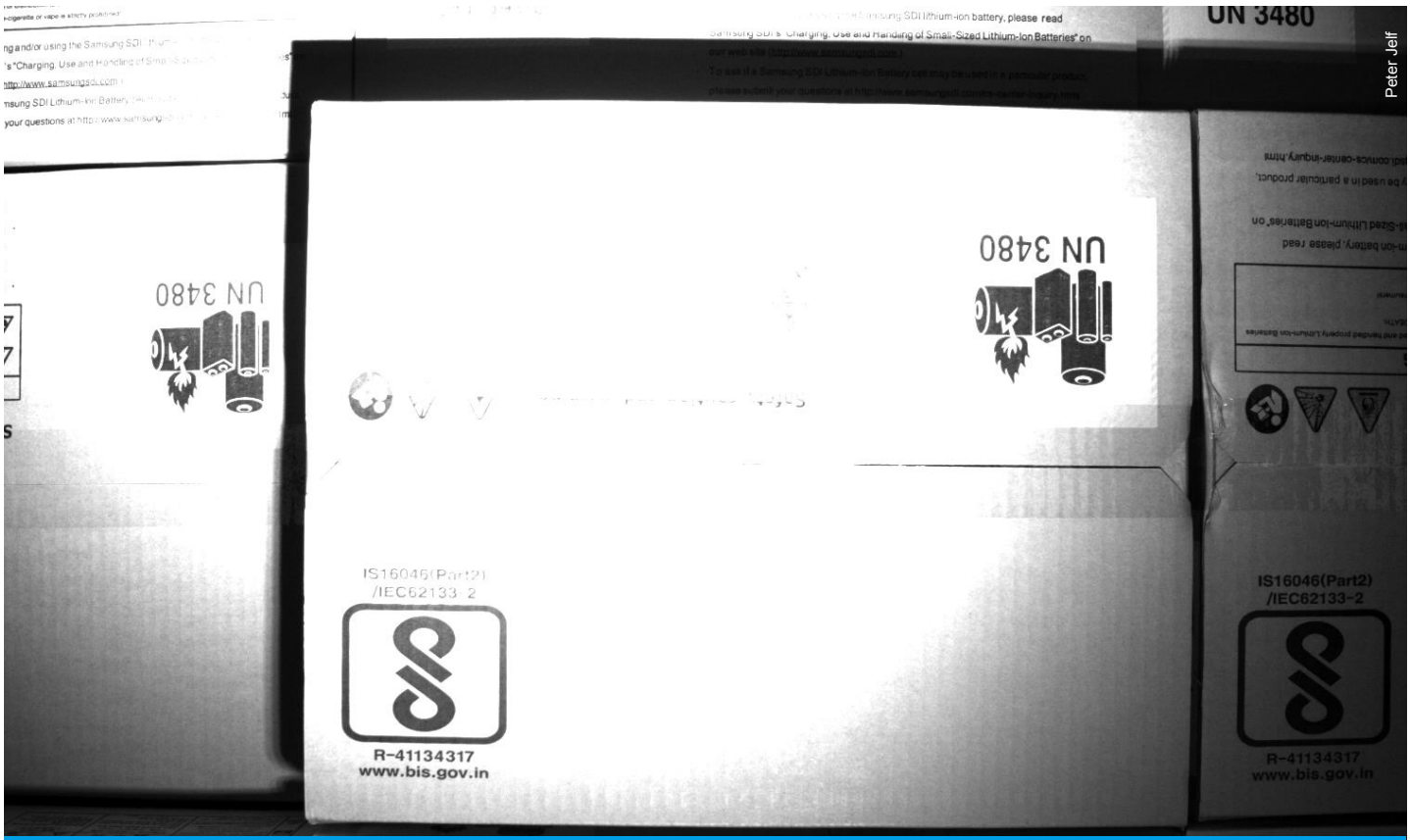
IMVE: As an integrator, what are the main things vendors in general could do to make projects easier for you?

PJ: Demo and test kit is the biggest thing I'd like to see from vendors. Things such as lighting products, you need to test them first. It's a conversation I've had many times with multiple suppliers. What I've got in the lab is what I'll use, because if I can't see how it behaves, I'm not going to put it on a job.

The last thing I'm going to do is buy £10,000 of kit from a lighting manufacturer just to get a cross-section of their products to test.

So, there either needs to be an easy way to get hold of test equipment or there needs to be a better relationship between vendors and integrators where you can ask them and they'll give you a light or even a cross-section of products to test.

We try to quote a two-week turnaround to do customer feasibility tests, but if you need a certain lens or a specific light we don't have, I've got to build that lead time into it. If I have to wait four weeks to get



Visicon got rid of the two bar lights, put a spotlight in one corner at 45º and completely washed out the top of the box. A black background was created, and the box's four connected edges could be found

that light and then find out it doesn't work, I'm already four weeks behind and I'm not going to be able to complete those tests in a decent timeframe. So, availability of loaned test equipment is probably one of the biggest things vendors could do for us.

IMVE: You say you don't employ any sales staff. Where does your business development come from?

PJ: Up until about four years ago, Visicon was just me. Back in those days, I didn't need as big a turnover and all the work I took on came from word of mouth. That was fine, but when I started to scale the business, I realised word of mouth doesn't scale, so we've had to put some time and effort into marketing to grow that side of the business.

> "The challenge is getting something that runs consistently on a production line without constant adjustment"

Obviously, being a partner with Cognex, we get a lot of inquiries through their partner network. And Mech-Mind, too. If they get a message from someone in the UK they'll introduce us. We're not going out knocking on doors or doing cold calls. Every time I speak to someone it's because they've come to us first.

IMVE: So what prompted that decision to scale the business four years ago?

PJ: Some of it was because the market had grown and to accommodate that, but mostly it was because COVID came along. COVID gave us all a lot of time to think. It made me acutely aware that being a one-man-band was great: I'm my own boss, I can pick the jobs I want, turn down the jobs I don't want. I can pick my hours and I get to work with interesting people.

But there were downsides. If I can't work, I can't earn. You've always got that in the back of your mind. I was in my mid-40s then, and you start thinking "do I really want to be climbing over machines for the rest of my life?".

There was also a question of what the future looks like for the business. Do I just retire one day and that's the end of it? So I decided to build a team around me. Spread the responsibility, take on more projects, and create something that isn't dependent on me being on site all the time. That was the main catalyst for me. Not just revenue protection, but training and supporting the next generation of vision engineers so that one day, Visicon can continue without me.

IMVE: You mentioned supporting the next generation of vision engineers. What do you think they most need to understand when they come into the industry today?

PJ: A lot of people coming into vision now are coming in through AI and software, which is fine, but it can give you the wrong starting point. What tends to happen is that people try to solve everything in software because that's what they're most comfortable with.

In reality, most vision problems aren't software problems, they're set-up problems. Lighting, lensing, how the part is presented. That's where most of the work is, and, if you get that right, the software side becomes relatively straightforward.

If you get it wrong, you end up trying to compensate for it, and that's when systems become complicated and unreliable. You can usually get something working in a demo.

The challenge is getting something that runs consistently on a production line without constant adjustment.

So, for me, the biggest thing is understanding the fundamentals first.

Once you've got that, the newer tools, including AI, become useful. Without it, you're just making things harder than they need to be. IMVE

visionaries

'We can just scoop it up with a crab net' – how the Hydrus drone miniaturised underwater monitoring

Advanced Navigation's Senior AI Engineer **Alec McGregor** (left) tells **James Wormald** how democratising underwater data acquisition could help Hydrus save the coral reefs

Imaging & Machine Vision Europe: Tell us about yourself and your work on the Hydrus drone with Advanced Navigation.

Alec McGregor: Advanced Navigation develops navigation solutions for areas where GPS is denied, and complex environments where we might not always have line of sight of the sky. This can be on land, in the air, in space or subsea. I work as a Senior AI Engineer in the subsea area, focusing on Hydrus.

We started developing Hydrus around eight years ago. It's a micro hovering AUV (autonomous underwater vehicle), which is, essentially, an underwater drone.

It makes underwater data collection a lot easier, a lot more economical and a lot less logistically challenging.

There's an increasing drive to get underwater data into the hands of researchers and government agencies so they can monitor ageing assets and infrastructure in the ocean, and make data-driven decisions to protect natural subsea ecosystems such as coral reefs. Because of this, one of our ongoing aims for projects with customers is to democratise underwater data acquisition.

IMVE: What kind of imaging components or technologies does Hydrus use to collect the data?

AMcG: In terms of the navigation solutions that are employed on board Hydrus, it has an inertial navigation system (INS). That's really the bread and butter of what Advanced Navigation does, so we

Advanced Navigation

Hydrus AUV entering the water

Shipwreck data map shared with the WA Museum

> "It's a bigger challenge to design something for the marine environment than for space. People don't understand that"

integrated it into Hydrus. It also features a Doppler Velocity Log (DVL) sensor, which we use for calculating the velocity of Hydrus as it travels above the sea floor. We also use it as a simple range finder to determine how high off the sea floor it is.

To communicate with Hydrus, we use a USBL (ultra-short baseline) acoustic sensor, called Subsonus. From that, we can get Hydrus's position as it completes its underwater missions. We also use a GNSS compass, which talks to Subsonus. Then Subsonus talks to Hydrus.

That means that with each image or video frame captured by Hydrus, we get a geo-referenced position for it – which is really difficult to do with traditional methods. Then we can use that data to create geo-referenced 3D models. Hydrus also has a camera that can simultaneously capture 12MP images and 4K video.

IMVE: Tell us more about the 3D models that are created. How are those used?

AMcG: The 3D models can be used in many different ways. One is data visualisation, to get a better idea of what is actually underwater. This is useful for big infrastructure projects. Having a top-down view of a large area can give you a lot of insight into what's actually going on, for example the structure or the size of a coral reef.

For coral reef monitoring, we've been using Hydrus to collect all the imagery which we've used to create 3D digital twins. Working with NOAA (National Oceanic and Atmospheric Administration) and AIMS (Australian Institute of Marine Science), we've been creating geo-reference models for them, so they can monitor the health of the coral reef and look at things such as changes in colour in subsequent scans.

Using Hydrus to get 3D digital twins, we can scan the same area, same geo location, multiple times over the course of a year – every three months or so. Then we can overlay those scans on top of each other and see whether or not there's any growth or reduction in the volume of coral.

IMVE: Are there any other historic or ongoing use cases Hydrus has been involved in?

AMcG: One of the projects we've previously worked on was with the Western Australian Museum, where we mapped a 60m-long shipwreck in the Indian Ocean. We spent a day sending Hydrus units down on missions to get geo-referenced imagery, then we were able to create a 3D model from that.

On another project, we worked with our customer O2 Marine, which is a marine services consultancy. We went out with them to look at a coral reef and, as a proof of concept, deployed three Hydrus units at the same time to scan and get 3D models of a larger area.

IMVE: So did this 3D model allow museum visitors to physically experience the shipwreck?

AMcG: The shipwreck data has been shared with the WA Museum for its public archives and can be seen in life-size form at the Curtin University HIVE on their immersive cylinder display.

We also worked with the museum to see whether or not there had been any noticeable degradation in the shipwreck, or if there had been changes from what divers had previously seen.

IMVE: Are there any other undersea imaging companies doing the same thing? How does Advanced Navigation differentiate itself in that marketplace?

AMcG: There are other competitor AUVs out there in the underwater data collection >

O2 Marine and Advanced Navigation deploying three Hydrus units at Hall Bank

Hydrus with lights

> area. However, they are usually a lot larger than Hydrus, with some of them going up to 10 times Hydrus's size. Because of that, you need to put a lot more effort into the logistics, in terms of the deployment and recovery of the vessel.

There are also consumer-grade ROVs (remotely operated vehicles) you can use, but they are tethered so you have to deal with the tether.

A lot of the smaller ROVs are also not depth-rated, and don't go down more than 20m to 50m, whereas Hydrus is depth-rated to 300m.

This is how Hydrus is able to stand out. We've managed to miniaturise the technology by working on pressure-tolerant electronics and trying to get the most thrust we can out of our bespoke thrusters.

IMVE: Right, so was the miniaturisation of the technology a specific target for you in development?

AMcG: Absolutely. We really wanted to make sure Hydrus would be deployable by our small team. We wanted to be able to deploy it while doing testing with just one person, chucking it in the water and then – when it's completed its mission – just scooping it up with a crab net.

We recently did some work with AIMS up in Ningaloo Reef in the north of Western Australia, and because of Hydrus's small size, we could just go out in a boat and drop it in the water.

Before, AIMS would have needed to get a bespoke vessel with cages and cranes, specifically designed to be able to take heavy AUVs out of the water without damaging them or the boat.

The miniaturisation really opens the door to more economical data collection of underwater environments.

IMVE: What were the main challenges the project presented?

AMcG: So, the main difficulty was miniaturisation of the technology. It's groundbreaking both mechanically and electronically. I was previously a mechanical engineer, working on things such as thrusters and designing the plastics.

One of the things that had to be taken into account was that in the underwater environment, a lot of ROVs and AUVs tend to get their thrusters stuck – either because seaweed gets caught or sand or grit clumps up and gets stuck in them.

Usually, this can only be fixed with a full servicing. You have to take the entire robot apart.

Because of this, we designed Hydrus with hubless rotors so seaweed can go straight through and won't get stuck.

Since all the moving parts of the rotor are on the outside, if the thrusters do seize up, we can remove them super quickly. It's literally just four bolts. You take it out, wash the bearings and put it back in.

Some of the feedback we've got from customers who've used Hydrus is that, when the thrusters do get jammed, it's so much easier to fix them compared with other AUVs or ROVs they've tried.

IMVE: How (and from where) did you source the optical components?

AMcG: We did compare a few different camera components. But then we integrated everything in-house. We have a team here that's basically trying to do vertical integration of the whole Hydrus, so we can do things outside the box while retaining full quality control.

IMVE: Where do you see the future of undersea inspection? Deeper? More remote? More detail? More data or insight? What aspect will be most important to the next generation of underwater inspection drones?

AMcG: In the underwater space, we'll always want to go deeper. Specifically for AUVs, we want to be more autonomous, which is what we're already doing with Hydrus. We plan the mission on land, put Hydrus in the water, and, because it doesn't have a tether, we force it to make decisions for itself on board. I think advancing that autonomous capability is where the industry should be heading.

IMVE: Is there a lot of involvement for things such as edge computing, then? And does being underwater make it harder to keep a stable connection to the device?

AMcG: For sure. When it comes to underwater communication, wireless connections can be very slow and there's limited bandwidth. We get a few updates from Hydrus when it's underwater, just to see its progress throughout the mission, but in terms of things such as obstacle avoidance or making decisions about which way it needs to go to overcome certain currents, that's all done on board.

IMVE: You said you specifically work in the subsea area, but are there any other ongoing projects you can tell me about that are designed to operate in other environments?

AMcG: So, I'm based in Perth, where Advanced Navigation's subsea R&D happens. Across our other offices, we develop navigation solutions for land, space and air applications. For instance, our photonics team is developing a novel space-graded sensor called Laser measurement Unit for Navigational Aid, or LUNA, which uses lasers to measure a spacecraft's 3D velocity and range.

It aims to solve the challenge of landing on the Moon by enhancing the safety and reliability of autonomous landing manoeuvres. We've also adapted this technology into a terrestrial version to help solve navigation challenges on Earth.

IMVE: How do you think the ruggedisation requirements compare, between subsea and space? Which is the harshest environment to develop an application for?

AMcG: I would argue that ruggedising something for the marine environment – with all the corrosion that's happening and keeping all the electronics dry – is much more difficult, but then I'm biased. I think it does have a lot more challenges compared with designing things to operate in space or land, though, and I think a lot of people don't appreciate that.

If you talk to a mechanical engineer or an electrical engineer that designs something for the marine environment, they'll tell you there are a lot of challenges because things always break.

So, you need to do a lot of testing – both in the office and on site – before you come out with something properly ruggedised that won't corrode and reduce the lifespan of the product. **IMVE**

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Bonsai

visionaries

Autonomous farming in extreme conditions with Bonsai's 'vision-first' AI

From lab to farm: can contextual AI and dense camera sensing bridge the gap between R&D and the real world? Bonsai CTO **Ugur Oezdemir** (left) details how continuous learning loops and multi-camera redundancy keep row-crop machinery operational

Imaging & Machine Vision Europe: Tell us about Bonsai and some of your projects integrating machine vision.
Ugur Oezdemir: At Bonsai, we build vision-first autonomy that understands farms the way a human does – through dense camera sensing and contextual AI – so our systems can reliably navigate in dust, shadows, low light and all the messy conditions that break most autonomy stacks.

One of our biggest recent projects was integrating our perception system into orchard and vineyard equipment with OEMs such as OMC and Flory. The vision stack keeps machines centred in-row, identifies canopies and adjusts spray patterns in real time. Growers have seen jobs completed 60% faster and operating costs drop by nearly half.

Another major project was bringing Bonsai's perception to the Amiga platform after acquiring farm-ng.

Now the Amiga can navigate narrow corridors, recognise beds and trellises and perform tasks such as mowing and weeding with the same level of environmental awareness you'd expect from a skilled operator.

IMVE: I'm sure it isn't all plain sailing, though… what are some of the major challenges you faced during development on projects, and how were they overcome?
UO: The biggest challenge was closing the gap between lab performance and field performance. Farms undo all the assumptions traditional autonomy makes, for example, lighting changes by the minute, dust coats lenses, and terrain is never consistent. It's a totally different universe than indoor robotics.

We overcame this by designing perception that's biologically inspired. Instead of brittle object detection, our system understands structure, context and geometry, even when 30%-to-40% of the visual scene is compromised. We field-tested relentlessly. We built for the worst-case scenarios first, such as dust storms, dense canopy shadows, uneven slopes. That's what makes our autonomy reliable.

IMVE: Have you had lab-tested solutions that didn't work out in the field, then?
UO: When we first deployed models that looked perfect in controlled testing, they

"Amiga can navigate narrow corridors, recognise beds and trellises and perform tasks such as mowing and weeding"

Amiga is put through its paces – literally out in the field

cracked immediately in the field: glare changed the scene semantics, dust masked structure, canopy growth shifted geometry, and wheel slip invalidated assumptions that worked fine indoors. Those failures taught us that real autonomy must be trained on the world as it actually behaves, not the world as we model it in a lab.

IMVE: How did the experience shape how you go about training now?

UO: We rebuilt our entire pipeline around variability and continuous learning. Instead of treating field failures as anomalies, we turned them into fuel. Whenever a robot struggles, with misalignment; a drift event or a perception dropout, for example, our system automatically tags the surrounding data and funnels it into an active-learning loop. Engineers review the hardest moments first, label only what's needed, and push those examples directly back into training.

The worst 5% of conditions become the most valuable 5% of the dataset.

IMVE: With your systems operating in messy agricultural environments, what specific techniques do you employ to ensure reliability and performance?

UO: You can't treat outdoor autonomy like an indoor problem with a slightly thicker coating. It's fundamentally different. We use multi-camera redundancy so the system can keep working even when one or two lenses are dusted or glare-heavy.

Our models also reason about context, such as crop row geometry or plant structure, so the robot can function even when visibility drops. And we've built self-diagnostics that constantly monitor lens clarity, exposure and calibration drift so the system can adapt before a human ever notices an issue.

IMVE: Do you buy off-the-shelf vision components and software, or do you develop them yourselves?

UO: We use off-the-shelf cameras, compute modules, and some sensor components, but everything core to autonomy is developed in-house, such as multi-camera fusion, perception, planning, control and the surrounding software infrastructure. Agriculture requires a level of robustness and contextual understanding that generic autonomy stacks don't deliver. Building the autonomy ourselves ensures we can push the limits of what's possible in dust, low light and high variability.

IMVE: What qualities matter most when selecting which product to buy or company to buy from?

UO: Reliability comes first, full stop. If it's not proven in dust, vibration, heat and low light, it won't survive a single season. We look for consistent calibration across units, stable long-term supply and clean APIs. Price matters, but only after a component has proven it won't cause downtime.

IMVE: Is there anything you'd like machine vision vendors to do differently? How can they be better for you?

UO: I wish more vision vendors tested in real outdoor conditions. Most data sheets describe how a sensor behaves in perfect lighting, which is the one thing we never have. We also need clearer long-term roadmaps. Sudden sensor discontinuations are extremely challenging when you're building multi-year platforms.

And we'd love firmware that's more tunable for robotics. Outdoor autonomy needs control at the edges, not just the centre of the performance envelope.

IMVE: What are some of the main limitations of the technology, and what are you doing to break through them?

UO: Lighting extremes remain one of the toughest challenges because direct sun, deep shadows and night operations push sensors to their limits.

We're also compute-constrained when fusing many cameras in real time without driving up cost. We're solving these with adaptive perception, more efficient edge AI and collaboration with sensor manufacturers on higher dynamic range and more rugged optics.

IMVE: Tell us about some of the newest emerging technologies you're most excited about integrating into systems for upcoming projects.

UO: Next-generation global-shutter HDR cameras are a game changer for low light and glare. We're also excited about more efficient edge AI accelerators that let us run richer perception and planning without bulky compute. Vision-language action models are opening the door to robots that understand scenes more like humans, and multi- or hyper-spectral sensing will unlock the ability to detect crop stress and disease days before the human eye can.

IMVE: What new capabilities will be provided to autonomous robots that seem out of reach currently?

UO: In the next decade, robots will manage crops at the plant level. They'll detect pests, disease or nutrient issues the moment they emerge, and treat only what's needed. Fleets of robots will operate 24/7, unaffected by lighting or weather. And the same autonomy we're proving in agriculture will expand into other off-road industries such as mining, construction, land management and defence.

Agriculture is simply the hardest proving ground. **IMVE**

Adigo Mechatronics

visionaries

From catch-weighing to ferry loading: robust machine vision for harsh maritime applications

Can ruggedised sensors and embedded AI overcome the punishing demands of real-world maritime environments? Adigo Mechatronics's AI Lead **André Ødegårdstuen** (left) tells **James Wormald** how the company's autonomous tracking system brings robust accuracy to the industry, from ferries to fisheries

André Ødegårdstuen: We're a product development company that specialises in robotics, mechatronics and embedded AI. We typically follow products from the concept stage to pilot series and have our own workshop and electronics lab that allow us to rapidly produce parts for iterative development. We also support our customers in finding other partners for further scaling. We deliberately try to work across a wide range of industries to be able to learn and challenge industry conventions. We also have some products of our own that we develop and fund in-house before spinning them off as separate companies. The most successful one of these is Kilter, an autonomous precision agricultural robot for plant-level weed control, but (our fish recognition product) CatchREG is also at an exciting stage because the newly established company has just gained its first paying customers.

Imaging & Machine Vision Europe: Tell us more about some of these products. What kinds of imaging technologies do they employ?

AØ: CatchREG is our most recent spin-off. It uses a camera to classify the species and estimate the weight of each fish in a catch. This enables fishers to report accurate catch numbers, which they are increasingly required to do due to stricter EU regulations. Weighing the catch is difficult at sea, especially on smaller vessels where space is at a premium and maritime scales are expensive. We used the Lucid Vision Phoenix camera. It's excellent quality, but it also allows more flexibility in the design of the sensor enclosure.

One of the biggest challenges we faced when developing CatchREG, was getting our AI models to work across a wide range of vessels and environments, but we quickly realised that with each new vessel we applied it to, the system required less and less work to get good results. Our main goal for the project was to generate estimates on a par with a professional fisher's own estimate. And that's something we achieved near the end of 2025.

Then another system we're developing is one for automated RoRo (roll-on/roll-off) ferry loading. For this we used Hatteland Seahawk IP cameras to get complete situational awareness of both the ferry and the vehicle staging area.

The reason we chose the Hatteland Seahawk IP cameras was because the product has already demonstrated its durability in the harsh conditions faced by Norwegian coast ferries.

A symbolic AI controls electronic signs to guide vehicles on board and ensures optimal weight distribution. It also enforces rules regarding dangerous goods and makes sure people with additional needs get the space and access they need. The goal is for the system to run autonomously, without intervention from a human operator.

Meanwhile, we're also developing a system that can be used to count the number of people inside vehicles. Also being used by ferry companies, the system counts the number of passengers per car using a GigE uEye UI-5240CP Rev 2.2 from iDS. Chosen mainly because of the NIR sensitivity of the imaging chip, used to see through tinted windows, the goal was to obtain more than 98% accuracy per crossing, which is something that has routinely been achieved since installation.

A new feature we've recently added to the system means it can make separate counts of children and adults, ensuring there's always enough safety equipment.

IMVE: What are the most common problems you encounter on these types of projects, and how do you work around them?

AØ: The most common challenge we face is the harsh environments we place our cameras in. On the hardware side, we combine our experience making solutions for maritime and offshore industries by making sure the systems are modular, resistant to harsh environments and it's easy to replace parts. We also use reliable service partners to ensure any issues are resolved quickly.

Meanwhile, on the computer vision side, we use our hardware experience to create optimal imaging conditions, and we use a systematic and iterative approach to update our machine learning models so they can handle a wide range of situations.

Adigo Mechatronics

The CatchREG fish classification and scales product was used during winter in Lofoten, Norway

Adigo Mechatronics

The automated RoRo vehicle guiding system uses computer vision-controlled signage to direct drivers onto the ferry

IMVE: Do your clients have realistic expectations about what a vision system is capable of, and what it isn't?

AØ: We find that most of our customers have a good idea of what is feasible and what isn't. If we do need to communicate something, it's often regarding the data requirement that covers the distribution challenge of detecting rare events. The onset of foundational and large multi-modal models also challenges our own conception of what is feasible and what isn't. We're currently in a project with a customer where we use a locally-hosted LLM to detect rare events.

IMVE: Is there a particular market sector/s you tend to focus on? And if so, why is that?

AØ: Actually no. We believe we are at our best when we work across a range of industries. Learnings from one industry are often applicable to others, and sometimes industries can benefit from doing things differently from what they have normally done. We have projects in agriculture, energy, maritime, circular and fisheries.

IMVE: What makes a good vendor of vision components? What can they do to give you a competitive advantage or make it easier to work with them?

AØ: We use several different vendors for different purposes. For our customer projects with tight schedules and a limited scope, we need a good selection and fast delivery times, and we often use Edmund Optics. For our own products and larger customer projects, we prefer having a closer collaboration with our suppliers. Having a competent sales representative at the other end often saves us time and money as they understand our needs and are able to suggest a better product than what we originally wanted to order.

IMVE: Is there any area you'd like to see vendors make improvements?

AØ: Yes. Ordering from some multi-region vendors can sometimes feel like we're doing it in the previous century. The customer experience leaves a lot to be desired. If there were one single site and account you could order from, instead of one for the EU and one for UK or Europe outside the EU, that would be an improvement.

IMVE: Where do you discover new business opportunities?

AØ: Usually, our consultancy customers come to us, but in some cases, we use our network to get in touch with customers we want to have in our portfolio. We typically start small to establish a good working relationship and then work hard to become a strategic innovation partner and get recurring projects from the same customer. For our own products, the strategy depends on the product, but for each one they focus on creating new markets, rather than entering existing ones.

IMVE: In which market verticals is machine vision showing the most growth, in your opinion?

AØ: I honestly don't pay too much attention to specific markets, but my experience is that computer vision and machine learning have reached a maturity that allows for a broad range of applications that previously wasn't possible. It can be automatic catch registration as we do in CatchREG, vehicle occupancy systems such as our nPax-system or our autonomous system for guiding vehicles boarding ferries. Computer vision has become a good hammer, and there is no shortage of nails. **IMVE**

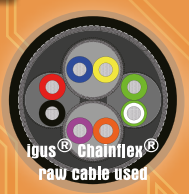
LONG DISTANCE CONNECTION

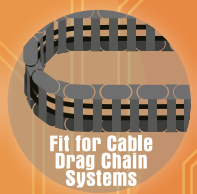
for Automated (Machine) Vision Inspection / AOI Systems

HIGH-FLEX

Length: 1m, 2m, 3m, ... , 20m

O.D.: 6.8mm





- Support High Resolution & High FPS USB3 Machine Vision Cameras without lost frames all the time
- Support both USB 3.0 (USB3.2 Gen1) and USB 2.0 data transfer
- USB 3.0 (USB3.2 Gen1) bus-powered, no external power supply needed

USB3.2 GEN1 TYPE-C CABLES

Passive CBL-HFPD3igCSHBK – 1m, 2m, 3m

Active CBL-HFD3igCSHBK – 4m, 5m, ... , 20m

Straight A to Straight C M/M

- Straight A Plug with locking screws
- Straight C Plug with 2 short locking screws

Angle C

Left & Right

CBL-HFPD3igCSHNBK – xmLRA

CBL-HFD3igCSHNBK – xmLRA

Up & Down

CBL-HFPD3igCSHNBK – xmUDA

CBL-HFD3igCSHNBK – xmUDA

USB3 (USB3.2 GEN1) MICRO-B CABLES

Passive CBL-HFPD3igMBSHBK – 1m, 2m, 3m

Active CBL-HFD3igMBSHBK – 4m, 5m, ... , 20m

Straight A to Straight Micro-B M/M

- Straight A Plug with locking screws
- Straight Micro-B Plug with 2 short locking screws

Angle Micro-B

Left

CBL-HFPD3igMBSHNBK – xmLA

CBL-HFD3igMBSHNBK – xmLA

UP

CBL-HFPD3igMBSHNBK – xmUA

CBL-HFD3igMBSHNBK – xmUA

Right

CBL-HFPD3igMBSHNBK – xmRA

CBL-HFD3igMBSHNBK – xmRA

Down

CBL-HFPD3igMBSHNBK – xmDA

CBL-HFD3igMBSHNBK – xmDA

JARGY Mobile Computing

JARGY CO., LTD. | jargy@ms17.hinet.net | +886-2-2662-5200 | www.jargy.com.tw.

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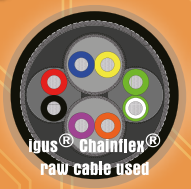

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Active CBL-HFD3igCCHHBK - 4m, 5m, ----- , 20m

Straight C to Straight C M/M

- Straight C Plug with short locking screws
- Straight C Plug with 2 short locking screws

Angle C

Left & Right

CBL-HFPD3igCCHHNBK - xmLRA

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visionaries

‘We translate ambition into specifications’ – the supplier’s role in machine vision

Machine vision projects don’t fail because of the camera alone. VA Imaging’s CEO **Gaspar van Elmbt** (left) tells **James Wormald** why success comes from engineering the entire imaging strategy around real-world constraints

Imaging & Machine Vision Europe: Tell us about VA Imaging. You sell off-the-shelf and custom components for machine vision systems, but also work on customer-specific OEM projects, right? What kind of systems do you tend to build and in which markets?

Gaspar van Elmbt: That’s right, we combine an off-the-shelf product portfolio with a custom and application-driven approach. We supply industrial cameras, lenses, lighting, software and accessories, but we also support customers with tailored camera, lens and lighting solutions for OEM and machine builder projects.

On the custom side, that can mean firmware modifications, special lens mounts, custom connectors, fixed-focus or fixed-aperture lenses, custom lighting sizes and wavelengths and even OEM lighting and controllers for customer-specific systems.

In practice, we work across a wide range of markets, including industrial automation, packaging, automotive inspection, agriculture, laboratory automation and other computer vision or robotics applications.

Our role is usually to help customers specify the right imaging architecture and then adapt it, where needed, so it fits their machine, space constraints, performance targets and production volumes.

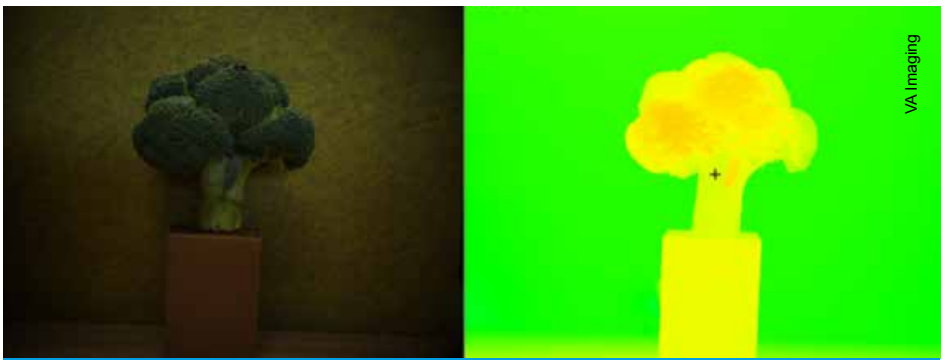
IMVE: Are there any recent projects you can tell us about?

GvE: A recent project we’ve completed that illustrates where machine vision is heading involved combining smart agricultural inspection with AI and stereovision. Working with a Dutch AI partner, the team set out to automate broccoli inspection, a task that quickly exposed the limits of traditional rule-based vision. Broccoli, naturally, varies in shape, size and colour, so a fixed approach struggled to deliver reliable results. What began with a single 2D camera for data capture and model training evolved into a stereo set-up once it became clear that depth and shape information were essential.

The final system used two 3MP GigE cameras with 6mm lenses. Earlier tests with a 3D camera had not delivered dependable depth data on thin stalks and irregular plant structures, so the team moved to a custom stereovision approach. The stereo pair provided more reliable depth estimation, tighter control over image settings and better dataset consistency.

The goal was not just to capture images, but to build an inspection and sorting system that could detect discolouration, measure size accurately and adapt to seasonal variation.

According to the case study, the result was a more flexible inspection workflow



'Broccoli naturally varies in shape, size and colour, so a fixed approach struggled to deliver reliable results,' says Gaspar van Elmbt

that improved consistency, efficiency and waste reduction.

The same application-led thinking shaped another recent automotive inspection project using near-infrared imaging. There, an NIR industrial camera with a global shutter, an 8mm lens and NIR spotlighting was selected to detect small defects across a large field of view on moving parts. NIR helped reveal cracks and coating irregularities that standard lighting could miss, while the global shutter minimised motion blur.

The challenge was balancing the optics, lighting and motion so that defects as small as 1.3mm could still be detected reliably.

A third example came from laboratory automation, where the requirement was to identify details as small as 1mm across a field of view of roughly 1,300mm × 1,000mm. That system combined a 12.3MP colour camera, a 6mm lens, bar lights and Zebra Aurora Vision software.

The challenge was to maintain fine-detail detection while covering a large area in a tight lab environment.

The result was a system that captured the full sample area in a single shot while improving sorting precision and consistency.

Taken together, the projects show a common pattern: successful machine vision systems are rarely defined by a single camera or sensor. They succeed when the entire imaging strategy is engineered around the realities of the application.

IMVE: How typical is this challenge to the projects you work on, and what's your usual work around?

GvE: Very typical. In machine vision, the same core problems come back again and again: field of view versus detail resolution, motion blur versus cost, difficult lighting, limited installation space and the gap between what the software needs and what the hardware can realistically deliver. Our way around that is always application-first: we start with the smallest feature the customer needs to detect, (take into account) the working distance, the speed of the process and the lighting conditions, and then build the camera, lens and lighting combination around them. Sounds simple, but it is where a lot of projects are won or lost.

IMVE: Is there still a mismatch between reality and client expectations of what a vision system can do? Or is the technical reality catching up with ambition?

GvE: There can still be a mismatch, yes, but it is a healthier one than it used to be. Customers are much more aware today of what machine vision and AI can do, but they still sometimes underestimate the importance of optics, lighting, environmental conditions and integration constraints.

IMVE: How do you walk the tightrope, then, between lowering a client's expectations and losing business?

GvE: The way we manage that is by translating ambition into specifications. We do not try to sell a perfect story; we try to define what is feasible, what is possible with trade-offs, and what would require a different approach. In the long run, that honesty helps you win better business, because customers remember who gave them a realistic solution instead of an easy promise.

IMVE: Is there a particular market sector you tend to focus on?

GvE: We are not locked into a single sector, but we are strongest in markets where imaging performance directly affects process quality and ROI. That includes industrial automation, automotive inspection, agriculture and robotics, laboratory automation and other OEM machine vision applications. Those sectors tend to need more than just a catalogue product: they need support with specification, integration and sometimes customisation, and that is exactly where we add value.

IMVE: As a vendor of vision components, does this give you an advantage over other system integrators, or does buying from a 'rival' make it more of a challenge?

GvE: I see it mainly as an advantage. Because we understand the component layer in detail, we can usually specify faster, troubleshoot more efficiently and make better trade-offs between cost, performance and scalability. It also helps that we can support low-volume customisation, which is important in many OEM or niche projects. Of course, the application has to come first, so if a project needs something outside our standard range, then the right technical choice matters more than where it comes from. The real advantage is not that we sell components ourselves; it is that we understand how those components behave in real applications.

IMVE: Where do you find new business opportunities?

GvE: A lot of our opportunities come from technical inbound demand. Engineers and OEMs usually start with a concrete imaging problem, so they look for practical guidance, fast support and clear product information. We've built the business around that: a strong online portfolio, technical articles, responsive support and customisation options even at relatively low volumes. That combination attracts customers who are already serious about solving an application problem, not just browsing components.

IMVE: How competitive is the machine vision market right now and how do you differentiate yourselves from the competition?

GvE: It is a competitive market, but it is also a growing one. At the 2026 A3 Business Forum, the outlook presented for machine vision was positive, with projected market growth through 2029 and particularly strong momentum in software, AI applications and newer verticals.

In that kind of market, differentiation becomes very important.

For us, that comes from being fast, technically hands-on, transparent and willing to support both standard and customised solutions, even in smaller volumes.

We sit somewhere between a pure component webshop and a traditional manufacturer/distributor: accessible on the front end, but very application-driven when the project gets technical.

IMVE: In which market verticals is machine vision showing the most growth, in your opinion?

GvE: I would highlight AI-driven inspection, 3D vision, agriculture and life science-related automation as particularly strong areas. Automotive is hugely important for many of our competitors, for example, but the real story is that machine vision is expanding well beyond its traditional manufacturing base.

It's entering the consumer market with applications such as bowling, golf, swimming and other sports and games, where cameras are used to track the object, do image analysis and improve an athlete's performance or show the object in a digital world. **IMVE**

Seeing Machines

visionaries

How active NIR tracking and smart algorithms can help to reduce driver error

Paul McGlone (left), CEO of Seeing Machines, tells **James Wormald** how its Guardian driver-monitoring platform handles glare, low light and driver variability and why the architecture is expanding into other applications

Imaging & Machine Vision Europe: Tell me about the history of Seeing Machines. What inspired the foundation of the company?
Paul McGlone: Seeing Machines was founded in 2000 at the Australian National University in Canberra by a group of engineers and scientists passionate about computer vision and human-machine interaction. The founders, thinking that the car would emerge as the world's first widely used robot, were inspired to harness emerging imaging and sensor technologies to address real-world safety challenges, particularly by monitoring human behaviour in vehicles and industrial settings.

The early work focused on developing algorithms that could interpret eye and facial movements, laying the groundwork for the advanced human monitoring solutions the company offers today.

IMVE: How has your mission evolved over the years?
PMcG: Initially, Seeing Machines' mission centred on understanding and improving the interaction between humans and machines, and encompassed a reasonably broad range of industries, including medical.

Over time, as the significance of driver fatigue and distraction became more widely recognised, the company sharpened its focus on automotive and transport safety.

Today, Seeing Machines strives to set the benchmark for driver monitoring technology, supporting global efforts to reduce road accidents and fatalities while also exploring broader applications in aviation, rail and industrial safety.

Our purpose is clear – to get people home safely.

IMVE: Tell me about the Guardian platform. How does it use image sensor technology to enhance driver safety?
PMcG: The Guardian platform combines advanced imaging sensors with real-time data processing to monitor driver alertness and behaviour.

By continuously tracking eye movements, head position and facial cues, Guardian can detect signs of drowsiness, distraction or inattention.

When a risk is identified, the system delivers immediate alerts to the driver and, where applicable, to fleet managers, enabling timely interventions and reducing the likelihood of accidents.

IMVE: How does Guardian address driver safety issues such as fatigue and distraction, and how does it handle challenges such as poor lighting, varying driver positions or environmental factors such as glare?
PMcG: Guardian employs NIR (near-infrared) imaging, which operates effectively in low-light and night-time conditions, ensuring reliable monitoring regardless of ambient lighting. The system's algorithms are designed to adapt to different driver physiques, seating positions and even the presence of eyewear. Additionally, advanced image

Seeing Machines

'The system's algorithms are designed to adapt to different driver physiques, seating positions and even the presence of eyewear', says McGlone

processing techniques help mitigate the effects of glare and other environmental interferences, maintaining high accuracy in diverse real-world scenarios.

IMVE: How can driver monitoring technology help automotive OEMs to deliver more personalised or adaptive driving experiences?

PMcG: Driver monitoring technology enables auto manufacturers to tailor vehicle responses to individual drivers. For example, systems can adjust seat or mirror positions based on facial recognition, provide customised feedback on driving habits or adapt in-vehicle notifications according to the driver's current state.

These capabilities enhance comfort, safety and user engagement, setting new standards for personalisation in the automotive industry.

There are also examples of OEMs using eye activation technology, underpinned by driver monitoring systems (DMS), to support convenience features such as active lane change, allowing drivers to initiate a lane change simply by looking at the corresponding side mirror.

IMVE: Global regulations surrounding driver monitoring and compliance are rapidly and constantly evolving. How do you stay ahead of them?

PMcG: Seeing Machines maintains a dedicated regulatory affairs team that closely monitors legislative developments worldwide. The company actively collaborates with industry bodies and regulatory agencies to help shape emerging standards, especially in Europe with the New Car Assessment Programme (NCAP). (Seeing Machines) is the Tier 2 representative on the driver state sensing committee. We also have a permanent resource in Washington working closely with rule-makers, consumer bodies and regulators as the US works toward a regulation for driver monitoring to reduce distracted, drunk and drowsy driving.

We also actively ensure that we are designing technologies that exceed current compliance requirements and anticipate future trends, and are therefore able to support our customers with advice and solutions that remain at the forefront of regulatory expectations.

IMVE: With higher levels of vehicle autonomy on the horizon, how will systems such as Guardian fit into the future landscape? Will there still be a role for monitoring technologies such as this in Level 4 and Level 5 systems?

PMcG: Seeing Machines works with self-driving car companies today. Guardian's back-up DMS is our solution focused on supporting these kinds of companies as they explore new regions and train their vehicles. We have also worked with logistics companies that are experimenting with 'platooning' and autonomous driving technology.

In the automotive sector, even as vehicles approach full autonomy, driver monitoring remains critical in transitional phases and shared-control scenarios.

For Level 4 systems, the technology ensures the driver is prepared to retake control if required. In Level 5 (fully autonomous) vehicles, monitoring may shift focus to occupant wellbeing and safety, such as detecting health emergencies or ensuring responsible use of the vehicle.

Thus, our DMS will continue to play a vital role as the industry evolves.

IMVE: Guardian was unveiled at CES 2025 back in January. What has the industry response been and how has the feedback shaped development?

PMcG: The Guardian platform's showcase at CES 2025 generated significant interest from automotive manufacturers, fleet operators and technology partners. Industry feedback highlighted the system's robustness and adaptability, with particular praise for its integration capabilities with existing vehicle systems.

Constructive input from potential customers has informed ongoing product development, including enhancements to user interface, data analytics features and expanded compatibility with emerging vehicle architectures.

IMVE: What standout use cases have emerged for the system over the past 12 months?

PMcG: Over the past year, Guardian has seen growing adoption in commercial vehicle fleets and public transport systems. There is strong momentum and there are many existing and emerging competitive options. However, as Guardian is scientifically proven to reduce fatigue-related events by more than 90%, we have carved out a niche with organisations that are genuinely seeking a solution that solves the problem.

We are also seeing a lot of momentum in Europe, especially with the General Safety Regulation which came into force in July, where all new vehicles on roads in that region will be required to have a camera-based DMS for safety.

We work with transport and logistics operators in Europe, but also with commercial vehicle OEMs as they seek to produce and sell compliant vehicles across the region.

IMVE: Tell me about the other sectors you're actively exploring.

PMcG: We're working on applications in aviation, rail, mining and heavy industry. These sectors share a common need for real-time monitoring of operator alertness and wellbeing.

In aviation, for example, we have business with global brands such as Qantas and Emirates. Early pilot programmes have demonstrated the potential for improving safety and operational efficiency in these environments, positioning us for continued growth across diverse markets.

Furthermore, we're also working on opportunities to support future mobility across transport.

Via our recently announced collaboration with Mitsubishi Electric Mobility Corporation, we expect to be developing technology to support industries such as factory automation and humanoid robots. **IMVE**

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Hyperspectral imaging in 2026

A look at the market for hyperspectral imaging and some of the cameras, sensors and other optical products available

What is hyperspectral imaging?

Hyperspectral imaging is an advanced imaging technique that can capture and process information from across the electromagnetic spectrum. Unlike standard photography, which records images in three colour bands (red, green and blue), hyperspectral imaging collects data across dozens to hundreds of narrow spectral bands. Each can capture light at a specific wavelength, to provide a detailed spectral signature for every pixel in an image.

Spectral range is one key aspect of hyperspectral imaging. Hyperspectral cameras can capture wavelengths beyond visible light, including the ultraviolet (UV), near-infrared (NIR), and short-wave infrared (SWIR) regions.

This provides a "fingerprint" for each material, as different materials reflect or absorb specific wavelengths uniquely.

Then there is spectral resolution. Each pixel in a hyperspectral image contains a full spectrum of data, which provides detailed information about the chemical composition, moisture level and other material characteristics.

Data-rich imaging is the third key aspect. Hyperspectral imaging creates a "data cube" where each layer represents a different wavelength, allowing for detailed analysis of spatial and spectral information together.

What are the advantages and challenges?

Hyperspectral imaging offers the advantage of a unique level of detail that allows for precise material identification and analysis that's impossible with traditional RGB imaging.

It also generates large amounts of data, which can be computationally intensive to process. The sensors can also be costly and require specialist expertise to interpret the data, however, as hyperspectral imaging continues to expand in scope and sensors become more compact, affordable, and capable, further potential could be opened up across a number of applications.

Hyperspectral imaging products on the market

Applied Spectral Imaging (ASI) develops and manufactures microscopy imaging and digital analysis tools for hospitals, service laboratories and research centres. The company provides hyperspectral imaging software and analysis tools, including solutions for microscopy for industries such as clinical diagnostics, genomics and pathology.

BaySpec was founded with the objective of providing rugged, reliable, high-performance devices. Its product range includes hyperspectral cameras, Raman spectrometers, and software for spectral data analysis, which is used in industries including pharmaceuticals, life sciences, agriculture and forensics.

Corning offers a suite of hyperspectral imaging and sensor products. The range includes hyperspectral cameras for

industrial, scientific, and environmental applications in industries such as security, agriculture, and environmental monitoring.

Cubert develops hyperspectral imaging solutions, with a focus on snapshot technology that is designed to enable real-time data capture. Unlike conventional hyperspectral camera systems, these are designed to capture the entire scene instantly, allowing for live data acquisition at video rates.

Delta Optical Thin Film specialises in the design and manufacture of high-performance optical filters in the UVA/VIS/NIR range for OEMs. The company's hyperspectral filters and optical coatings are often used in industries such as life sciences, industrial and environmental monitoring.

Diaspective Vision develops and produces hyperspectral and multispectral camera systems for use in various areas of medicine. The company's Tivita family of hyperspectral cameras is designed specifically for medical imaging, with focus on real-time applications.

Headwall provides hyperspectral sensors and imaging systems for airborne, field and lab applications. The company's Hyperspec family of hyperspectral sensors and imaging systems are designed to be small, light and rugged, and operate across the 250nm to 2500nm wavelength range.

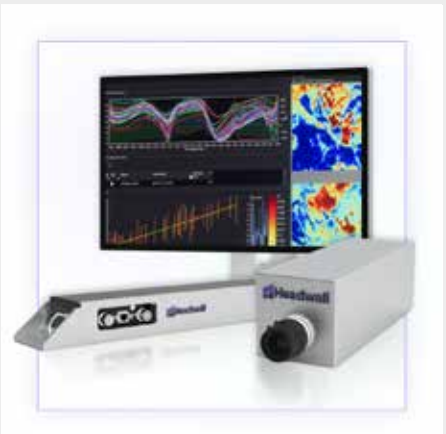
Hinalea Imaging provides multispectral and hyperspectral imaging cameras for handheld and embedded systems in fields including machine vision, industrial inspection and scientific research.

IMEC offers compact hyperspectral imaging sensors on silicon for integration into various devices. The company's on-chip filter technology was developed to make hyperspectral and multispectral imaging more compact, scalable and capable of real-time performance. It has found applications in medical imaging, agriculture and drone-based imaging.

Norsk Elektro Optikk (NEO) has been involved in projects, prototype development and manufacturing of hyperspectral cameras and applications for more than a decade. The company's HySpex cameras and imaging systems are known for high spatial and spectral resolution.

Photon etc. develops and supplies hyperspectral imaging cameras for visible and near-infrared applications. These are widely used in medical and scientific applications, cancer research, life sciences and material science.

Headwall Industrial Intelligence



Headwall Industrial Intelligence helps machines understand what materials are – not just what they look like – and turn that insight into real-time decisions for industrial inspection, sorting and process monitoring. Proven across nearly 5,000 deployments, Headwall helps machine builders, systems integrators and innovation teams apply hyperspectral imaging and inductive sensing to distinguish visually identical materials, uncover contamination, verify composition and quality, and recognise process drift before it creates waste or rework.

From feasibility through deployment, customers can define what the machine needs to know, develop and validate the right approach, and integrate actionable intelligence into automation. The result is material intelligence that enables faster, more consistent decisions at production speed, helping industrial teams improve quality, strengthen process control, reduce waste and automate with greater confidence.

Find out more information about Headwall Industrial Intelligence at https://headwall.com/industrial-inspection/?utm_source=IMVE+Tech+Focus&utm_medium=media+product+listing&utm_campaign=VISION

Photonfocus is a supplier of hyperspectral sensors for machine vision, particularly in the SWIR range. It is found in industries such as food quality control, sorting and industrial inspection.

Resonon designs and manufactures hyperspectral imaging systems for use in challenging environments. The company's hyperspectral cameras cover the ultraviolet, visible and infrared spectral ranges, with laboratory, outdoor, airborne and industrial systems. While its integrated hardware and software systems were designed to produce high-quality data to stimulate new insights and solve problems.

SILIOS Technologies has a portfolio of off-the-shelf multi/hyperspectral sensors and cameras, including the TOUCAN camera (VIS/NIR) and the CICADA (SWIR). SILIOS says it can build custom multispectral sensors and cameras based on any CMOS and/or InGaAs sensors of the market.

Available from **SpecTIR** are hyperspectral and geospatial solutions that have been designed to enable critical mission operations for government and commercial clients. Products include hyperspectral imaging systems, particularly for environmental and remote sensing applications.

Telops designs and manufactures high-performance hyperspectral imaging systems and infrared cameras for defence, industrial, and academic research applications. The company additionally offers R&D services for optical systems technology development, tailored to meet customer needs.

Ximea is a developer and provider of machine vision cameras for industrial and scientific applications. Products include hyperspectral cameras with compact, USB-controlled designs, focusing on integration in small platforms. These can be found in applications such as industrial inspection, scientific research, and quality control. **IMVE**

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

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Our pick of the hyperspectral imaging products on the market

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Cubert develops hyperspectral imaging solutions, with a focus on snapshot technology that is designed to enable real-time data capture. Unlike conventional hyperspectral camera systems, these are designed to capture the entire scene instantly, allowing for live data acquisition at video rates.

Delta Optical Thin Film specialises in the design and manufacture of high-performance optical filters in the UVA/VIS/NIR range for OEMs. The company's hyperspectral filters and optical coatings are often used in industries such as life sciences, industrial and environmental monitoring.

Diaspective Vision develops and produces hyperspectral and multispectral camera systems for use in various areas of medicine. The company's Tivita family of hyperspectral cameras is designed specifically for medical imaging, with focus on real-time applications.

Headwall provides hyperspectral sensors and imaging systems for airborne, field and lab applications. The company's Hyperspec family of hyperspectral sensors and imaging systems are designed to be small, light and rugged, and operate across the 250nm to 2500nm wavelength range.

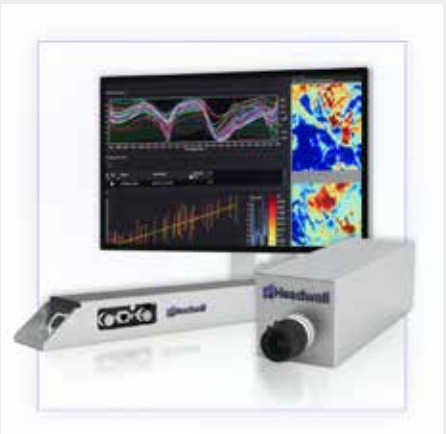
Hinalea Imaging provides multispectral and hyperspectral imaging cameras for handheld and embedded systems in fields including machine vision, industrial inspection and scientific research.

IMEC offers compact hyperspectral imaging sensors on silicon for integration into various devices. The company's on-chip filter technology was developed to make hyperspectral and multispectral imaging more compact, scalable and capable of real-time performance. It has found applications in medical imaging, agriculture and drone-based imaging.

Norsk Elektro Optikk (NEO) has been involved in projects, prototype development and manufacturing of hyperspectral cameras and applications for more than a decade. The company's HySpex cameras and imaging systems are known for high spatial and spectral resolution.

Photon etc. develops and supplies hyperspectral imaging cameras for visible and near-infrared applications. These are widely used in medical and scientific applications, cancer research, life sciences and material science.

Headwall Industrial Intelligence



Headwall Industrial Intelligence helps machines understand what materials are – not just what they look like – and turn that insight into real-time decisions for industrial inspection, sorting and process monitoring. Proven across nearly 5,000 deployments, Headwall helps machine builders, systems integrators and innovation teams apply hyperspectral imaging and inductive sensing to distinguish visually identical materials, uncover contamination, verify composition and quality, and recognise process drift before it creates waste or rework.

From feasibility through deployment, customers can define what the machine needs to know, develop and validate the right approach, and integrate actionable intelligence into automation. The result is material intelligence that enables faster, more consistent decisions at production speed, helping industrial teams improve quality, strengthen process control, reduce waste and automate with greater confidence.

Find out more information about Headwall Industrial Intelligence at https://headwall.com/industrial-inspection/?utm_source=IMVE+Tech+Focus&utm_medium=media+product+listing&utm_campaign=VISION

Photonfocus is a supplier of hyperspectral sensors for machine vision, particularly in the SWIR range. It is found in industries such as food quality control, sorting and industrial inspection.

Resonon designs and manufactures hyperspectral imaging systems for use in challenging environments. The company's hyperspectral cameras cover the ultraviolet, visible and infrared spectral ranges, with laboratory, outdoor, airborne and industrial systems. While its integrated hardware and software systems were designed to produce high-quality data to stimulate new insights and solve problems.

SILIOS Technologies has a portfolio of off-the-shelf multi/hyperspectral sensors and cameras, including the TOUCAN camera (VIS/NIR) and the CICADA (SWIR). SILIOS says it can build custom multispectral sensors and cameras based on any CMOS and/or InGaAs sensors of the market.

Available from **SpecTIR** are hyperspectral and geospatial solutions that have been designed to enable critical mission operations for government and commercial clients. Products include hyperspectral imaging systems, particularly for environmental and remote sensing applications.

Telops designs and manufactures high-performance hyperspectral imaging systems and infrared cameras for defence, industrial, and academic research applications. The company additionally offers R&D services for optical systems technology development, tailored to meet customer needs.

Ximea is a developer and provider of machine vision cameras for industrial and scientific applications. Products include hyperspectral cameras with compact, USB-controlled designs, focusing on integration in small platforms. These can be found in applications such as industrial inspection, scientific research, and quality control. **IMVE**

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

Humanoid

visionaries

‘Humans shouldn’t waste their potential on repetitive low-value tasks’

Artem Sokolov (left), CEO of Humanoid, tells **James Wormald** about the company’s HMND 01 Alpha Bipedal robot, designed to navigate human environments and perform real-world tasks, detailing its vision systems, use of AI and fast-tracked journey from concept to prototype

Imaging & Machine Vision Europe: Give us some history on Humanoid’s HMND 01 Bipedal standing robot… what industries and specific tasks was it designed for?

Artem Sokolov: Humanoid was created with a clear mission: to empower humanity by building the most reliable, safe and helpful humanoid robots. From day one, we focused on two platforms, wheeled and bipedal, because different environments require different types of mobility.

HMND 01 Alpha Bipedal robot is the first “legged” addition to our portfolio. We built it incredibly fast: only five months from concept to working prototype, whereas most companies take 18-24 months. We designed it as a foundation for future home and service applications, where robots will mostly have to move like humans, so the legs become necessary.

HMND 01 Alpha Bipedal is already capable of walking, turning, sidestepping, squatting, hopping, running and manipulating objects accurately. It can recover from pushes, interact with other robots and communicate via a head display, LEDs, audio and voice. Combined with our VLM/VLA-based framework (vision language models), it can perform advanced reasoning and task execution.

In the early stage, we’re using it mainly for R&D, safety testing and AI development across industrial, household and service scenarios, teaching it the real-world tasks it will eventually perform.

IMVE: Our vision of robot-helpers began with humanoid figures, but in reality were simplified due to ease of development and practicality. Why do you think legged robots still have a place in the autonomous landscape? What is the advantage?

AS: The short, straightforward answer is that the world is already made for humans. Our infrastructure, buildings and interiors are designed for the human body. That is why I am convinced that the humanoid form will eventually be the one to prevail. Moreover, to train robots with modern AI frameworks, we need data gathered from the human body.

However, it should also be noted that a humanoid robot does not necessarily have to replicate a human body completely.

Their design should correspond to their functions. For instance, if it’s a job of picking up an item, a simple gripper will do. If the task is more delicate, like handling fragile things, then the dextrous hand is what you’ll need.

In the same way, wheels would be the best option on wide and flat factory floors, but legs become essential if you have to go up the stairs or if the place is complicated to navigate.

What we need to do is think carefully through each use case. When we spoke with potential customers early on, we realised most of the capabilities they needed were more efficiently carried out by a wheeled platform. It is safer, more stable

Humanoid

The HMND 01 Alpha Bipedal robot can delicately handle fragile items

and more controllable. So, we started with a wheel robot.

Now, we are moving towards more complex use cases with a bipedal robot. In the future, we anticipate bipeds to be more involved in service and home applications, where mobility similar to that of humans becomes a real advantage.

IMVE: What kind of vision components and systems have been integrated into the robot, and how integral are they to its operation?

AS: Our HMND 01 Alpha Bipedal relies on a very rich vision and sensing system, which helps it interact with humans and other robots. In the head, we've built a full 360° vision system. It uses six RGB cameras and two depth sensors, so the robot can see its surroundings in detail, understand distance and recognise objects.

We also added a six-microphone array, speakers, a head display and LED indicators. Together, they allow the robot to hear, speak, react and interact in a very natural, human-friendly way.

Across the body, we've integrated force/torque sensors, haptic sensors and wrist-mounted cameras – so the robot can understand what it's touching, how much force it's applying and how to adjust its movements safely. All of these signals run through a hybrid compute platform powered by Nvidia Jetson Orin AGX and Intel i9 processors, which gives the robot the power to process vision, audio and touch data instantly.

IMVE: How did you go about sourcing the components used? What criteria were most important for you when selecting and working with vendors?

AS: When choosing vendors, we look beyond bill of materials (BOM) cost. From the start, our strategy combined a COGM-centric view with supply-chain resilience and geopolitical awareness. For our alpha and beta prototypes, flexibility is the most important factor. We choose partners who could support rapid iteration, frequent design changes and low-volume builds without friction.

We also put a lot of thought into resilience early on – diversifying suppliers, avoiding high-risk regions and learning from how other robotics companies structure their supply chains. That benchmarking helped us make smarter decisions much earlier than most teams do.

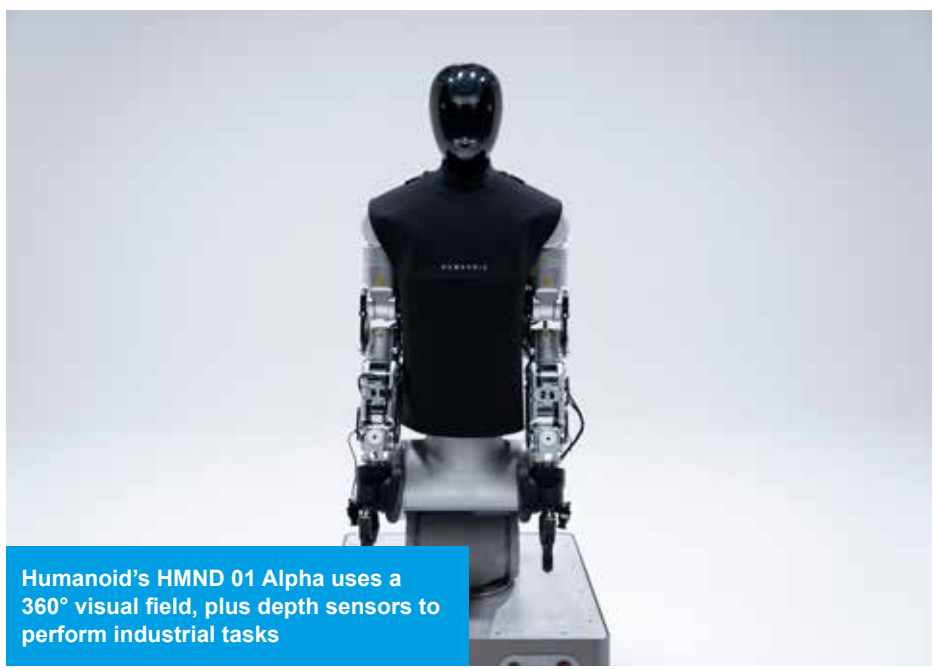
We also adopted a phased sourcing model, which will allow us to move smoothly from prototyping to high-volume production without reworking the supply chain later. For strategic components, such as compute, batteries and sensors, we maintain direct relationships with key suppliers to stay close to critical technologies and avoid high-risk countries. For non-strategic parts, we leverage contract manufacturing partners for bulk purchasing.

IMVE: You've already completed a few pilot projects. Tell us about some of the results of those and how they've shaped further development on the robot.

AS: First of all, I would like to highlight something that really differentiates us from almost all the competitors: Humanoid is a commercially driven company, not an R&D lab. This means that our objective is to take robots to real environments as soon as possible. That's why early proofs of concept (POCs) and pilots are a big part of our strategy, and we started running them with our pre-alpha robot.

One example is the POC with Schaeffler. We brought our humanoids to their sites in Erlangen and Schweinfurt, Germany, where they performed bin-picking of metallic >

Humanoid



Humanoid's HMND 01 Alpha uses a 360° visual field, plus depth sensors to perform industrial tasks

Humanoid

Humanoid believes humanoid robots will enter factories, logistics centres and retail operations to take over repetitive, monotonous tasks

> **"Humanoid robots are just AI, coming out of the screen and getting a body"**

bearing rings in a cluttered, near-production set-up. The robot met all the criteria we had set and the project proved that our team can quickly build new skills and transfer policies from the lab into a live industrial environment with almost no adjustments. That's exactly the kind of feedback we need to create real value for customers and understand where the next improvements should be made.

We also recently announced a joint POC with SAP and Martur Fompak International scheduled for this year, this time focused on intelligent kitting. There are many more use cases ahead and each of them contributes to the robot's development.

IMVE: Partners you've worked with so far include Nvidia, SAP and QSS Robotics. In which areas of the design and development process have these collaborations proven crucial?

AS: At Humanoid, partnerships are a foundational part of our strategy. The humanoid robotics industry is incredibly hyped right now, but, in reality, it's still at a very early stage. No single company can create this future alone. So, we want to develop an ecosystem: bring together commercial partners, AI leaders and manufacturing experts to increase the adoption, strengthen the competitiveness and scale the production.

For example, we integrate Nvidia's accelerated computing, edge processing technologies and advanced simulation tools into our development process. With platforms such as Nvidia Isaac Sim or Nvidia Omniverse we can iterate robots in simulation environments and reduce prototyping cycles.

We also employ reinforcement learning training and data generation to train robot policies, preparing robots for complex real-world tasks. Moreover, with the help of Nvidia we train sophisticated Vision-Language-Action (VLA) models.

Working with SAP is about getting the robot off the ground in the real world of enterprise operations. What we are doing is initiating a series of POCs where our HMND 01 platform is combined with SAP's enterprise software. This enables us to understand customer needs better and fine-tune the robot to be used in real operations.

Our partnership with QSS AI & Robotics focuses on expansion. Saudi Arabia currently is one of the most ambitious markets globally when it comes to cutting-edge technologies. The collaboration aims to accelerate the deployment and local manufacturing of humanoid robots across the kingdom. As a part of this collaboration, we have recently opened the first humanoid robotics showroom in the Middle East.

IMVE: How do you go about training your systems for real-world environments?

AS: By now, we understand that data is the key ingredient behind more capable and intelligent AI systems. That same paradigm now applies directly to robots and their AI as well. With our models, we only need 800 episodes of data collection, about a single working day, to achieve autonomy for a specific use case, for example, bin picking.

We train our systems using three primary sources of data. First, we collect data directly from customer on-site deployments. Second, we use physical twins with customer equipment in our labs. The third source is outsourced data collection, enabled by low-cost, rapidly scalable devices through partnerships. This combination helps us efficiently train vision systems that generalise real-world environments while remaining scalable and aligned with customer use cases.

IMVE: How important has it been to provide enough on-board compute power to the robot, to enable real-time vision plus perception? Was this a challenge?

AS: It is actually one of the most important and challenging technical aspects of our

Humanoid

The HMND 01 Alpha Bipedal robot's dextrous hands can also lift heavy objects

work right now. And that's exactly why we're accelerating our development by integrating Nvidia technologies, particularly Jetson Thor. It's a high-performance "robotic brain", an extremely powerful edge computer that allows us to run the latest, largest and most capable robotic foundation models directly at the edge. This level of compute brings unprecedented intelligence to the robots: they can have real-time, intelligent interactions with both people and their surroundings, an essential aspect in making humanoids autonomous and useful in the real world.

IMVE: Tell us about the next step for HMND? What are your plans for 2026?

AS: Humanoid's next year will be all about scale, both in terms of technology and business. The interest in our solutions has been phenomenal. We already have 20,500 pre-orders, six completed POCs, which is the biggest pipeline in the industry for a company at our stage. In fact, we have no more slots available for POCs in 2026. We are now focusing on getting long-term partnerships, strengthening collaborations and shifting the conversion from the projects to the actual implementation of the ideas.

On the product side, we have plans to advance both our wheeled platforms to their Beta stages, implying higher reliability, more autonomy and being able to operate in the real world.

IMVE: What's your vision for, say, 10 years from now? How will robots such as HMND be operating within our industrial infrastructure?

AS: We can already see how AI is enhancing people's capabilities, not replacing them. And now think of such intelligence in a physical form: one that can understand the context of the real world, move in places where humans normally go and handle things. Humanoid robots are basically AI coming out of the screen and getting a body. So, I would say that humanoids could be the next major technological shift, in the same way as the internet or smartphones, that will change all aspects of our lives.

But that future won't happen overnight, of course. Technology needs time to evolve, and people need time to adjust. I see the humanoids rising in three phases.

Phase one is industrial: humanoids will enter factories, logistics centres and retail operations to take over repetitive, monotonous tasks.

Today, only about 20% of operations in these sectors are automated.

Phase two is service: robots that can assist, guide or support people will become essential. The global population trend turning towards ageing will be the main factor behind the exponential rise of service robotics.

Phase three is the home. This is the dream everyone imagines: a robot that folds your laundry or does the dishes after the meal. Across 3.5bn households, every day people spend more than 16bn hours on unpaid domestic and care work.

Humanoid robots will reduce that burden. They'll become our helpers in the execution of daily chores, care-giving and even in the battle against loneliness. Our HMND 01 Bipedal was designed with this long-term vision in mind: we're using it for R&D now, but the end goal is household and personal assistance.

And the big question that most of the people I meet ask me is: "Will robots replace humans at work?" I don't think so. Every major technological revolution created new jobs we couldn't have predicted. Embodied AI will do the same. The reality is that humans shouldn't waste their potential on repetitive, low-value tasks, either at home or at work. Robots will handle the chores while humans will focus on what only we can do. That's the future we're building. **IMVE**

Sentinel Vision

visionaries

‘It’s not a magic box’: building a vision system with scale

Alvaro Oliveira (left), Co-Founder and CTO at integrator Sentinel Vision, talks to **James Wormald** about how the company builds tailored inspection systems and turns them into scalable vertical solutions. He discusses AI expectations, feasibility testing, vendor transparency and why data-driven companies make the best clients

Imaging & Machine Vision Europe: Sentinel Vision integrates vision components into machine vision systems. Tell me about some of the industries and companies you create systems for, and the products and technologies you use.
Alvaro Oliveira: We develop our own software and we use it to create tailor-made solutions. We evaluate each project based on the customers’ requirements, we select the hardware that best fits the needs for that project, then integrate everything together with our software. Then we customise it to make sure not only that it works well, but also that it’s easy to maintain and to train new products, and new product variations, on the same line. We offer customers these vision systems, both with or without AI, with 2D or 3D cameras, for example. We select the best technology to solve specific problems, and that’s how we develop a solution.

The main idea at Sentinel is to develop specific solutions for specific clients, then we try to find situations where we can replicate the project for other clients. We want to create verticals that we can sell around the world. That’s how we scale to take on more projects and generate ongoing revenue from these verticals. But to find these verticals, we need to be close to our customers, to understand their problems before we can propose solutions.

IMVE: So you build bespoke, client-specific systems, then sell them as off-the-shelf products to other customers?
AO: Yes. Every project we do we always starts with our base software. For all the projects we work on, we use VisionCore, a low-code software platform where we can arrange and connect different blocks to implement different solutions. So first we check if all the blocks/features we need are there or not. If not, we need to implement them. If they are there, we sell the standard software with the blocks arranged in a way that solves the problem.

In some situations, clients need extra features that we need to develop. That’s why we need to create verticals. We’re creating very niche systems – such as the inspection machine that we worked on with

Zebra Technologies, to detect issues with car doors. It was a very specific machine with very specific needs. It needs to connect to client ERP, detect the components on each door dependent on the ERP information, make sure everything is in the correct position, make sure everything has the correct reference and so on. To do that, you need software, you need cameras and you also need the machine, and we built it. Our verticals are often like this, customised hardware and software.

IMVE: Are there any examples of bespoke projects you can tell me about that you've developed in the past and turned into usable base solutions for other customers?

AO: We previously developed a solution that we call SmartLine. We call it that because instead of having a lot of smart cameras installed on a production line, we have standard cameras and a vision station. That's a centralised station that processes all the information that is coming from the cameras.

We did this for BorgWarner, which was building a heater device. From start to end, we had something like 40 cameras installed on the line, with everything being processed in this one vision station. Using that method, we were able to use AI in all the cameras without incurring the costs of installing smart cameras. The system also means that we could make improvements to the algorithm directly at the vision station, and all the cameras would benefit from that improvement.

Another solution was the one that we developed for Visteon, for bead inspection. When the bead was deployed on a car display screen, it was checked so we could tell the robots if anything needed correction or if there were defects.

Then, another solution is the one we developed with Zebra Technologies to inspect car doors for a different issue. That was especially complex because there's a lot of variation in car doors, with different buttons and textile colours. For the operator on the line, it's difficult for them to understand which are the correct parts.

Our machine communicates directly with the client's ERP so it is able to check the references and then adapt if any changes are made, without manual intervention.

IMVE: So how do you kick things off? What's the first stage that you go through when you start working with a new client?

AO: We always try to make sure the requirements are well established. It's one of the most important tasks when we start a project, making sure everyone is aligned. We work in many industries; we work in PCB inspection, automotive, plastics and so on. And the "language" between us and the clients is not always the same. Sometimes, for example, what they're saying is obvious to them, but it's harder for us to understand because, although we know vision systems and AI, we are not fully aware of their process or the details that are specific to their industry. That's why we make sure our clients bring some examples to the table as early as possible, so we can capture the right information from the start.

Another thing that we do is feasibility tests. We try to capture images and send reports to the customer. This always generates discussion between us, and that helps us to align together, which is, of course, very important.

After we make sure we're aligned, and after the viability tests, then we give a quotation. And then it's like a normal project. We try to build it as quickly as we can so we can deploy the system fast in line and start having real images, that's when we start having a lot of data to work on and adjust the solution to perform as expected.

IMVE: How do you balance performance versus cost? We presume most clients ask for as much of one and as little of the other as possible, but how do you determine what performance means for individual clients?

AO: We have more than 16 years of experience making these systems, so we have some red lines that we know we can't go below if we want to make a system that can measure something or give a certain minimum resolution. We know what kind of camera we need to use, and the resolution limit we need to respect, for example. So we have some guidelines to make sure we don't end up on the risky side.

After that, if there's one thing we do at Sentinel it's test. We test the cameras. We test the hardware. We make sure it's all OK so that when our teams start a project, they know they can select a certain camera from a certain vendor because it's approved for use. We try to make sure projects run as smoothly as possible, of course, because where there is risk, there is variation. A lot of the details are hard to imagine when you start a project, but they can bring problems, so we try to avoid them as much as possible.

IMVE: What do some of these approved vendors do that you appreciate, and in which areas could the ones you don't work with improve?

AO: Because we work with a lot of different technologies, it's very hard to go really deep into the technology. Okay, we go there when we need to, but sometimes it's difficult to keep technical details in mind. That's something that good vendors do very well. If and when we have any doubts, we're able to call them and get some answers very quickly. Promotion is also important, like we've done on the car door inspection project with Zebra Technologies, for example. Sentinel is a company that does great work developing these solutions, so it's good to be able to communicate that.

One area that I think vendors could improve is commercial transparency. When we're doing the feasibility tests for a project, for example, there are often many different solutions for the same problem. Because we want to reduce the cost of the system as much as possible for our clients, we need to know the prices of different components and we need them fast.

We can't send an email whenever we need to request a quotation, we really need to have a clear view of the prices and be able to move forward quickly. However, I can already see some companies doing this – for example, having more transparency, or websites where we can buy directly. I think >

Zebra Technologies

Sentinel's 3D laser inspection system to detect defects on plastic injection-moulded parts for the automotive industry was "especially complex", said Oliveira

Zebra Technologies

Sentinel Vision's Poka-Yoke Evo system integrates cameras, software and customised hardware. It was originally developed as a dedicated solution for automotive door inspection and has since evolved into a repeatable, scalable vertical product

> the market, and the industry, is all going in that direction and it's good for us.

IMVE: Which industries would you say are furthest ahead in their use of machine vision?

AO: I would say you see a lot of vision systems installed in the automotive industry. Also, in semiconductor production, there are many companies with long histories that are building vision systems, and you also see them a lot in logistics, too.

I feel like these industries use it more than others because they have a really clear view of the return on investment. It's easy for them to see that because they're controlling the full process. They're very data-driven so they have a lot of information that enables them to understand the value of a vision system. If they have a problem such as a product recall, for example, they will know exactly the level of expense that it can cause them, so they're among the first to install the technology.

But they're still growing as well. More and more vision systems are being installed in these industries because, as technology matures and evolves, problems which, in the past, couldn't be solved, can now be solved with innovations such as AI. It also makes those types of companies easier to work with as they're more experienced in this type of technology.

IMVE: If you're working with a company that's new to machine vision and AI, how big is the gap between what they expect the system to do and what the reality is? How much education must you provide?

AO: If we're talking with a company that works in automotive, for example, they usually know what they want. They know more or less the capabilities of a machine-vision system and communication is easier than in another sector such as textiles, let's say. We are working in areas where these types of companies are not used to vision systems, but we need to be able to discuss the details with them. We need to control the process to make sure the system runs 24 hours a day without problems, and we often need to lay down some rules and best practices to be able to show them that the technology is good for them.

But it's not a magic box. It will not necessarily work in all situations without issues. We need to make really sure that they understand that our system can solve their problem, but the part needs to reach the machine in the right condition. If that happens, the problem can be solved and the client will, of course, be happy. This can take a little more time, but these companies are going through a transition to automation. They are willing to put the money in because they need to do it to stay competitive in their market.

IMVE: What's the biggest challenge you face integrating vision systems, and is that being solved with the use of AI?

AO: There's a lot of expectation around AI at the moment. That's because people see how AI can have great performance when a lot of data is available, such as in LLMs, but that's not the case if there are not many defects or you don't have many images when you start the project. We need to ensure clients understand this.

One of the things that can happen is we see that the machine might not start working on the first day. We need to grab some images. We need to label them. We need to improve our models. Then, after one or two weeks, we will have great results – but we need to be able to show them why it's not simply a magic wand where everything works in an hour.

When we use AI technology, the system will work better in the end, but it takes time to get there. We need to make sure the customer understands that and is willing to wait for it. We understand, of course, it can be difficult for them as, if you have a production line going, you can't have people there inspecting all the time.

So, I would say that we understand the client side too. That's why we try to implement strategies to make sure we don't need that much data. But it's always a tough problem to solve. **IMVE**

Allied Vision

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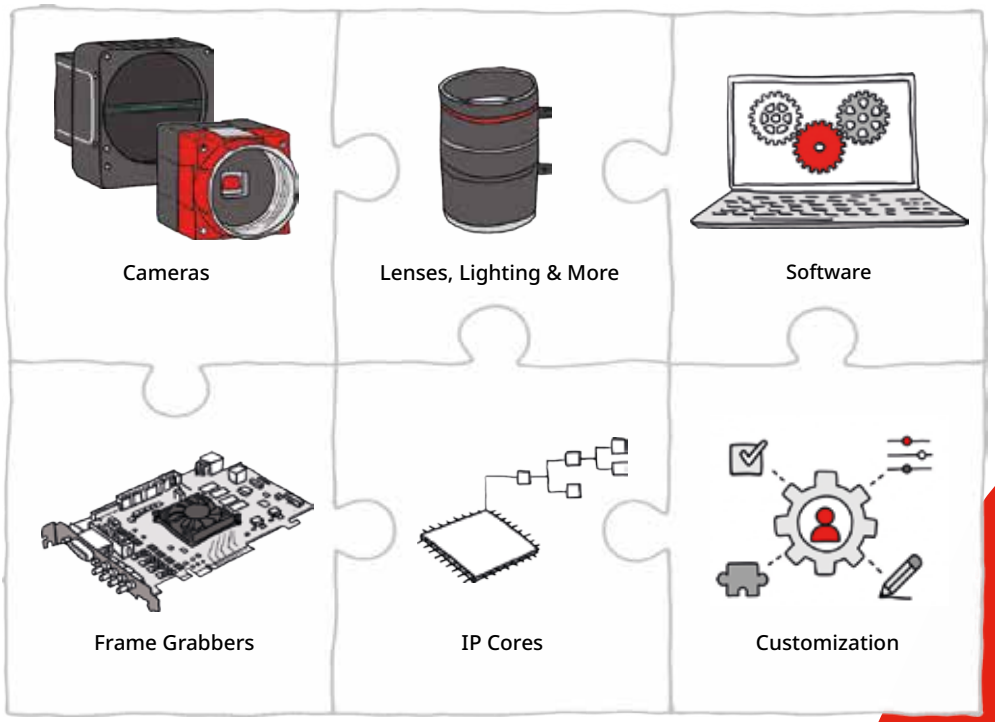

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Simbe Robotics

visionaries

Autonomous robots bring ‘ground truth’ to retail with real-time shelf intelligence

Simbe’s Director of AI and Computer Vision **Jari Safi** (left) tells **James Wormald** how the company’s Tally robot autonomously uses advanced imaging, AI and edge compute to improve store efficiency

Imaging & Machine Vision Europe: Tell us about Simbe Robotics… what do you provide and in which markets?
Jari Safi: Simbe is a store intelligence company combining robotics, AI and computer vision to give retailers real-time, shelf-level visibility across every retail store. Our flagship robot, Tally, autonomously traverses aisles in nearly a dozen retail sectors, including grocery; club; hypermarket and home improvement environments, capturing millions of shelf images and product tags daily – and scans RFID tags dependent on the store configuration. This provides store and corporate teams with a continuous, data-driven view of inventory, pricing and product placement, identifying out-of-stocks, low-stock conditions and pricing errors with unmatched accuracy.

Today, Tally is deployed across three continents and 10 countries, powering measurable results such as 60% fewer out-of-stocks, 90% improved price accuracy and ROI in less than three months.

IMVE: You describe the physical store environment as one of retail’s “last great data deserts”. What do you mean by this? And how does Tally use computer vision to address it?
JS: In e-commerce, data is relatively easy to come by. Warehouses are a more controlled environment where only the workers are interacting with the items on shelves, so every movement can be logged accurately. That’s much harder to achieve in a front-of-store retail environment where you have customers in the mix, and events such as out-of-stock products are not logged immediately. A robot such as Tally, recording the true state of the shelves multiple times a day, helps fill this gap. We call it capturing “ground truth”, giving retailers a continuous, unbiased record of what’s happening in their stores so they can act on it right away.

IMVE: Tell us more about the sensing and imaging components you’ve integrated into Tally and the accompanying platform, and the capabilities they provide?
JS: Tally uses 3D cameras and a laser rangefinder for navigation. For shelf capture, we use a suite of smartphone-style colour cameras combined with depth-sensing 3D cameras. This combination allows us to create a more seamless “scan” of the shelf, improving accuracy when determining if items are out of stock.

The volumetric measurements possible on the 3D data also help identify when something is low on stock, but fronted to look full. Over time, we’ve refined this multimodal imaging based on billions of captured shelf images, enabling the robot to perform reliably in different lighting and fixture conditions.

IMVE: How does the system process the data it receives, and where does this occur – on the edge or in the cloud?
JS: We use a hybrid compute model. Part of the processing happens onboard Tally as

All images: Simbe Robotics

Adhering to privacy rules, Tally does not capture images of people

soon as the photos are captured, and other parts happen in the cloud. Each generation of Tally has shifted more of that compute to the edge as technology has improved. Newer Nvidia Jetson modules, for example, allow us to run more AI processing directly on the robot without needing large servers.

IMVE: How have you been able to ensure enough accuracy in the system for it to be trusted?

JS: This is an exercise we've performed with every major customer that has scaled the technology. We run side-by-side validations against manual audits and continuously fine tune the models based on those results. Across these deployments, we consistently achieved more than 99% shelf condition precision and SKU-level accuracy, which has been independently validated by customers such as BJ's Wholesale and SpartanNash. That trust has been earned by proving accuracy repeatedly in stores, not just in the lab.

IMVE: That's an impressive number, but is it difficult to convince prospective clients of the overall value of the system? Not just in accuracy of stock records, but usability and profitability as well?

JS: That has depended a lot on the specific customer, but in most cases it's actually less difficult than expected. Once retailers see Tally's data next to their manual checks, the value is clear. Tally uncovers gaps in availability, pricing and placement that would otherwise go unnoticed.

During pilots, we typically show measurable gains within weeks, around a 60% reduction in out-of-stocks, 90% improved price accuracy and up to 50 hours of audit time saved per store, per week. That translates to ROI in about three months.

On the trust side, we've built confidence by validating results jointly with our clients, showing that Tally's detections match or exceed human accuracy. That has given even our customers confidence that the system can scale reliably.

Store teams are usually our strongest champions. They see Tally as taking on repetitive tasks so they can focus on shoppers, and many describe a noticeable "Tally Effect," (meaning) better execution, fewer empty shelves and higher morale. Shoppers also respond positively, viewing the robot as a sign the store is well managed.

IMVE: What's the single biggest barrier to sign-up to your service?

JS: The biggest challenge today isn't convincing retailers that the technology works, it's change management. Rolling out something such as Tally touches multiple departments: store ops, supply chain, manufacturing, IT and finance. Everyone has to understand how to use the data and where it fits in their workflow.

That said, we've experienced a major shift recently. Investment in in-store technology is up more than 150% year-on-year, with robotics as the greatest area of investment, and Simbe is now in 10 countries across three continents.

Two years ago, topics such as on-shelf availability, pricing accuracy and product location weren't boardroom issues.

Now they have C-level visibility because they directly affect revenue, labour efficiency and shopper experience.

We help retailers manage organisational change. Our strategy team designs value realisation strategies that integrate with business and cross-departmental goals. We've also developed playbooks that align all departments, from operations to finance, which we customise and implement hand-in-hand with our partners. Once teams experience that, adoption moves quickly.

IMVE: How well does the system handle variety in store layouts and typologies? And how much training has this taken?

JS: Quite well. We've proven that the system can adapt to very different store environments. We started in grocery, scaled up to club stores such as BJ's, and are now proving the system in hardware stores such as HomeBase USA.

Every new environment requires new training of computer vision models, but the process has been much faster. What used to take months, now takes weeks, thanks to improved configurability in both the robot hardware and our software stack. Once we have built the system out for one specific store, going to new stores in the same category takes less work.

This is a testament to the founding members of Simbe, who spent countless hours researching all the possible stores that could be our customers one day. This informed the team to design a "one size fits many" type robot (Tally).

Tally was designed to be relatively easy to modify for specific store needs as well. In my role specifically, I have ensured the computer vision software is built in a very configurable fashion to allow for this variation.

IMVE: When designing the collaborative hardware/software system, how did you decide which imaging components you required and how did you choose between various vendors?

JS: Non-stop testing. Our original Tally units used an array of USB cameras without autofocus. Those cameras taught us a lot about why autofocus and robust interfaces matter. We used those learnings to evaluate various capture systems and settled on a MIPI and Nvidia Jetson-based solution to support a larger array of autofocus cameras.

For the next generation of Tally, we're integrating advanced camera systems and refined computer vision that can better interpret challenging shelf environments – such as recessed bunkers or areas with small, hard-to-read price tags.

While Tally already operates effectively in glass coolers and reflective settings, these upgrades will further enhance its precision and coverage across the most complex parts of the store.

IMVE: Are you planning improvements to the system, and what informs the need for them?

JS: Software improvements are constant. The computer vision software updates multiple times a month as we add new fixture types and tweak algorithms for higher accuracy.

On the hardware side, we are working on updates for an even better camera system, support for specialty fixtures and improved edge compute capabilities. Some of this stems from the existence of newer technologies and some directly from customer feedback as we scale into new retail sectors. **IMVE**

AI starts with photons

Illumination is one of the most important, yet most overlooked factors in machine vision performance

Artificial intelligence (AI) is reshaping machine vision at speed. Deep learning tools that once required specialist expertise are now accessible to vision engineers through mature software frameworks and pre-trained models. The results are genuinely impressive: systems that detect subtle defect classes, adapt to product variability, and improve over time as more data becomes available.

But, as AI has become more prominent in machine vision, a worrying assumption has taken hold. Increasingly, AI is treated as a magic layer, a sufficiently powerful algorithmic stage capable of correcting whatever the imaging system fails to capture cleanly.

End users request AI-based inspection without specifying image quality requirements. System integrators face pressure to deploy AI solutions on timescales that leave little room for illumination optimisation. The implicit belief is that the algorithm will manage.

"We see this regularly," says Alexandre Cottereau, Head of Product & Marketing at Effilux. "There is a growing expectation that AI will solve imaging problems that should have been addressed in hardware. By the time the limitation becomes apparent, the project is already well advanced and the cost of going back to optimise the illumination is significant."

It will not simply manage. And understanding why begins with an unarguable principle: the best AI model in the world cannot recover information that was never captured by the camera.

What the algorithm actually receives

A machine vision AI does not perceive the physical world. It processes pixel data, a numerical representation of the light that reached the sensor during image acquisition. Everything the model knows about the inspection target is encoded in that data. Features that are not represented in the image cannot be detected, classified or segmented, regardless of how sophisticated the network architecture is.

Consider a common industrial challenge: detecting micro-scratches on polished, cylindrical metal components. Under standard diffuse white light, specular reflections wash out the metal surface, rendering the scratch virtually invisible to the sensor. If an engineering team attempts to train a deep learning model on these images, the network will struggle, generating high false-negative rates regardless of how many thousands of sample images are fed into the training pipeline.

Place that same component under darkfield, low-angle directional illumination, and the flat surface reflects light away from the lens while the scratch scatters light directly into the camera. The defect instantly appears as a high-contrast white line on a dark background. The AI model can now identify the defect instantly, with almost 100% confidence and minimal training data.

"AI starts with photons," Cottereau states. "Everything the algorithm knows about the part in front of the camera comes from the light that reached the sensor. If that information is missing or degraded, the model cannot reconstruct it. That is simply not what neural networks do."

The real cost of poor image quality

In practice, the belief that AI can compensate for weak imaging tends to manifest as a sequence of escalating interventions. Initial model performance is disappointing. The response is to collect more data, extend training, and increase network complexity. Each step may yield marginal improvement while the root cause, inadequate image quality, remains unaddressed.

The downstream costs accumulate. Models trained on poor-quality images require larger datasets, because the network must learn to extract signals from data where the signal-to-noise ratio is inherently poor. Training cycles lengthen. Models become brittle, sensitive to changes in imaging conditions that a well-specified lighting system would render inconsequential. False positive and false reject rates remain stubbornly high.

"Sometimes a better light is cheaper than a better AI model," Cottereau observes. "We have seen projects where months of additional development could have been avoided by addressing the illumination at the start. The investment in a well-designed lighting system is almost always modest relative to the cost of what follows when image quality is poor."

Where illumination sits in imaging chain

The imaging chain in a machine vision system runs from object through illumination, optics and sensor to algorithm and decision. Information can be lost or degraded at each stage. It cannot be recovered once lost.

Illumination occupies a uniquely influential position in this sequence. The choice of lighting geometry, wavelength and intensity distribution determines which features of the inspection target generate contrast and which do not. A defect invisible under diffuse illumination may be immediately apparent under directional or darkfield lighting.

A surface contamination indistinguishable under white light may be clearly visible under UV fluorescent excitation or specific short-wave infrared (SWIR) bands. These are not marginal differences. They are the difference between a detectable and an undetectable defect, independent of whatever algorithm is applied downstream.

"Illumination determines what information enters the system," Cottereau explains. "Contrast, signal-to-noise ratio, feature visibility, repeatability across shifts, all of these are established at the lighting stage. AI performance starts long before data reaches the neural network. The model is trained on the images the system produces, and if those images do not reliably encode the features that matter, there is nothing downstream that will fix that."

Designing for AI from the start

The practical implication is straightforward: AI-ready machine vision systems must treat image quality as a primary design objective, not a secondary consideration.

This means defining image quality requirements before specifying hardware, and validating illumination performance before collecting training data. A dataset collected from a poorly configured imaging system encodes the artefacts of that system alongside the characteristics of the inspection target. Models trained on such data become dependent on those artefacts, making them fragile to any subsequent change in the imaging set-up.

"Improving image quality is often the fastest way to improve AI performance," says Cottereau. "We encourage engineers to think of illumination as a data-quality tool rather than simply a source of brightness. The goal is to maximise the contrast of the features the algorithm needs to detect, and to eliminate variability that is irrelevant to the inspection decision. If you do that well before you start collecting training data, the model development becomes significantly more straightforward."

Hardware and software should be developed iteratively, with imaging system performance and model performance assessed together. Where illumination changes improve image quality, the effect on model performance should be measured. Where model performance falls short, the imaging system should be the first element reviewed.

AI and lighting as partners

None of this is an argument against AI in machine vision. The capabilities that deep learning brings to industrial inspection are real and still expanding. The argument is that those capabilities will only be fully realised when they are combined with imaging systems designed to give them the information they need.

"The future of machine vision will not be driven by AI alone," Cottereau concludes. "It will be driven by the combination of better illumination, better optics, better sensors and smarter algorithms, each developed with awareness of the others. The companies that understand this will build systems that consistently outperform those that treat AI as a substitute for good imaging."

Machine vision performance is ultimately determined by the quality of information entering the system.

As AI models become more capable, the value of high-quality image data increases rather than decreases.

AI starts with photons. The systems built on that understanding will outperform those that are not. **IMVE**

Find out more by downloading the latest White Paper from EFFILUX – Illumination: The foundation of AI machine vision

Hypersphere Consulting

visionaries

Why you can't just 'plug in a vision system and it works'

From matching lens resolutions with sensors, to sourcing hardware and managing vendor lock-in, Hypersphere Consulting's **Raffaella Riccato** (left) discusses why no vision system is ever truly plug-and-play, and why being a one-person operation keeps her close to both the problem and the client

Imaging & Machine Vision Europe: Tell us about Hypersphere Consulting. What kind of systems do you build and in which markets?
Raffaella Riccato: Hypersphere Consulting isn't tied to any specific market. As long as there's data and software engineering involved, I'm happy to get stuck in. The main focus is on machine vision solutions, but the data doesn't necessarily need to come from a vision sensor. Projects range from early-stage proofs of concept and research work, through to designing systems from scratch and seeing them through to commissioning. I also work with various vision integrators as a subcontractor. Currently, it's a one-person operation, which keeps things flexible.

IMVE: Sounds interesting. Tell us how this has worked in some recent projects.
RR: I've been involved in a few different projects over the past two years.

Some were research-related proof-of-concepts, while others were more about maintaining existing applications.

One example was a project to perform maintenance on a microscopic software solution from Micropix. The customer was using the hardware alongside an existing bespoke software vision application. They needed multiple small changes and one-off bits of maintenance on the software, but it didn't make sense to do it internally. Using me meant they had the flexibility to add functionality as and when they needed it. So far, this has included developing a stage module for automated image acquisition across multiple wells, in addition to new features and bug fixes.

At the end of each phase, the customer evaluates the solution provided.

One customer had a problem with their existing HDR (high dynamic range) system. The cameras and PCs were obsolete, so I replicated the existing system with newly available hardware.

One requirement was that it would remain familiar to operators who had used it for years, so it needed to behave in a very similar fashion to the existing system. I spoke with various suppliers, obtained loan units for different cameras and evaluated them all with the customer.

Then I replicated the user interface to

match the old version. The next step was to replicate the original software with the new camera as well, and it's currently being evaluated by the end customer.

On another project to evaluate Raspberry Pi for use as an embedded platform, the challenge was whether or not the low-cost, commodity-embedded hardware running Linux could run a CPU-intensive machine vision application that would ordinarily be deployed on an industrial Windows PC.

In addition to setting up the development environment and replicating the code, I created a web service on the Raspberry Pi to configure the camera and provide a live stream for set-up purposes.

Streaming the data at full speed over the home network brought everything to a halt, which was an interesting challenge in itself, but the proof of concept showed it was feasible, and it's also now with the customer to decide on the next steps.

As well as these, there are a few other projects I'm not able to discuss in more detail, but highlights include fusing data from motion capture and local IMU sensors using Kalman filters, developing an embedded stereo vision system on an Nvidia Jetson and several research projects and collaborations with other integrators.

IMVE: How typical are these issues? What are the most common pain points you tend to encounter, and how do you overcome them?

RR: Typical issues include selecting the correct components. While a solution may look simple on paper, environmental factors or component variations are only noticed after initial testing. Having worked with Stemmer Imaging for around 10 years, I've made many connections and friends in the industry. I stay in contact with many of them, and quite a few have moved on to different companies. That's handy because being able to loan cameras, lights and optics at this stage is useful; it reduces both risk and cost.

Then there's taking the customer on a journey, especially if they haven't used vision systems before. It's easy to think you just pick a camera off the shelf, plug it in and the software knows what to do. But AI isn't quite at the point of reading your mind yet, and the devil is in the details. A lens has a specific resolution that needs to match the sensor, the camera needs to keep up with the line speed and the processing needs to be fast enough. I currently have a project where I'm not getting enough light, so I'm at that point where I'm having to re-evaluate the options and talk to various suppliers.

Another challenge right now is sourcing PC hardware. Prices for memory and storage have increased drastically, and suppliers can sometimes only hold a quote for a week before the prices change again. A lot of that is driven by demand from data centres, which is where manufacturers are focusing their capacity right now.

IMVE: On the subject of AI and the mismatch between customer expectations versus reality… how do you communicate that without losing business?

RR: There are two types of client – those who have used camera systems before, and those who haven't. For the latter, the journey from idea to final product is important. It would be great to be able to just plug in a system and see it work straight away, but that doesn't happen.

Every vision system is unique because it depends on the individual business's requirements, and requirements are often more like ideas until they get to the first research stage.

That's when product variability, environmental constraints and many other challenges reveal themselves. It's only after that stage that people can sit down and make informed decisions about whether the approach is feasible. And, if not, work out what else is needed to improve the process.

Employing an external contractor can feel daunting, as the knowledge is held by them. So, as an external contractor, I think it's important to train the customer so they can understand the software and, if they wish, the code.

It's tempting to think you can just hand ChatGPT instructions and get a finished product, but you still need to know what you're asking for. People like to learn, and if a client wants to bring things in-house eventually, I'm happy to act as a consultant they can lean on. Someone to ask questions and draw from experience.

IMVE: You say you don't focus on any specific market sector. Why is that?

RR: I've always loved a good challenge. Not everything I do is pure machine vision. It really depends on what the customer needs. That might mean consulting on additional security requirements, running analytics to understand why something is failing or passing, or helping them get to the root of an underlying process problem. Keeping things broad like that means I get to work on interesting problems across different industries. And I tend to follow the interesting problems rather than track market verticals.

That being said, there's clearly a lot of activity around automation in logistics and warehousing, and quality inspection in manufacturing continues to grow as companies look to reduce waste and improve consistency. The push toward embedded and edge processing is also opening up applications that weren't practical just a few years ago.

IMVE: What qualities in component vendors would you say make them most attractive to work with, and where can they improve as a whole?

RR: People like to do business with people they know and like, and I think that holds true with vendors. So keeping good relationships is essential. That means both sides being open and responsive, helping answer questions and being part of a project when a product is used. Not having to chase for information or quotes is definitely a plus.

> "It's easy to think you just plug in a camera and the software knows what to do, but AI can't read minds quite yet"

Since speaking to more people outside the industry, I've noticed that some concepts (GigE, GenICam) are very specific to machine vision and aren't well known in open-source communities. There's an opportunity for vendors to help bridge that gap, whether through better documentation, more accessible SDKs (software development kits) or supporting design decisions early in a project.

Vendor SDKs are typically free, but they often lock you into that vendor's cameras, making it harder to swap components later.

IMVE: As a sole trader, how do you market yourself? Where do you find new business opportunities?

RR: All my projects come through people I've worked with before. That goes with what I was saying earlier about the importance of good relationships. I go out to exhibitions specifically to meet people and catch up with vendors. And it's always great to see what's being developed.

I'll need to do more deliberate outreach at some point, I'm sure, but I prefer the organic approach. Word of mouth and reputation carry a lot of weight in this industry.

IMVE: How competitive is the market right now? Is there a need to differentiate yourself from the competition?

RR: There's a real skills shortage in manufacturing right now, so I think there are plenty of opportunities out there. I don't mind taking on smaller projects. Some companies are only interested in larger integration jobs, so that leaves a gap. Being a smaller operation means I can be more flexible and give clients direct access to the person actually doing the work. Larger integrators can't always offer that. IMVE

visionaries

‘I can build that in a week, I thought. Boy, was I wrong!’

Full-time aerospace engineer and part-time bedroom creator **Arpan Mondal** (left) tells **James Wormald** how he built a drum kit without the drums. He explains why he shifted from sensors to computer vision to make air drums a reality, and what it takes to turn bold DIY ideas into working tech

Imaging & Machine Vision Europe: Tell us about yourself and the work you do.
Arpan Mondal: By day, I am employed as an aerospace engineer working in AI research and development at a firm in India. But, by night, I’m an avid maker and the person behind the do-it-yourself YouTube channel Makestreme.

My passion lies in blending art and creativity with technology to build fun, useful and out-of-the-box projects. I like to design devices that feel intuitive rather than just functional. For example, instead of building a standard digital monitor to track my room’s air quality and temperature, I built Gus: a smart desktop robot that processes the environmental data, but also communicates it back to me through physical emotions rather than numbers on a screen.

I love finding new ways to bridge the gap between complex hardware and the human experience.

IMVE: And one of these projects was Space Drums, where you integrated computer vision to realise a working set of ‘air drumsticks’. How did that project start and how do the drumsticks work?
AM: That’s right, Space Drums are a pair of smart ‘air drumsticks’ that let you play a full virtual drum kit using just the sticks and a smartphone camera. The project started because of a lifelong habit: whenever I see cool tech, instead of buying it, I try to build it myself. I saw a video of some commercial air drums online and my first thought was, ‘I could build that in a week’. Boy, was I wrong!

At its core, the hardware is fairly simple. I put custom circuit boards with accelerometers and gyroscopes inside the sticks.

When you swing in the air, the accelerometer detects the sudden stop of the ‘hit’ and instantly fires off a drum sound.

IMVE: So, computer vision wasn’t part of your original plan?
AM: Not at all! Originally, the plan was to rely entirely on the hardware sensors. I wanted to use the accelerometers to detect the hits and the gyroscopes to detect the orientation of the sticks to figure out which drum I was hitting. But during prototyping, I realised the gyroscope started drifting within the first minute of continuous play.

Microscopic math errors would build up, and my virtual drum kit would slowly rotate away from me. I spent a month trying to fix it, but it was unplayable. So, eventually, I pivoted to computer vision and used OpenCV and Python to track my wrist positions instead. >

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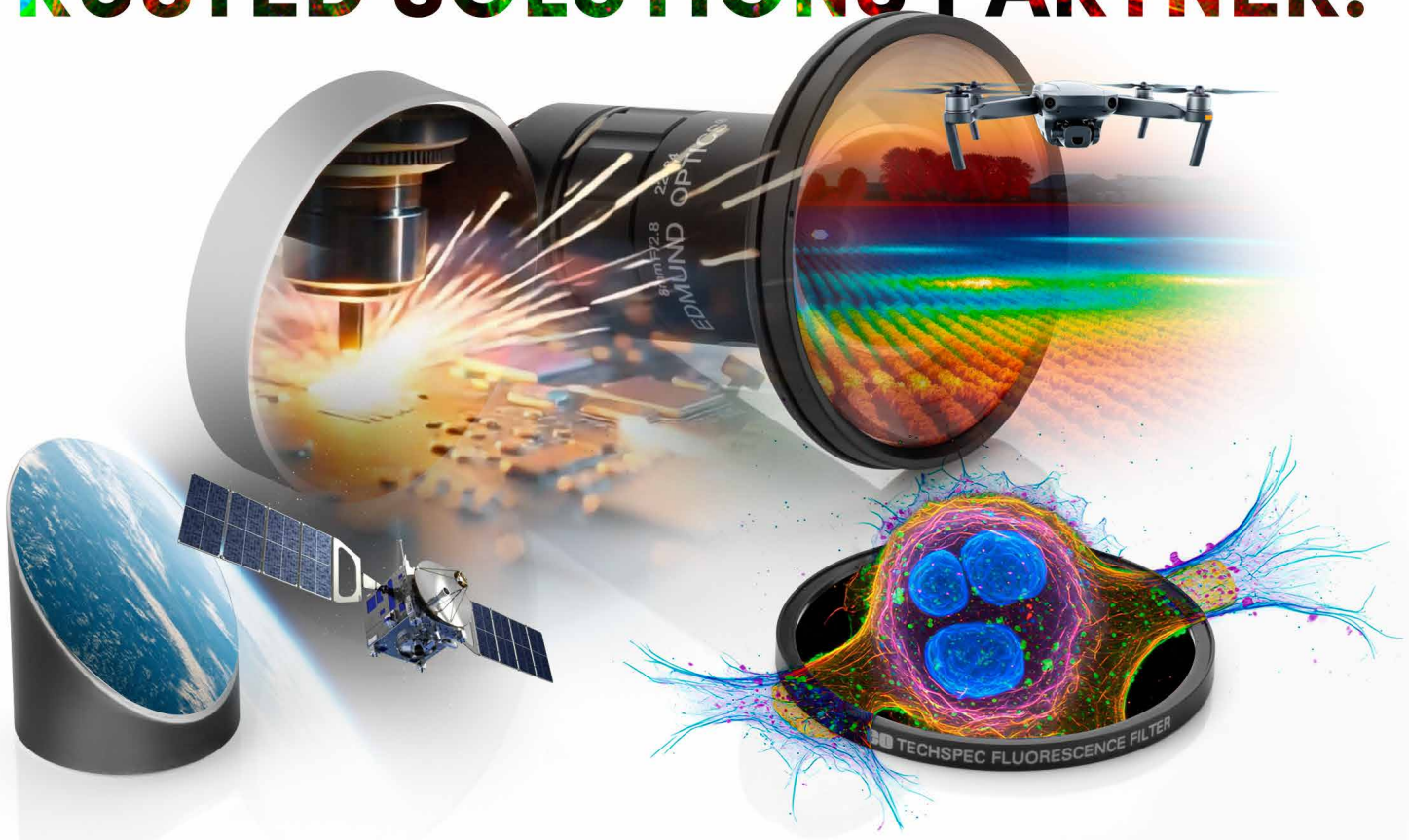

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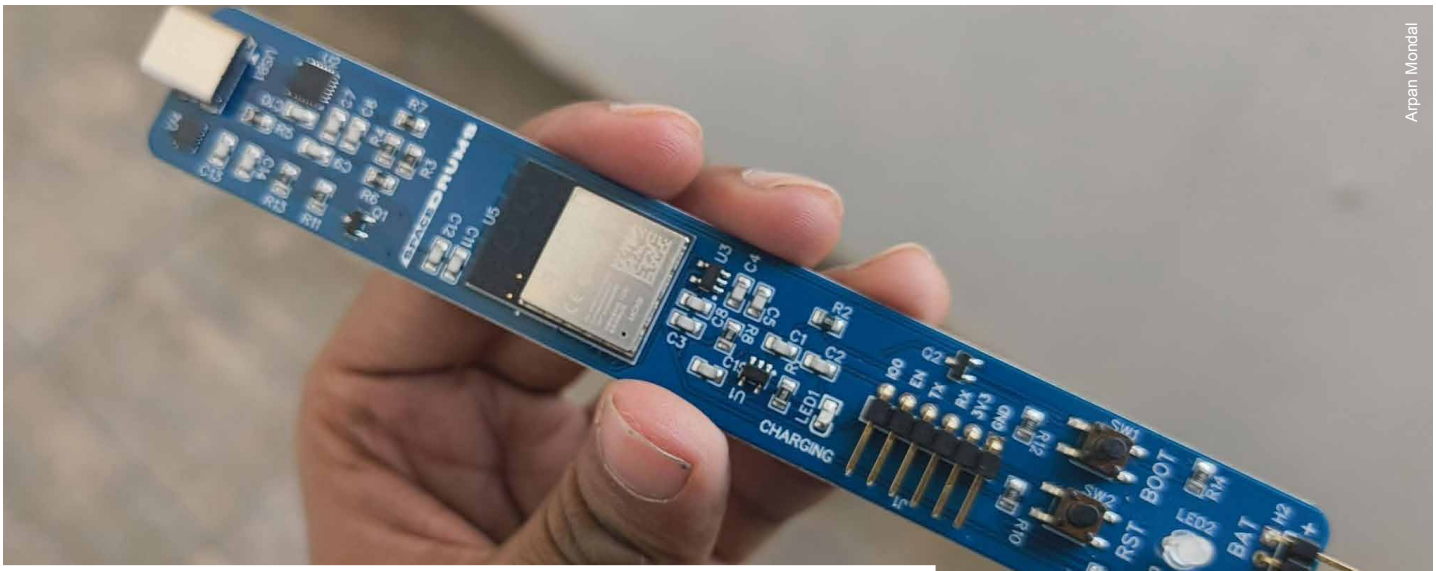

As an independent maker, Arpan designed custom PCBs using EasyEDA and had them delivered

The finished V1.0 Space Drums sticks

> **IMVE: And this worked much better?**

AM: Absolutely! Computer vision anchors the invisible drum kit directly to the user's body. Hardware sensors only understand relative movement; they don't know where 'forward' actually is in the real world and need constant calibration. With computer vision, the camera acts as an absolute reference point. The open source MediaPipe library by Google maps my shoulders and wrists, so the snare drum is always perfectly centred in front of my body, even if I'm not perfectly aligned with the camera angle. It eliminated the frustrating drift problem and made the invisible drums feel like they actually existed in the room with me.

IMVE: Were there any issues you faced when attempting to integrate vision into the solution? And how did you overcome them?

AM: There were many problems, but the biggest hurdle by far was latency. Google's MediaPipe model needs a few milliseconds to process the video frame and map the coordinates of my shoulders and wrists. Because of that, the drum sound would trigger a split second after my physical swing. I'm not a professional drummer, but even a tiny delay can destroy the rhythm of an amateur or professional.

To fix this, I wrote what I call a 'time machine' algorithm. Instead of waiting for the camera to confirm where the stick is, the code analyses the current motion trajectory and predicts where the stick will land a few milliseconds in the future.

This, effectively, cancels out the vision model's processing delay. It is not perfect, but it made the virtual kit quite snappy and much more playable.

IMVE: Were there specific vision components you needed to acquire to build the prototype, and how did you decide where to get them from?

AM: For the first prototype, the core hardware requirement was a reliable IMU (inertial measurement unit). Standard consumer-grade IMUs are incredibly easy to source, which is great for initial prototyping, but, after battling the issues with gyroscope drift and the occasional false hit, I realised that cheap sensors have their limits. I started researching the advanced IMUs used in high-end VR headsets with built-in sensor fusion and much higher accuracy.

But, as an independent, self-funded maker building these projects on nights and weekends, acquiring industrial-grade components is a major financial hurdle.

I'm currently planning to build Space Drums V2.0 around these higher-end sensors and I am actively looking for hardware partners or sponsors to help support the project.

IMVE: What do you think vendors could do to better support independent makers on these types of projects?

AM: I think the biggest hurdle is accessibility. Getting your hands on cutting-edge vision tech or advanced IMUs often requires signing NDAs, buying expensive developer

> "Instead of waiting for the camera to confirm where the stick is, the code... predicts where the stick will land a few milliseconds in the future"

boards or committing to massive minimum order quantities.

It would be amazing if more vendors offered 'maker tiers'. Subsidised dev kits or hardware seeding programmes specifically for independent creators doing weird, out-of-the-box R&D.

Furthermore, pairing that hardware with strong, open-source libraries for Python or Arduino, rather than locked-down enterprise software, makes a big difference.

IMVE: How easy is it to work with these open-source libraries to realise a project?

AM: I've been building DIY hardware projects for more than eight years now, and working with open-source software has never been easier.

The community is more active than ever, and the rise of AI assistants such as Gemini and Claude is definitely an advantage.

In the past, hitting a roadblock with a library such as OpenCV or MediaPipe meant spending hours digging through forums and dense documentation.

Today, these AI tools can instantly search the web for community discussions and guide you in the right direction.

IMVE: What does Space Drums' future look like long-term?

AM: I've already started the research for V2.0, but my ultimate goal is to make it a completely seamless plug-and-play system. A user shouldn't have to worry about complex calibrations, perfect camera angles or readjusting for drift mid-song.

I also plan to add velocity sensitivity, so hitting the 'drum' harder makes it sound louder, and haptic feedback. To achieve this, I'll definitely need those higher-end sensors and reliable documentation.

As for commercialisation, I don't have any plans to sell a consumer version. I intend to keep the project fully open-source so the maker community and I can continue to build on it and learn from how it evolves.

IMVE: Alongside Space Drums, then, what's next for Arpan Mondal?

AM: I am always tinkering with something new. Right now I'm building a smart telescope. My background is in aerospace engineering, so I have a massive passion for space and astronomy.

Naturally, instead of buying an expensive commercial set-up, I decided to build one from scratch.

I'm designing it to be equipped with gyroscopes and a digital image sensor. Because the receiver is digital, I could use computer vision as a sort of 'digital co-pilot' to compensate for the lack of motors.

For example, I'm looking to implement a digital tracking system, where it locks onto a drifting planet and digitally crops and shifts the live feed to keep it centred on my screen.

Another use for computer vision could be to clean up the images. When looking through a telescope, the Earth's atmosphere boils and blurs the image. I could write a script that watches the live feed, grades every frame for sharpness, throws away the blurry ones and automatically stacks the clear ones in real-time.

It is going to be a fun challenge.

IMVE: How easy do you think it is for others to do what you do? To have an idea and just go out (or stay in) and build it.

AM: I love this question. To anyone out there wanting to build something, I can honestly say it is easier now than ever before. Focus on how incredibly fun the end result will be, rather than getting overwhelmed by the complexities of the journey.

Will the process be easy? Not always. But every time you overcome a technical hurdle, you level up your skills and gain the confidence to tackle even bigger ideas.

With today's vast open-source communities and AI assistants, you are never truly building alone.

So, don't overthink the roadblocks, just clear some space on your workbench, pick a project and get started! **IMVE**

acp systems

visionaries

How to compensate for shrinkage with sub-mm vision-guided precision

Thomas Lang (left), of acp systems, tells **James Wormald** how vision-guided robotics compensates for carrier tolerances and cooling shrinkage to reach ±0.1mm accuracy in wafer handling

Imaging & Machine Vision Europe: Tell us about acp systems' work as an integrator of machine vision. How do you include imaging components in your solutions?
Thomas Lang: acp systems operates in advanced clean production, related process automation and system integration. Our core technologies are snow jet cleaning with quattroClean and powerSnow technology, micro-dispensing and automation solutions, especially smart handling. As most of our automation solutions are highly customised, the imaging components integrated in the applications depend on each client's use case.

IMVE: Take us through a use case where you've applied imaging technology in an innovative way, and what was the outcome?
TL: We are using fully integrated, highly flexible sensory camera monitoring, for example for automated positioning and calibration. These vision-guided solutions enable adaptable, integrated systems for precise monitoring and documentation of motion control in automated production lines. Tool and workpiece movements are processed to provide real-time position data for automated handling and quality control.

In a recent project for loading and unloading workpiece carriers containing wafers of different sizes in an automated process prior to PECVD (plasma-enhanced chemical vapour deposition) coating, acp systems has developed a robotic solution aided by image processing for a leading manufacturer of space solar technology. It ensures that the positioning accuracy of +/- 0.1mm in the nests of the workpiece carriers is met, and that both the manufacturing tolerances of the carriers and their shrinkage caused by cooling during loading are compensated for.

IMVE: What range and types of optical components do you buy, and how do you select the right ones dependent on the project or product you're working on?
TL: In our automation projects, we are using optical components ranging from optical vision sensors used for detecting presence, position, distance, colour or surface characteristics, to optical inspection systems that use cameras and image processing to detect defects in parts and components. Vision-guided systems are also implemented for object recognition, alignment and quality control. Choosing the suitable components is always one of the main challenges within a specific project.

IMVE: What about the challenges involved in sourcing them? What are your main pain points, and what can vendors do to better support you through them?
TL: When sourcing vision components, we require high flexibility from vendors, especially during production line design

and in the suitability of vision components regarding product characteristics and changing product requirements.

IMVE: How do you differentiate yourselves from your competitors?
TL: High purity and technical cleanliness play a major role in modern automated production scenarios, and where we have the in-house knowledge to do so, we integrate highly specialised processes, such as CO^2 cleaning, into existing production lines.

The combination of mechanics, software and image processing is central to modern automation, especially in precise handling processes. The material handling of complex substrates and flexible materials (foils), and their reliable processing, is also a demanding field that requires know-how in mechanics, sensors and process control.

In addition, we have strong relationships in the R&D community, working with leading organisations, institutes and universities to advance and develop technologies.

IMVE: How important is the quality of the components to your clients? Where does it sit on their list of priorities?
TL: When a client, typically a production company for high quality products and solutions, purchases equipment from us, the quality of components is a top priority, often ranked above cost and speed of delivery. Precision engineering, reliability and adherence to quality standards, especially in industrial automation, play a key role for us and our clients.

IMVE: When working with new clients, how do you deal with expectation management in terms of what a vision system can (or can't) do? Can you give any examples of mismatches you've encountered in this area and how you overcame them?
TL: Vision systems are very specialised tools which you can use in various areas, but which system serves the solution best will always depend on the use case.
For every practical use case, specialist knowledge needs to be applied (and it often) comes down to experience and know-how when to implement a suitable, effective and efficient solution.

IMVE: Where do you usually find new business opportunities?
TL: Due to financial restrictions, our presence online and on social media is very important for us, as well as offline channels. More and more buyers are doing their first research without getting actively in contact with potential partners or vendors.

National and international trade fairs, however, are still an important source for new business opportunities for us, as active networking and partnering within our ecosystem is even more relevant.

IMVE: What do you think your biggest challenge will be over the next 12 months?
TL: The current global climate poses multi-faceted challenges, from a reluctance to invest, technology adoption and cybersecurity threats to skill shortages and supply chain disruptions.

IMVE: Which sectors are showing the most growth in machine vision, and why do you think this is?
TL: Miniaturisation, increased quality and technical cleanliness standards and autonomous applications are all driving growth in this sector, especially when it comes to industrial automation and industries such as micro-electronics and semiconductors. Automotive and life science industries also have various areas where machine vision is applied. Selective cleaning applications based on AI-trained systems may have a major role in future.

IMVE: Tell us about your engagement in these areas and how mature your involvement is.
TL: These are the industries we have been working with since our foundation in 1997, and where we have good working relationships. **IMVE**

"We can deliver a fully automated and repeatable wafer-scale optical test solution"

In December 2025, US semiconductor test and measurement supplier FormFactor acquired German start-up Keystone Photonics to integrate its optical probing technology into production test platforms. EPIC's **Lidia Briquets** spoke to FormFactor **CEO Philipp Dietrich** alongside **Kainoa Kekahuna**, a Development Manager at Keystone, about the acquisition

Lidia Briquets: What was the motivation behind the acquisition?

Philipp Dietrich: For us, the motivation was mostly because our end customers – primarily silicon photonics device makers and foundries – are under strong pressure to scale quickly because the underlying markets of AI, cloud and telecom are moving from R&D to high-volume deployment.

Right now, testing is one of the main bottlenecks for scaling photonics. On our own, we had limited manufacturing scale, long qualification cycles and a small customer base.

By joining FormFactor, we've been able to embed our technology into production-grade test systems and gain access to high-volume semiconductor customers.

From an industry perspective, the acquisition is a clear indication that people want photonics in volume and that photonics is transitioning from being semiconductors' little brother to become an important part of today's semiconductors industry.

Kainoa Kekahuna: We began engaging with Keystone as our customers were moving towards edge coupling. It was a relatively new thing, especially on wafer.

We had some other products that we had tried to adapt, but there were quite a few limitations as they were high loss, difficult to install and calibrate, and very sensitive.

Then, we heard about Keystone. Its technology provided a highly differentiated solution for low-loss, repeatable optical coupling on edge-coupled wafers.

Integrating these capabilities into FormFactor's semiconductor test platforms enables customers to move more efficiently toward scalable silicon photonics manufacturing.

LB: How important was the increasing demand for AI and high performance computing as a motivational factor?

PD: The rise of AI and HPC demand was a central motivating force, because it accelerates the need for scalable silicon photonics, and our technology could address one of the main manufacturing challenges – how to test photonic chips quickly and accurately before packaging.

Kainoa Kekahuna (left) and CEO Philipp Dietrich

KK: Demand driven by AI and HPC is accelerating the transition from purely electrical interconnects toward optical architectures. As a leader in semiconductor test and measurement, FormFactor saw a strong opportunity to expand its capabilities in optical probing to support the next generation of AI infrastructure.

LB: How do your technologies complement each other?

PD: FormFactor's roots are in electrical testing. They have built amazing probe cards that have more than 100,000 needles – but these needles test electrons, not photons. Keystone provides the optical interface that enables FormFactor to access photonics.

KK: By combining FormFactor's expertise in precision automation, alignment and calibration with Keystone's micro-optical probes, we can deliver a fully automated and repeatable wafer-scale optical test solution that supports higher throughput and manufacturing scalability for customers.

LB: What challenges do companies face moving from R&D to mass production?

KK: Customers moving toward high-volume manufacturing require proven and repeatable test infrastructure.

FormFactor's Triton platform was developed to address this need by providing a fully automated, production-grade silicon photonics wafer test solution.

Again, Keystone integrates very closely, both on the R&D side and also in the production space for the Triton platform.

LB: How important is training in implementing these integrated solutions?

KK: Absolutely critical. Typically, we send engineers along with the installation team so we can verify the performance of the system as it's installed. We then work very closely with the customer over the next three-to-four days, deep diving into everything from how to install, how to calibrate, how to perform a measurement on their wafer or their device, how to set up automation and so on.

This close collaboration is an important part of how FormFactor supports customers during deployment and production ramp-up.

Keystone Photonics

Following the acquisition, Keystone has maintained its base of operations in Karlsruhe to continue its work on optical probing and wafer-level testing

LB: What are the main challenges in scaling production?

PD: One of the key challenges is to considerably decrease the cost of testing, which goes hand in hand with increasing throughput. Second, the photonic production cycles involves several insertions, i.e., taking the wafer out of the process flow for test or measurement and then returning it to processing. The challenge here is to provide test technology that works consistently at every insertion point, not just one step.

Another challenge is speed in that we will need to respond quickly to sudden changes in customer requirements from a low level of activity to a massive increase in production volume.

KK: Regarding edge-coupled measurements on wafer, the challenge is to very accurately place the fibres into the trenches. Fortunately, Keystone's technology, along with our Pharos fiducial, a magnetically detectable reference marker used for alignment, allows us to do this.

Another key challenge is repeatability of measurement. And again, Keystone's micro-optical lenses allow for this.

LB: How will your locations in different continents affect future collaboration?

PD: FormFactor has a long history of having commercial and R&D activities in Germany and the US. Keystone is used to working between these two countries, so I think we can certainly cover FormFactor's presence in the US.

Additionally, as Europe is in the centre of the overall global value chain, we are in a good position to address other markets around the world, particularly China.

KK: We have service centres, engineers, salespeople in Europe, Japan, Korea, Taiwan, China, as well as the US. Our customers, both in and outside Europe, increasingly understand the importance of addressing global markets, particularly the US. As a result, we're seeing more cross-regional collaboration, knowledge sharing, and a broader range of technical and manufacturing challenges that need to be addressed at a global scale.

LB: What impact would you like the acquisition to have over the next five years?

PD: Although the acquisition was a little more than three months ago, I think we've made tremendous progress. I'm impressed and very happy to work with FormFactor – it's really been very positive and I hope this continues.

What we want to achieve jointly is to unleash the photonics industry to engage in real volume production because this will improve many people's lives. Also, importantly, we will do this without disadvantaging current Keystone customers.

Of course, this is the first step and we have a lot of work to do. While it may not be an answer to all of the industry's problems, what we have is high volume ready that we believe will provide the market with extremely powerful technologies.

KK: I'd echo Philipp's answer, it's a very positive experience. What excites us most is the opportunity to help accelerate the adoption of silicon photonics in high-volume applications. As production scales, we expect these technologies to deliver tangible benefits across AI, cloud and communications infrastructure.

LB: What's your advice for a company thinking about a merger or acquisition?

PD: If you start a company without the intention of engaging in M&As, and then someday suddenly go in that direction, you will encounter a lot of difficulties. My advice, therefore, is to think about what you want to achieve from day one of establishing the company and be very clear and involve employees and stakeholders.

It's also essential to have a vision of what you want to achieve with an acquisition. FormFactor and Keystone have this vision and it's very well aligned. For this reason, we both believe the acquisition was a very good idea and we're very positive on executing it.

KK: One thing that has really made the transition a success so far is the fact that we've worked closely together for quite some time. We understand each other's customers and how to adapt well with one another. So, this acquisition has felt like a natural next step because of the strong alignment between our technologies, customers and long-term industry goals. **IMVE**

FormFactor

FormFactor operates advanced cleanroom facilities worldwide to manufacture, test and repair high-performance semiconductor probe cards

A-Z of key suppliers

Our pick of the companies involved in the provision of vision-related products and services

www.imveurope.com/suppliers

Allied Vision,
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Allied Vision brings machine vision technologies together into one integrated ecosystem. The product portfolio ranges from line scan and area scan cameras to lenses and frame grabbers, and from image processing libraries to IP cores – designed to work together from the start across the entire machine vision workflow. As a trusted partner with a global network of experts and local support, Allied Vision stands by its customers and partners, making collaboration as easy and reliable as possible. Thanks to the integrated 'one-stop-shop' ecosystem, customers benefit from reduced integration effort and faster application deployment. Allied Vision is part of the Machine Vision division of the TKH Group. It covers the following industries: agriculture and food, life sciences, logistics, manufacturing, security and defence, sports and entertainment, and traffic and transport.

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AP Technologies offers optoelectronic solutions for machine vision, 3D sensing and automation, including 3D vision cameras and time-of-flight sensors using both indirect and direct ToF technologies. Its team provides the technical expertise to help businesses select, integrate and optimise the right solution, from concept to production. Solutions include:

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Effilux specialises in designing, manufacturing and selling powerful, flexible and easy-to-use LED lighting solutions for machine vision, quality control, scientific imaging, biomedical, optical measuring devices, and many other applications. It was established in 2009, when three graduates and a researcher specialising in optics decided to create a start-up to offer innovative machine vision lighting. With an in-depth know-how in optics and a strong passion for creating flexible and easy-to-use lightings, Effilux has been transforming and expanding rapidly over the past decade. Quality is of utmost importance at the company, and it is committed to providing reliable products to meet its customers' requirements. All its lighting follows stringent standards and tests at every stage of product development and production, ensuring it delivers top-quality products and solutions to its customers.

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Exosens is a high-tech company, with more than 85 years of experience in the innovation, development, manufacture and sale of high-end electro-optical technologies in the field of amplification, detection and imaging. Today, it offers its customers detection components and solutions such as advanced cameras, travelling wave tubes, neutron and gamma detectors, instrument detectors and light intensifier tubes. This allows Exosens to respond to complex issues in extremely demanding environments by offering tailor-made solutions to its customers. Thanks to its sustained investments, Exosens is internationally recognised as a major innovator in optoelectronics, with production and R&D carried out on several sites in Europe and North America and with more than 2,000 employees.

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Nortech Systems Incorporated, based in Maple Grove, Minn., is a full-service electronics manufacturing services (EMS) provider of wire and cable assemblies, printed circuit board assemblies, and higher-level complete box build assemblies for a wide range of industries. Markets served include industrial equipment, aerospace/defence and medical. The company has operations in the USA, Latin America and Asia. Nortech Systems Incorporated is traded on the NASDAQ Stock Market under the symbol NSYS.

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Opto Engineering designs and manufactures optics, industrial cameras, lighting and software for advanced machine vision applications. With nearly 25 years of experience, it develops innovative, reliable and cost-effective technologies, providing customers with well-documented products and comprehensive technical support. Its strong focus on research and innovation, together with collaborations with universities and research institutions, has led to a broad portfolio of patented and distinctive technologies. From advanced optical systems to cutting-edge software, its solutions are designed to meet the specific needs of a wide range of industries and help customers achieve their goals with confidence.

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Teledyne DALSA is part of Teledyne's Vision Solutions group and a leader in the design, manufacture and deployment of digital imaging components for the machine vision market. Teledyne DALSA image sensors, cameras, smart cameras, frame grabbers, software and vision solutions are used in thousands of automated inspection systems around the world and across multiple industries including semiconductor, solar cell, flat panel display, electronics, automotive, medical, packaging and general manufacturing.

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Pleora Technologies helps organisations build, deploy and scale high-performance imaging and sensor systems for machine vision, medical imaging, defence and industrial automation applications. Its hardware, software and embedded solutions simplify the integration, transport, synchronisation and processing of image and sensor data across Ethernet and USB 3.0 networks. By enabling standards-based connectivity and interoperability, Pleora reduces development complexity, lowers integration risk and accelerates time-to-market. Customers use Pleora technology to connect cameras, sensors, and edge processing platforms into reliable systems that support inspection, automation, situational awareness and real-time decision-making.

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