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Winter 2025

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Leaving the factory floor: the AI-assisted embedded vision tech headed to your home

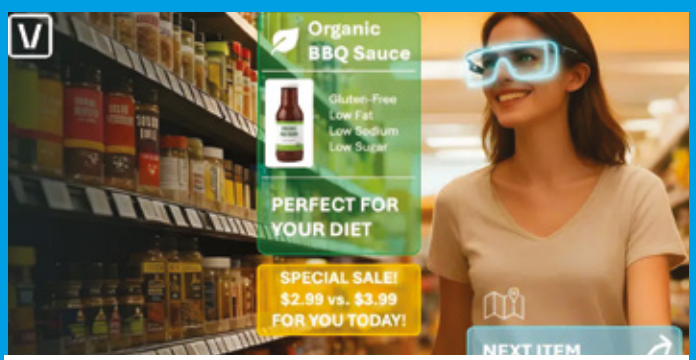
Across retail, logistics, healthcare and navigation, intuitive assistants based on embedded vision are emerging to guide, support and protect everyday users. **James Wormald** reports

For years, machine vision lived in specialist domains: factory floors, research labs, high-end inspection rigs and controlled industrial lines. It was the kind of technology only professional engineers, trained operators or computer-controlled systems themselves interacted with directly.

Although the use of machine vision for industrial automation is stronger than ever, a new generation of user-friendly vision-enabled systems is emerging, designed not for expert technicians, but for shoppers, patients, delivery drivers and anyone looking for improved eye-level information-led experiences.

Embedded vision is becoming something anyone can use without training and, often, without even thinking about it.

These developments signal a profound expansion in the imaging sector. Cameras now pair with edge AI, spatial modelling and natural-language understanding to assist people as they make decisions, navigate complex spaces, perform physical tasks or rehabilitate from injury. Machine vision, in effect, is learning to meet humans where they are, in real time and in real environments.



Vusion Group's EdgeSense AI allows product information to jump off retailers' shelves and into consumers' field of view

Retail shelves designed to see and be seen

Retailing is a space where this transformation is at its most visible. VusionGroup's recently developed EdgeSense AI system, for example, turns physical stores into what the company calls "AI-native environments", merging 3D locationing, computer vision and language models to give store shelves signage and infrastructure – a form of spatial intelligence that allows them to directly interact with shoppers and staff.

"With EdgeSense AI, we are making the physical world natively intelligent," said Roy Horgan, SEVP Strategy, Marketing & Communications at VusionGroup. "For years, AI has lived in the cloud. Today, it's becoming spatial, embodied and present, capable of understanding the context of every interaction inside the store."

Shoppers can ask the system questions such as "where's my favourite pasta?" and receive guidance to the exact aisle and shelf, along with recipe suggestions and personalised offers.

What began as electronic shelf labels has evolved into a dense, connected sensing grid spanning tens of millions of digital nodes. This network functions as a constantly updated spatial map that AI systems can tap into, forming a real-time digital twin of the store.

"LLMs, smart glasses and autonomous agents all need to understand where things are and what's happening around them," said Andreas Rössl, Group CTO of VusionGroup. "EdgeSense provides that layer, a precise, living data grid for the physical world."

Combining on-edge sensing, spatial context, edge compute and natural language, the application's development gives engineers and integrators good reason to add computer vision to their shopping list.

Honeywell's CT70 is a handheld device that combines computer vision and agentic AI

Forward-looking retail with glasses that guide deliveries

It's hard to discuss digital innovation in the retail landscape over the past 20 years without mentioning Amazon. And although online delivery services can't use machine vision to improve in-store experiences, it can be used to ensure packages reach us even quicker and more easily. Bringing machine vision into the wild, Amazon has provided some of its delivery drivers, or delivery associates (DAs), with smart glasses that combine AR, AI and embedded cameras to make improvements to last-mile logistics. Activating as soon as a DA parks a vehicle, the glasses help to locate

Amazon's smart glasses offer an AR map view, directing drivers to the recipient's door on foot

The system is completed by a vest that includes operational controls, a swappable battery and an emergency button

the right package before directing them straight to its recipient's front door and verifying the delivery, without the need to use a phone.

"The smart delivery glasses leverage AI-powered sensing capabilities and computer vision, along with cameras to create a heads-up display that includes everything from navigation details and hazards to delivery tasks," says Amazon, with driver feedback shaping the application's ergonomics, brightness and field-of-view priorities.

"I felt safer the whole time because the glasses (put) the info right in my field of view," said one DA tester. "Instead of having to look down at a phone, (I) can keep (my) eyes forward and look past the display."

Not being confined to controlled factory environments means the system needs to be able to work in all weathers, good and bad; in crowds; with pets and inside complex urban layouts. Meanwhile, from a user and customer point of view, vision assistance that supports users to navigate real-world uncertainty in real time means logistics can be performed faster, more safely and with fewer cognitive demands.

Navigation and safety for all, from research to real-world assistive tech

Another example shows how recent academic research is pushing the use of embedded machine vision further into universal accessibility. A team from the University of Isfahan has developed a panoptic segmentation model designed to help visually impaired users navigate environments safely. Unlike traditional methods that either detect objects or classify scene elements, this single-stage system integrates both to deliver a pixel-level understanding of the environment. It identifies obstacles, predicts safe paths and performs reliably in low-light and obstructed conditions.

The researchers report a Panoptic Quality improvement of 4.092 points compared with previous methods, which represents a meaningful gain for real-time applications. Crucially, the system is designed not for robotics labs, but for future wearable devices, emphasising speed, efficiency and a human-first interaction model. The work signals how cutting-edge segmentation research is converging toward practical and embedded assistive systems.

The workplace assistant that sees what you see

As one of the first sectors to integrate computer vision, industrial environments are not lagging behind either. Designed for frontline workers in sectors as diverse as logistics, retail and transportation, Honeywell's CT70 handheld computer combines machine vision, edge inference and language-enabled guidance into a rugged industrial tool. Equipped with Qualcomm's Dragonwing Q-6690 processor, which Qualcomm claims is the world's first enterprise mobile platform with fully integrated RFID, the device can scan, classify, identify and guide users through operational tasks and give real-time feedback.

The convergence of "next-generation mobile computers with machine vision and agentic AI" are delivering immediate productivity gains, said David Barker, President of Honeywell. Rather than relying on distant cloud analytics or manual workflows, CT70 performs inference at the edge, delivering faster decision support of visual inspection tasks, barcode capture, payment processing and RFID-enabled inventory workflows directly into workers' hands.

The device also introduces an AI assistant that workers can interact with via camera and natural-language inputs. Honeywell says the assistant can identify objects, highlight faults and guide troubleshooting steps visually and conversationally. In practical terms, it extends machine vision from a backend quality-assurance tool to a real-time guidance system for everyday operational decisions.

Wellness is in sight with home rehabilitation

Healthcare is experiencing a parallel evolution, with at-home camera-based systems supporting recovery outside the clinic. TailorCare's integration of Stabl's markerless motion-analysis platform exemplifies this shift. Using only a standard camera, the software analyses posture, joint angles and motion patterns in real time to guide patients through rehabilitation exercises at home.

This vision-guided physiotherapy model strips away the complexity historically associated with motion capture: no wearable sensors, no lab-grade hardware and no professional operator required. Instead, computer vision and biomechanical modelling run in the background while patients follow on-screen cues and correction prompts.

"This addition to our self-care offering represents a major step forward in our journey to build an industry-leading, integrated platform to support patients navigating and managing their MSK conditions," said Rachel Winokur, founder and CEO of TailorCare.

However, the system's goal is not just to capture the data. Ultimately, it hopes to improve recovery outcomes by increasing exercise accuracy and adherence. In essence, the computer vision-enabled system becomes a personal coach, transforming motion analysis from a specialised diagnostic tool into an accessible part of everyday wellbeing.

From automation to assistance

Across retail, rehabilitation, logistics, delivery and mobility support, the core narrative is the same: embedded vision is moving out of controlled settings and into everyday life. It is becoming conversational, wearable, context-aware and invisible in the best sense, disappearing into workflows rather than demanding its users learn new ones.

This marks a philosophical evolution for machine vision. The value of a system is no longer measured only in accuracy or throughput, but in how naturally it integrates into human activity and how effectively it enhances user capability.

The change will bring new challenges, along with new opportunities for imaging professionals, as designing for real users in real environments means embracing variability, prioritising ergonomics and creating hardware and user interfaces that serve human intuition.

As vision systems learn to support people in ordinary tasks such as finding pasta, performing physio, scanning parcels, delivering packages or navigating the streets safely, they cross a threshold. Machine vision, once confined to the world of industrial automation, is emerging as an everyday technology. **IMVE**

AWS, Nvidia and MassRobotics' Physical AI Fellowship puts vision at the heart of intelligent automation

The integration of robotics, artificial intelligence (AI) and machine vision is defining the next phase of intelligent automation, according to AWS. The company says this convergence, termed as Physical AI, represents a shift from digital-only intelligence to systems that "perceive, understand and manipulate the tangible world".

Alongside Nvidia and MassRobotics, AWS has launched the Physical AI Fellowship to provide support for start-ups developing robotic and automation technologies that bridge this digital-physical divide. The initiative aims to accelerate solutions that "fundamentally transform how enterprises operate across industries", said AWS in a blog statement.

While robotics and AI provide the intelligence and control, it is machine vision – or, more broadly, high-fidelity perception – that enables these systems to function in unstructured environments.

"High-fidelity perception models, powered by multimodal sensors," said AWS, "enable machines to interpret complex environments," and this focus on perception underscores the machine vision sector's critical role in the evolution of automation.

The inaugural cohort of Physical AI fellows includes eight companies working across a range of industrial sectors from manufacturing to agriculture:

- **Bedrock Robotics** retrofits existing construction machinery with autonomy through rapid hardware and software integration.
- **Blue Water Autonomy** develops uncrewed surface vessels combining sensors and AI for extended ocean operations.
- **Diligent Robotics** focuses on humanoid robots that interact with people in dynamic environments.
- **Generalist AI** is creating end-to-end foundation models to give robots dexterity and general-purpose intelligence.
- **RobCo** provides modular robotic hardware and a no-code interface for industrial tasks such as machine tending and welding.
- **Tutor Intelligence** develops AI-driven robots to deliver rapid ROI in manufacturing and warehouse automation.
- **Wandercraft** produces exoskeletons designed to restore walking ability for rehabilitation.
- **Zordi** applies AI and robotics to greenhouse agriculture.

Across these examples, robust visual sensing is essential for real-world interaction, from detecting human proximity in collaborative robots to navigating ocean environments autonomously.

From automation to adaptive intelligence

For organisations to evaluate and understand what they require from a physical AI-based system, AWS has outlined a four-level spectrum, ranging from basic automation to full autonomy. At the foundation level, robots execute predefined tasks in controlled stages. Stage 2 introduces adaptability and learning, capabilities that depend on accurate perception. Stage 3 is for systems that are tasked with "planning, executing and adapting tasks, with limited human input," relying on vision-guided feedback loops and multimodal sensing. And the highest level is fully autonomous physical AI, featuring systems capable of "multi-domain operations with minimal supervision".

Amazon's Vulcan Pick robot

AWS identifies several enabling technologies, including advanced control theory, edge AI accelerators and digital twin systems for simulation and validation.

Yet it is vision that forms the essential bridge between algorithmic reasoning and physical action.

Industry outlook and measured impact

According to AWS, the AI robotics market could reach $124bn by 2034, with digital twin technologies growing to $379bn. To support this, the company highlights tangible results already seen in automation, such as Amazon improving supply chain efficiency by 25%, Foxconn reducing deployment times by 40% and AI-assisted healthcare procedures achieving 30% fewer complications.

For the imaging community, these examples illustrate how perception-driven intelligence is becoming an operational differentiator. As the Physical AI Fellowship progresses, machine vision will remain the linchpin that connects digital intelligence to the physical world, enabling robots not just to act, but to truly see and understand their surroundings.

Vision systems help to power growth in warehouse automation

The global warehouse automation market is predicted to reach $91bn by 2034, a compound annual growth rate (CAGR) of 15.1% from 2025, according to a new report from Allied Market Research. The data suggests the surge is being fuelled by pressures from e-commerce expansion, labour shortages and the demand for faster, more accurate order processing – all of which can be eased by imaging, sensors and machine vision technologies. The report highlights how technologies such as automated storage and retrieval systems (AS/RS), robotics, AI and IoT are improving inventory management, space utilisation and operational efficiency.

Vision technology is at the core of automation

Imaging and machine vision systems underpin many of the market's key hardware categories – from sensors and scanners to robotics systems and picking and packing equipment. These technologies enable robots and conveyors to identify, locate and verify products with precision, providing the spatial and object data needed to handle complex logistics tasks. In high-density warehouses, vision-guided AS/RS platforms rely on 3D imaging, barcode reading and optical sensors to ensure accuracy and reduce downtime.

According to the Allied Market Research report, the AS/RS segment held the largest market share in 2024, accounting for nearly one-fifth of global revenue. Its strength lay in its ability to "optimise space utilisation, improve inventory accuracy and enhance picking speed".

Data-driven software growth

While data confirmed vision hardware remains essential, it also identified software integration as the fastest-growing area. The software segment, which includes warehouse management, control and execution systems, is projected to grow at 21.8% CAGR through 2034, reflecting the increasing demand for data-driven operations, real-time analytics and AI-enabled decision-making, often powered by imaging inputs that feed into digital twins or predictive models for warehouse management.

Dexory's record-breaking 45-foot-tall robot is capable of scanning 100,000 pallets a day

E-commerce and manufacturing lead adoption

The e-commerce sector accounted for more than half of the global warehouse automation market in 2024, and is projected to grow at 15.9% CAGR, the fastest among the segregated applications. Attributing this to the "continuous rise in online shopping, demand for faster deliveries and increasing adoption of automation technologies by e-commerce companies," the report predicts vision-based sorting systems, robotic arms with image-based object recognition and smart scanners will become increasingly common in fulfilment centres.

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Apple plans to buy Prompt AI for computer vision talent and tech

Apple is to acquire staff and technology from computer vision company Prompt AI, a start-up founded by researchers from UC Berkeley, beating Elon Musk to the deal, according to a CNBC report.

Founded in 2023 by Tete Xiao, PhD in computer science, and Trevor Darrell, Co-Founder of the Berkeley Artificial Intelligence Research (BAIR) Lab – a leading centre for visual recognition and deep learning – Prompt AI focuses on advanced computer vision applications.

According to the report, Apple is in "late-stage talks to acquire top talent" from the 11-person computer vision start-up, "as well as the company's technology". The deal would reportedly see some Prompt AI engineers join Apple, while those who do not will "be paid a reduced salary and encouraged to apply for open roles at the company".

Prompt's flagship application, Seemour, connects to home security cameras to enhance image recognition and scene understanding. The system "helps cameras detect specific people, pets and other animals or objects around a household, and sends alerts and text-based descriptions of unusual activity or answers questions about what's been happening in front of the camera".

But, despite its technical success, Prompt AI struggled to turn its vision technology into a sustainable business. Xiao told employees that "while Prompt AI's technology and the Seemour app were working well, the business model wasn't". The company now plans to retire the app, delete user data and protect user privacy.

Prompt raised $5m in seed funding in 2003 from investors including AIX and Abstract Ventures. Although they will get some of their money back, said the company's executives, "(they) will not be made whole" in the deal.

Other potential suitors including Elon Musk's xAI and Neuralink also approached Prompt AI, interested in the company, without anything materialising. For Apple, however, the acquisition would fit a pattern of small, targeted deals to acquire specialist teams and technologies. So far, the company has avoided large-scale mergers and, instead, used 'acquihires' as a strategy to strengthen its internal development, particularly in the areas of AI and computer vision.

Apple's corporate headquarters in Cupertino, California

Although the Apple Intelligence initiative for generative AI has faced delays and mixed reviews, its visual intelligence systems have achieved stronger results. The company's Vision Pro headset and iPhone camera already integrate advanced object and scene detection, for example, and these are areas that align closely with Prompt AI's research.

With Prompt expertise "likely to become part of Apple's HomeKit smart home division," reports CNBC, "the Seemour platform's capabilities could enhance Apple's home security device ecosystem".

And, although the move is relatively modest in relation to big money deals from Meta ($14.3bn for Scale AI), and Google ($2.4bn for Windsurf), if completed, it could mark another quiet strategic step in Apple's long-term effort to embed computer vision more deeply across its hardware and software platforms.

Virgin Media O2 adopts IQGeo's AI computer vision to increase network accuracy

Virgin Media O2 (VMO2) has begun deploying AI-powered computer vision technology from IQGeo to improve quality assurance and network data accuracy across its fibre infrastructure. The system applies automated visual verification to field work, helping engineers confirm that construction and maintenance tasks meet specification.

Developed by Deepomatic, a company recently acquired by IQGeo, the technology uses computer vision algorithms to analyse images captured in the field. Engineers photograph each completed task, such as laying ducts, splicing fibre or installing cabinets, using a smartphone app. IQGeo's AI then compares these images with the network's design data and verifies that the work matches the specification.

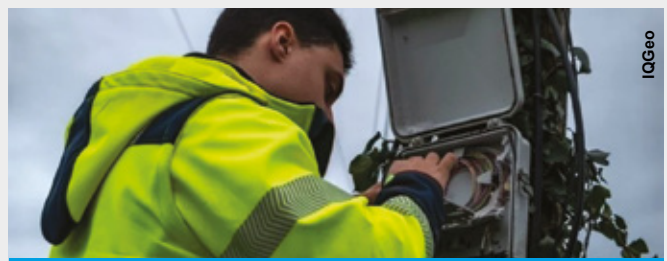
According to IQGeo, this visual validation is key to improving the accuracy of digital network records, which form the foundation for a "continuously accurate network digital twin".

The company says that by combining its AI analysis with its Network Manager Telecom software, VMO2 can automatically update network data with verified information in real time.

VMO2 hopes the integration will eliminate errors introduced by manual data entry or inconsistent contractor practices, both persistent issues during fibre roll-out.

"Inaccurate network data slows everything down, from fixing faults to connecting new customers," said Kerry Casey-Foulkes, Director of Transformation Enablement at VMO2. "With AI running real-time quality checks in the field, we can stop poor-quality data ever entering our systems, delivering faster, more reliable service and creating a stronger foundation for growth."

In environments such as this, where infrastructure work is dispersed and often subcontracted, the effect computer vision can have is particularly significant. By analysing images at the point of work, the system can flag deviations before they become service-affecting problems, such as a misaligned cabinet or missing splice, saving hours of troubleshooting and repeat visits.



IQGeo says its AI-powered network intelligence platform delivers real-time field data verification

"Poor network data quality is one of telecom's most pressing challenges," said Raf Meersman, SVP EMEA at IQGeo. "With AI, we're turning field data into an accurate, up-to-date picture of the network that operators can rely on. That's how you reduce churn and win new subscribers in a highly competitive market."

The technology also supports offline operation, allowing engineers to capture and verify data even when working in areas with limited connectivity. Once uploaded, these verified images become part of VMO2's digital twin, providing a visual record of each intervention that can be used for maintenance, training and auditing practices.

By embedding AI into network operations, VMO2 is creating a platform for more advanced automation and scalable operations. IQGeo's approach, blending geospatial intelligence with computer vision, reflects a broader trend in telecoms towards data-driven network management.

GenFeA: lowering barriers to machine vision integration

Generic Feature Access is a proposed standard programming interface for the configuration of machine vision devices. **Roman Moie,** a member of the EMVA's GenICam Working Group, explains its advantages

The Generic Feature Access (GenFeA) initiative aims to simplify implementation, reduce resource consumption and enable broader compatibility across embedded systems and heterogeneous device architectures. Initiated by the GenICam working group, GenFeA is tailored to the needs of the machine vision industry and addresses several long-standing requirements for using GenICam devices in a leaner and more efficient way. The GenICam standard is hosted by the European Machine Vision Association (EMVA).

Addressing practical challenges

GenFeA is designed to reduce the effort required to integrate machine vision devices into software systems. It offers several key advantages. Among these are lower entry barriers for vendors. Manufacturers with existing device APIs are able to participate in the GenICam ecosystem without the need to generate and maintain XML files.

This is particularly beneficial for companies entering the machine vision market from adjacent fields, such as embedded vision.

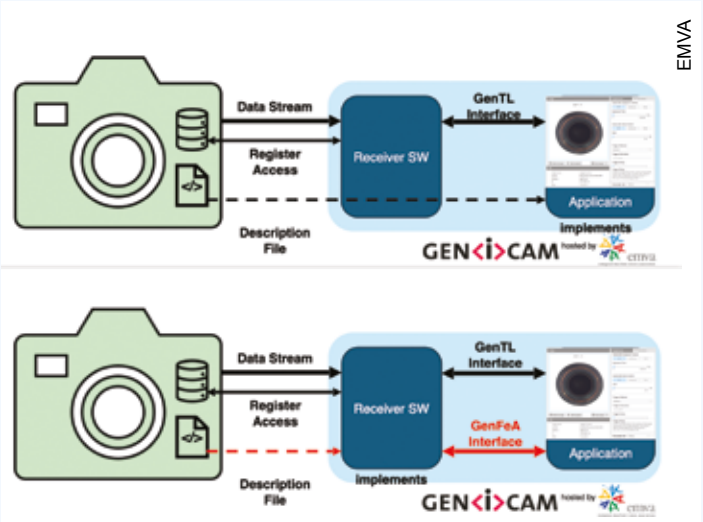
Furthermore, GenFeA enables simplified integration for software developers, as device configuration can be performed using a straightforward C-style API, similar to the GenTL interface already used for image transmission. This reduces the complexity of development and facilitates faster integration. In addition, the new GenICam module offers support for modular system architectures.

GenFeA enables the combination of components from different vendors, such as cameras, lens controllers and image signal processors, into a cohesive system. This modularity supports scalable and flexible solutions.

Finally, GenFeA proposes improved compatibility with emerging technologies. Devices such as embedded cameras or software-defined components can be more easily integrated into the GenICam ecosystem. This promotes innovation and broadens the scope of machine vision applications.

A flexible approach to feature access

By addressing all the challenges mentioned above, GenFeA introduces a more adaptable way of describing and accessing device features, as it focuses on the presence and behaviour of features, without prescribing implementation details; and supports both standardised and vendor-specific features. It also allows vendors to avoid XML parsing at runtime, while still supporting XML internally if preferred. By doing all this, it remains compatible with the GenICam Standard Feature Naming Convention, ensuring consistency across tools and interfaces. This approach makes GenFeA suitable for a wide range of applications, from lightweight embedded systems to complex industrial environments.



EMVA

GenFeA is designed to reduce the effort required to integrate machine vision devices into software systems

Implementation progress

To support adoption, the GenICam working group is developing a wrapper library called FeAForGenApi. This shared library exposes the GenFeA interface while internally relying on the existing GenICam reference implementation (GenApi). It provides access to the same functionality as GenApi, but through a simplified and more accessible interface.

This initial implementation offers a practical way to begin working with GenFeA. It allows developers to benefit from the new interface without needing to replace existing infrastructure.

Conclusion

GenFeA provides a structured and efficient solution to long-standing challenges in machine vision integration.

By reducing complexity and supporting modularity, it enables more streamlined development and broader adoption of machine vision technologies. For decision-makers, GenFeA represents an opportunity to enhance interoperability, reduce development overhead, and support innovation across a diverse range of platforms and industries.IMVE

Roman Moie is the Product Owner Hardware Integration at MVTec Software and a member of the EMVA's GenICam Working Group

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 tells **James Wormald** how democratising underwater data acquisition could help Hydrus save the coral reefs

Imaging & Machine Vision Europe: Tell me 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?
AM: 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

Hydrus AUV entering the water

Advanced Navigation

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 me more about the 3D models that are created. How are those used?

AM: 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?

AM: 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?

AM: 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?

AM: There are other competitor AUVs out

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

Hydrus with lights

there in the underwater data collection 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?

AM: 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?

AM: 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 wouldn'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 out in the field 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?

AM: 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?

AM: 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 like edge computing, then? And does being underwater make it harder to keep a stable connection to the device?

AM: 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?

AM: 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?

AM: 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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Vision AI for safer industrial vehicles

‘The number one priority is protecting people’

SICK’s vision expert Nathaniel Hofmann (right) speaks to **James Wormald** about the power of AI-integrated 3D stereo vision, and how it’s making outdoor automation safer

Imaging & Machine Vision Europe: Tell me about SICK’s Visionary AI-Assist. What is it and what applications can it be used for?

Nathaniel Hofmann: The Visionary AI Assist is a stereo vision camera with an in-built 2D colour camera and an industry-trained AI algorithm. We’ve travelled to the sites of our target customers, and captured image data of live people and scenarios of outdoor automation, then we run that on the device using a Halio AI chip.

The system provides driver assistance for instances of outdoor automation. It’s a warning system as opposed to a safety product, so it won’t take control of the vehicle. It’s very much aimed at the outdoor industrial automation sector, meaning large-scale construction vehicles, trains, agricultural vehicles, things like that. It’s designed to observe obstacles (including people) in a scene, and then to warn the driver.

IMVE: And what’s the market like for those kind of warning systems? What’s currently available and what does this camera do differently?

NH: Traditionally, lidar and radar is the technology that’s been used in these kinds of vehicle guidance and collision monitoring devices, certainly with SICK products. Lidar and radar are exceptionally good over longer distances, but, in terms of the actual area resolution you get on a particular surface, there are more effective technologies that give a view of the entire scene. You get a good idea of where the object is, but not what it is.

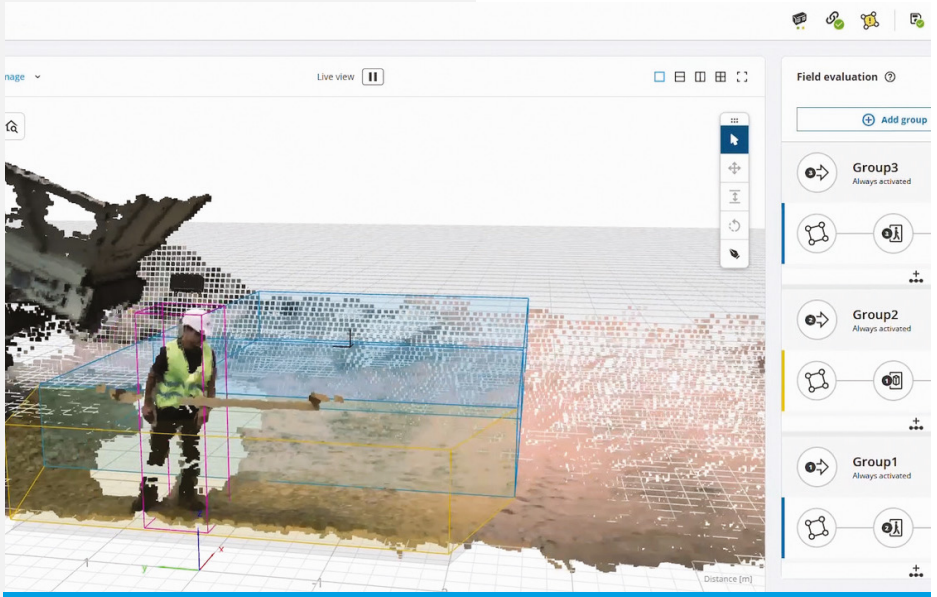
2D lidar is a single plane or layer, whereas our 3D lidar is up to 32 layers. That makes it a lot easier to differentiate between a tree and a person, for example, and you can get a lot closer to a tree without serious consequences, than you can a person. In fact, the ability to get close to people has become quite a key driver these days for many reasons.

3D lidar technology takes things to the next level because the system, and therefore a driver, is able to determine between a person and an object – such as a vehicle or a tree – and ultimately, there are a lot of safety concerns surrounding the protection of people in workplaces.

A 3D vision system takes it to an even higher level, as it covers the complete scene. Additionally, with the progression of autonomous vehicles, people are more used to camera-based systems

All images: SICK

SICK’s Visionary AI-Assist is designed to help protect workers from machinery in outdoor environments



The Visionary AI-Assist system

providing collision avoidance and warning. As I said before, this isn't a safety-rated device, it's an awareness device, but it still adds that extra level of accountability for employers to protect people in dangerous environments. It also protects the hardware, of course. Clearly the number one priority is the people, but protecting hardware from damage is still a key driver in the current market as a way to reduce costs.

IMVE: Were there any unexpected challenges you found you needed to overcome during the development or testing phases?

NH: We're aiming at the harsher end of the environment scale. Construction environments with big earth movers are quite extreme, so the major challenge was really a matter of gaining the technical reliability and repeatability we needed from a 3D vision system, while also coping with the vibrations, the shocks and the potential temperature extremes that it would have to work in.

Ultimately, making sure the embedded platform and whole camera platform reached the required IP69 rating [dust- and water-tight] along with standards for the shocks, vibrations and likely environmental conditions was a key factor we had to consider during development. The general construction of the device needed consideration, too. These things are going onto heavy plant equipment, so you don't want the mounting, the device's wiring or interfacing to shake loose.

Another consideration was that we had to implement the CAN (Controller Area Network) standard into the device. So rather than just a typical machine vision output, it had to have the CAN interface J1939, while still making sure it adhered to all the other standards and is ultimately a user-friendly product.

AI hardware and embedded platforms are improving on a regular basis, so we wanted to make it as powerful as possible, but also not continually waiting for the next platform generation. That meant we had to find a scalable, supportable hardware platform, and that was one of the reasons we went with a Halio chip.

We learnt a lot from how our traditional Visionary S stereo camera worked in these environments, so it was really just a case of upping the processing capability by adding the AI chip, and then physically adding robustness to the package.

IMVE: And have those development challenges been overcome and is it available and approved for use?

NH: Yes, we launched the product at the end of September and we're already working with a number of key global vehicle manufacturers that are using these devices and successfully testing them across temperature extremes, for both reliability and repeatability.

As SICK, we wouldn't put our name on a device that wasn't thoroughly tested in all environments, and met the relevant standards unless we were satisfied. So, the development was based on real-world testing, alongside the development of the software.

IMVE: You've mentioned the higher resolution advantages of 3D stereo vision as opposed to 2D lidar, but were there any other disadvantages you had to balance?

NH: As every use case is different it's hard to mention specific disadvantages. It will depend on what the right product is for each individual application. But, in general, stereo vision is actually inherently less millimetre-accurate than lidar, because light is more deterministic. But stereo vision has a much wider scope in terms of its level of coverage. You have a single layer with 2D, as I said, and you may have multiple layers with 3D, but with stereo vision every pixel has 3D distance data associated with it. So, while lidar may go further than the 65m maximum of this 3D stereo vision system, it's only looking in that single layer. With stereo vision you're getting the full scene in 3D, so you're getting more perspective and more objects within that scene.

If you think of a construction yard, you have overhanging items which you wouldn't necessarily see because they might fit in between one of the layers of the lidar, whereas stereo vision provides more complete coverage.

Another downside of stereo cameras over lidar is that you only have a limited →

> "3D lidar technology takes things to the next level because the system, and therefore a driver, is able to determine between a person and an object"

The Visionary AI-Assist system detects people and objects in dangerous positions near to moving vehicles

> "In the more harsh environments that we're looking to deploy [AI deep learning], sometimes you can't run it on the cloud. The ability to use local processing is essential"

angle. Typically, it's a maximum spread of 130°, whereas lidar is generally either 276° or 360°. So you don't get as much spread, but you do get much more coverage over that area, which is why, for backing up or for looking into a display, the user still gets the benefits of a 2D image, as well as the actual 3D object detection, so it's much more meaningful from a user's perspective.

If you think about when you park your car, it's easier to park if you have a camera that sees the whole scene, rather than just a sensor that tells you how close the sensor is getting to an object; you get a better overall impression of whether you can fit in a gap or if you're going to hit something with the tow bar because it's further out from where the sensor is. When you think about it from a user's perspective, we all like reversing cameras because they give us a visual representation. So for a user, having that 2D visual that you get from a stereoscopic camera adds to the additional data, and makes it a lot more user-friendly for someone not trained with machine vision.

IMVE: The system relies on on-device AI decision-making. How does this compare with cloud-based processors in terms of latency, reliability, power use, size and weight, etc. Where is the sweet spot between them?

NH: In this particular instance, we trained it in the cloud, then we deployed it locally on the device. So we used some of our cloud-based AI deep learning, but obviously in the more harsh environments that we're looking to deploy it in, sometimes you can't run it on the cloud. You could be in a mine, for example, where there's no signal, so the ability to use local processing is essential. To have a locally deployed solution was obvious because of the types of deployment.

With it being vehicle-mounted, power was also a key factor. It couldn't be battery-operated, of course, but at the same time it couldn't make an overall impact on the running of the vehicle, so it became about optimising power usage.

Ultimately, the onboard processing capabilities of the Halio chip were able to meet that requirement, and that's where advances in GPUs and CPUs are making cloud learning and local edge deployment a lot more flexible, because of the energy consumption.

IMVE: How adaptable is the system to varied or changing spaces and uses? How much relearning does it need to do in new environments, for example?

NH: We have worked on the product to make it the most flexible it can be with no relearning needed. Not only did we train it on a wide variety of industry-relevant image data, we've also had it working on construction sites and mines, etc. and we've included some normal, standard people, too, because you can't guarantee everyone's going to be wearing a high-vis jacket or hard hat when they should be.

Talking about different environments and different spaces, though, we've also had customers who have deployed the system as part of a security option, for the protection of sensitive areas and making sure the number of people in those sensitive areas is appropriate. There are possible applications where it's used not in a truly agricultural or industrial sense, and that's possible because of the quality of training data, and it would also be possible to work with customers on specific use cases that may not be in our standard training.

IMVE: Would you say automated machinery and systems are gaining more trust from employees who are tasked with working alongside them?

NH: This is where the technology and its applications starts to border on sociology. My opinion would be 'yes, you're 100% right'. The acceptance of AI in everyday use cases is certainly interesting, and it is making it more socially acceptable for people to use AI. Autonomous cars are a really good example of that. When you look at the accident rate of autonomous vehicles, it's almost negligible for the amount of miles they do without a problem.

However, when you look at other areas such as the medical or pharmaceutical industries, AI is accepted, but is still struggling to get through the legal hoops because of the black box decisions that AI can make, and this could be a problem in such a regulated industry.

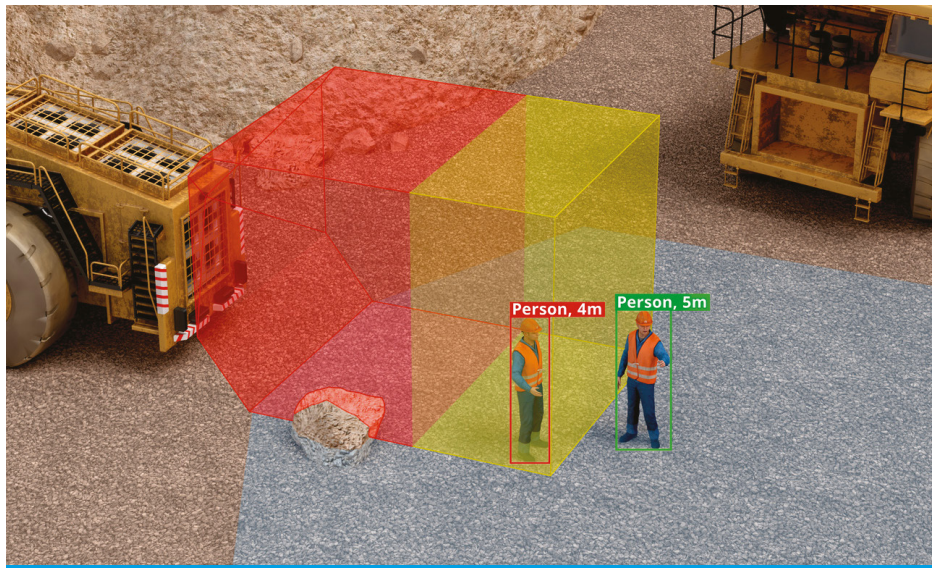
If a car crashes due to a fault with the AI, it can be seen by some people to theoretically undermine the acceptance of AI-based self-driving cars, but if a person crashes a "normal" car then it's the person's fault and people accept that it is an accident. I believe that, per mile, AI-driven cars have fewer accidents than humans, yet we still are not all only using AI self-driving cars. For me, it's the same when it comes to machine vision and vision systems in general. There's certainly a lot of very powerful AI, and it's picking up defects that humans just could not programme for, from a vision software perspective. It's continually improving, but there are still cases where the traditional rule-based approach is more effective or quicker, so each application is different. If you have a natural variation of form – like with people or organic objects – there is

very little better for dealing with that natural variation than AI.

I think that the growing social acceptance of AI, along with the rapid development of enabling hardware, will lead to much more powerful embedded devices. We all carry an embedded device with us in our pockets. A mobile phone is a very powerful embedded device, and it runs AI, so there's a lot of acceptance happening on a regular basis already.

On the cost: even five years ago, the cost of the hardware was so much higher. Either the cost or the electrical power requirements needed to run or train them efficiently made these systems completely unviable. But it's all led to such a big push to develop AI systems that I don't think we've reached the peak of it yet. Personally, I think there's a long way to go.

My only concern is that everything is being categorised as AI, whether it actually is, or whether it's actually just clever software that's doing a lot of rule-based computations with an AI label stamped on it, or is it actually AI but only used because it looks like it's cutting-edge?



Too close for comfort? The system detects two people in a potentially dangerous position and gives the vehicle driver a warning

IMVE: What's next for the growing intelligence of these AI systems – how close are we to sensors that not only detect, but also predict, for example?

NH: When I look at the current SICK portfolio, we have a lot of products that are using AI to look at existing data from all our sensor devices, not just vision devices, and we have some exciting developments around the corner that will use that historic data to come up with preventative monitoring systems.

Again, that's where the wider SICK offering is so powerful, because we have the sensor data, we have the vision data and we have so many data sources that can all come together, and we're able to analyse it all.

Turning my sales pitch off… in my opinion, I'd say that AI use in safety applications is becoming a very exciting, but also a challenging, topic.

While I'm not a safety expert, I can see the challenges of using AI in a safe environment, especially if you need to put performance-level certification and documentation around it.

While I appreciate it will be possible and there will even be companies in the market that say they're at that level, there's always going to be an added challenge with adhering to certified safety standards, in the same way as with the acceptance of autonomous cars using AI.

It's always nice to have a fallback, and when you're using AI, there is a black box you can't go back to and look at how a decision was reached or what the process was that was followed to reach that decision.

In the wider use of AI in general, I think that there are a lot of areas where it will improve historical data analytics, and it will pick up applications where there is natural variation.

I also think that the importance of the quality of training data, and the argument of synthetic versus real-world data, and the applications that require or perform best with the different data types will become clearer. I still think that there are a lot of situations in the consumer world where AI disappoints, and this will continue to influence people's awareness and acceptance of AI and automated systems.

If you look at VAR in football, for example, while that's based on fact, it often still comes down to a handful of people's opinions on whether it's one decision or another.

If you used AI to automate those decisions, the circumstances may not be taken into consideration, and explaining an AI decision in football would become subjective… And we can already see the controversy when a VAR decision is made and is perceived to be wrong by pundits, who can explain their decision. With any scenario, there's generally three opinions: yours, mine and the truth, which is generally somewhere in the middle.

This is where AI can be exceptionally powerful, but at the same time, it needs to be guided in the right direction. It needs to be fed the right training data and needs to be optimised for the application it's used for. I think, with the digitisation of every part of a production line, AI can only improve that process monitoring.

Do I think we'll ever get to 100% self-sustainable self-learning AI? I hope not, because then I think I'd be out of a job, and we would be living in a sci-fi world where we are servants of the machines. **IMVE**

How the AI-based system assists users by detecting people and objects

visionaries

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

Simbe Robotics’ Tally robot combines advanced imaging, AI and edge compute to capture what the company calls ‘ground truth’ shelf data. Simbe’s Director of AI and Computer Vision Jari Safi (right) told **James Wormald** about how the company built a system that autonomously improves stock accuracy and store efficiency

Imaging & Machine Vision Europe: Tell me 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 me 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 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: As a user of machine vision in public settings, how hard has it been to adhere to privacy rules when it comes to visual data – what measures have you built into the system to do this?
JS: Our system is designed in a way to avoid capturing any images of people.

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

All images: Simbe Robotics

Tally's accompanying software platform gives 'retailers a continuous, unbiased record of what's really happening in their stores so they can act on it right away', says Jari Safi

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

Jari Safi says shoppers respond well to the presence of Tally in store

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 like 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.

> "We use a suite of smartphone-style colour cameras combined with depth-sensing 3D cameras…"

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: What is the most important thing a vendor can do for you as a buyer/integrator of vision components?

JS: Above all, software support and after-sales support. Imaging components evolve fast. Having responsive and reliable partners makes a big difference. A strong, predictable supply chain also helps ensure we maintain consistent performance across fleets.

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**

Top to bottom: Prof Sarah Bohndiek, Dr Francis Kalloor Joseph, Abdel Karim Ruvalcaba-Perez, Augusto Carimatto

Advancing imaging: insights from the 2026 Photonics100

Leading researchers recognised in this year's Photonics100 are developing imaging technologies that address fundamental challenges across medical diagnostics, industrial inspection and scientific research

The Photonics100, an annual celebration of photonics research published by our sister title, *Electro Optics,* regularly features researchers working in imaging technologies. This year's crop ranges from single-photon detection to computational imaging systems, with applications spanning early cancer detection to high-speed surface inspection.

Medical imaging innovation

At the University of Cambridge, Prof Sarah Bohndiek is developing multispectral imaging technology that exploits the spectral properties of biological markers for early disease detection. "Multispectral imaging represents a new frontier in medical physics that enhances colour vision and enables measurement of local concentrations of key biomarkers," Bohndiek explained. "For example, the distinct spectral properties of oxy- and deoxy-haemoglobin can be exploited to infer local blood concentration and oxygenation." Her focus on cancer detection stems from understanding tumour physiology. "The dynamic cellular ecosystem of a growing tumour mass requires a vascular network to obtain oxygen and nutrients, leading to marked changes in vascular structures during the early evolution of cancer that can be exploited for disease detection," she noted. Her team at Cambridge works closely with clinicians on first-in-human clinical trials of technologies including endoscopy and photoacoustic imaging.

Dr Francis Kalloor Joseph at Erasmus Medical Center in Rotterdam has developed a compact photoacoustic imaging system specifically for stroke prevention.

"My current work focuses on developing and translating low-cost photoacoustic imaging systems for clinical use, specifically in the area of stroke prevention," said Joseph.

His approach replaces traditional high-energy lasers with diode lasers, significantly reducing cost and complexity.

Joseph's system targets carotid plaque imaging, addressing limitations in current clinical practice. "A key application I am targeting is carotid plaque imaging to identify vulnerable plaques (which) are critical indicators of stroke risk, rather than the current clinical method of the degree of stenosis. Existing imaging methods cannot reliably assess plaque composition," he explained. His system has achieved "for the first time, in vivo imaging of the carotid artery using laser diode-based photoacoustics, offering a practical system towards plaque quantification imaging".

A significant innovation addresses the challenge of spectral colouring. "A known challenge in carotid photoacoustic imaging is spectral colouring, where overlying tissue alters the wavelength-dependent photoacoustic signal from the plaque, reducing accuracy. For the first time, I have addressed this by using blood inside the arterial lumen as a reference chromophore, allowing for more accurate interpretation of the plaque signal," said Joseph. "This method is not only more accurate but also far more practical than existing inversion-based approaches, which are computationally intensive and less feasible in an in vivo setting." Clinical studies are currently underway comparing imaging results with extracted plaques.

Agricultural imaging

Abdel Karim Ruvalcaba-Perez, a PhD student at Friedrich Schiller University Jena, is working on the development of broadband multispectral sensors that integrate silicon and III-V Compound-based photodiodes, covering a continuous spectral range from 400nm to 2,300nm.

"This system is designed for real-time, non-invasive monitoring of agricultural products, with a focus on identifying optimal harvest windows to reduce global food loss," he said. "Given that approximately one third to one quarter of all food produced is ultimately discarded – often as a result of the inability to accurately identify the optimal time of harvest – addressing this challenge is of critical importance."

> "These innovations allow us to image neural activities in brains 10-100 times faster than standard imaging techniques"

Left: Shahida Imani; **right:** Dr Leonel Malacrida

Ruvalcaba-Perez says that what sets this work apart from existing solutions is its compact integration of dual photodiode architectures, enabling simultaneous acquisition across VIS-NIR-SWIR-eSWIR domains on a single, miniaturised platform.

"While conventional solutions rely on bulky hyperspectral cameras or limited-range sensors, this approach delivers comparable spectral precision in a scalable, field-deployable format.

"One concrete example of its impact is its application in crop monitoring. The sensor has successfully tracked ripening markers such as water loss, chlorophyll degradation, and sugar accumulation, validated against destructive lab techniques."

Single-photon detection technologies

SPAD (single-photon avalanche diode) technology represents a fundamental shift in imaging sensor design. Augusto Carimatto, Head of Integrated Circuit Design at Pi Imaging in Lausanne, described the advantages: "SPADs are photodiodes working in Geiger mode that have high Photon Detection Probability (PDP) with zero read-out noise; thus, making its Signal to Noise Ratio (SNR) higher than CMOS-based image sensors, resulting in higher quality for low light conditions."

Time resolution is equally important. "In addition, SPADs are well known for their highly accurate time resolution, making them invaluable for applications where the time of arrival of the photons carries fundamental information," Carimatto explained. For fluorescence lifetime imaging microscopy (FLIM) applications, "both light sensitivity and time information are extremely important in order to generate a high-quality image; two properties that SPADs excel at".

Pi Imaging's sensor comprises a one-million pixel array with a 17-picosecond step time-gating window, and has already been implemented by microscope manufacturers. Pi Imaging's SPAD Alpha camera took home the first prize at this year's Europa Science-sponsored Innovation Award, presented at Laser World of Photonics in Munich. (https://www.electrooptics.com/article/innovation-award-2025-winners-announced-laser-world-photonics).

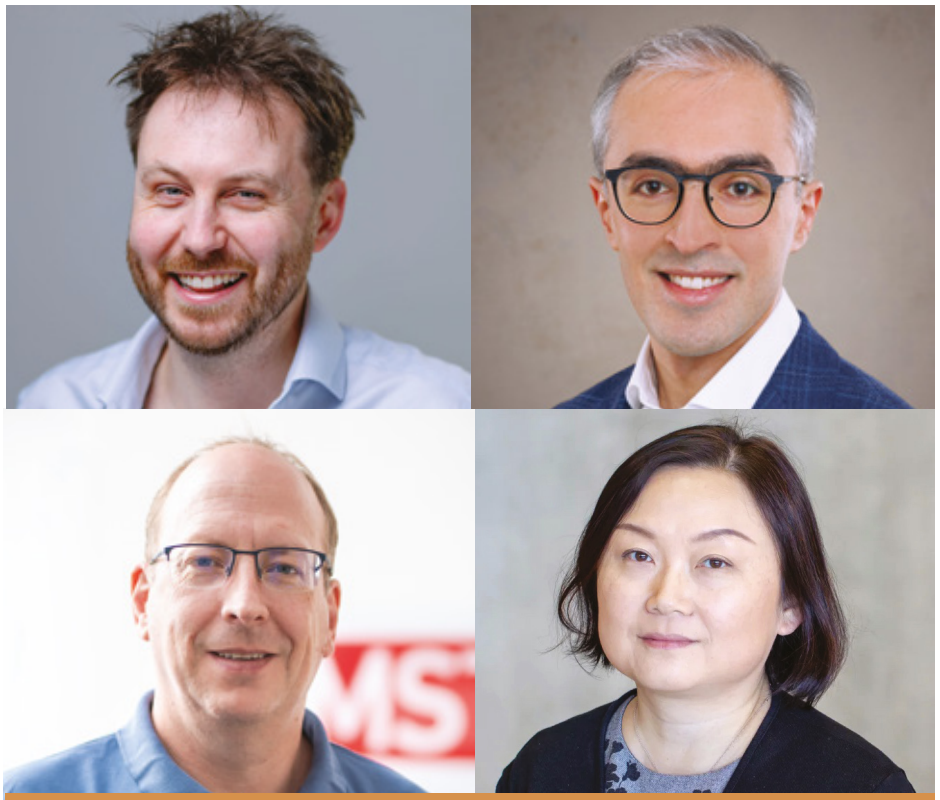
Shahida Imani, CEO and co-founder of Singular Photonics in Edinburgh, is advancing SPAD technology beyond basic detection. "We are pioneering a new generation of single-photon detection technology by transforming SPAD sensors from simple photon counters into integrated computational engines," she said.

"Our core focus is to redefine the capabilities of SPAD technology through embedded, real-time processing and adaptive signal analysis – directly on-chip."

This deals with a specific drawback. "This work addresses a longstanding limitation in the field: the inability of traditional SPADs to go beyond raw photon detection to enable real-time, meaningful data extraction," Imani explained. The on-chip intelligence enables real-time analysis of photon timing and correlations, edge processing to reduce bandwidth requirements, and adaptive AI filtering for noise suppression. Applications span personalised healthcare, space exploration, industrial automation and secure communications.

In Uruguay, Dr Leonel Malacrida heads the Advanced Bioimaging Unit, a joint initiative between the Hospital de Clínicas and the Institut Pasteur de Montevideo, developing FLIM and hyperspectral imaging applications.

"My research focuses on the development and application of novel imaging technologies – including FLIM, hyperspectral imaging (HSI) and phasor analysis – applied across multiple domains such as label-free metabolic imaging, quantitative imaging for diagnostics and spectroscopic characterisation of the biophysical properties of cells and



Clockwise from top left: Prof David Phillips; Pouya Rajaeipour; Dr Leilei Peng; Michael Stelzl

tissues," said Malacrida. His open-source tools address accessibility challenges. "A key pillar of my work is the development of robust open-source tools, such as PhasorPy – a Python-based library for phasor analysis of FLIM and HSI data," he explains. "These approaches offer intuitive, model-free analysis of complex imaging datasets, overcoming the limitations of conventional methods that often require specialised expertise, model-based fitting, and high computational resources."

His team pioneered Uruguay's first multiphoton FLIM microscopes, including the DIVER microscope optimised for imaging in highly scattering tissues.

Developing imaging through complex media

Prof David Phillips at the University of Exeter leads the Structured Light Lab, addressing the challenge of imaging through scattering media. "A key current theme of our research is to understand how to recover images from light that has propagated through highly complex scattering media, such as frosted glass, biological tissue, or multimode optical fibres," he explained.

The fundamental principle involves recovering scrambled information. "While light readily passes through such materials, images are seemingly randomly fragmented into an unrecognisable mess. Yet the image information carried by this light hasn't been lost – just mixed up," he noted. "We work on methods to characterise how this information has been 'scrambled', and then try to build optical systems that can physically 'unscramble' it again."

Phillips's long-term vision is "the realisation of new types of adaptive optical technology capable of automatically self-configuring to unscramble light that has passed through any complex optical system it is connected to. This promises new applications across an array of areas, from the miniaturisation of endoscopes for biomedical and industrial imaging, to increasing the information capacity of free-space and fibre-based optical communication links."

Pouya Rajaeipour, CTO and co-founder of Phaseform, has developed practical adaptive optics solutions. "At the heart of our innovation is the Deformable Phase Plate (DPP), a new class of transmissive wavefront modulators that redefines how dynamic aberration correction is integrated into optical systems," Rajaeipour explained. "Unlike traditional reflective modulators, the DPP enables compact, alignment-friendly, and scalable designs, unlocking new possibilities across imaging platforms."

The DPP has been integrated into clinical and research systems. "Notable examples include an OCT-based ophthalmoscope for in vivo human retinal imaging and a two-photon microscope for deep brain imaging. In both cases, the DPP was seamlessly added to existing set-ups, enabling enhanced imaging without major optical redesign," he said.

His current development addresses accessibility. "I am now leading the development of a complete adaptive optics system, a plug-and-play solution for commercial microscopes. Traditional AO systems are complex, expensive and limited to expert-built set-ups.

"Our approach changes that: a camera port attachment that allows users such as neuroscientists or cancer researchers to benefit from real-time aberration correction in their existing instruments, with no optics expertise required."

The race to high-speed computational imaging

Michael Stelzl, Managing Director of MSTVision, has developed high-speed imaging solutions for industrial applications. "Currently, we are launching several new products in the field of computational imaging, with a particular focus on photometric stereo," said Stelzl, who adds that his company's core expertise lies in "high-speed line scan cameras and the ability to process high data bandwidths with minimal latency. This is achieved by distributing computational loads efficiently across CPUs, FPGAs, and GPUs".

The performance specifications are notable, said Stelzl. "One of our most innovative developments is the combination of programmable frame grabbers from Basler with our newly developed photometric stereo line light. We believe this is the fastest solution on the market: the FPGA in the frame grabber can process up to 3.6GB per second, while our line light, optimised specifically for photometric stereo, delivers the high intensities and fast switching times required for applications that were previously impossible."

Applications include quality inspection in e-mobility, including battery foil and bipolar plates for fuel cells, as well as embossed surfaces in furniture manufacturing.

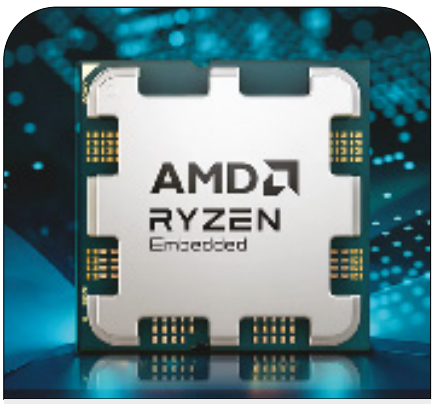
"By performing the photometric stereo algorithm directly on the FPGA, CPU load is minimised, leaving it available for other image processing tasks. This technology is particularly well suited for surface inspection of large, moving objects," he noted.

Dr Leilei Peng at the University of Arizona focuses on biological imaging speed. "My lab has made high impacts in several imaging technology development areas: high-resolution fluorescence imaging in deep tissue, multiplexed imaging in cells and tissue, and super-resolution microscopy," Peng stated. "Currently I am working on faster deep tissue 3D imaging with a two-photon light sheet microscope. My lab invented a low-cost random depth access method and a novel 3D projection imaging method to boost 3D imaging speed in tissue. These innovations allow us to image neural activities in brains 10-100 times faster than standard imaging techniques." **IMVE**

Ten of the best

The most eye-catching components, devices and applications to appear in our inbox over recent weeks

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



AMD
Ryzen Embedded 9000 Series processor

Designed for industrial PCs, automation systems and machine vision applications, AMD's Ryzen Embedded 9000 Series processors offer up to 16 cores and scalable power from 65-170W. For imaging workloads, integrated AMD RDNA 2 graphics support high-performance visualisation and video processing without discrete GPUs, while the processors also include AVX-512 instruction support for AI and image analysis tasks, such as defect detection and quality inspection.

Swisslog
IntraMove AMR fleet

The IntraMove autonomous mobile robots (AMRs), developed by Swisslog, are designed for point-to-point transport within integrated warehouses and automated logistics operations. Available with either 600kg, 1,500kg or 3,000kg capacities, the AMRs operate under Swisslog's AI-based IntraMove fleet management software, using real-time sensor data and vision-based navigation for obstacle detection, route planning and coordination across complex warehouse environments.

The Triton smart camera from Lucid Vision Labs combined with a Sony IMX501 vision sensor

The Triton smart camera, launched by Lucid Vision Labs, is a compact system built for machine vision and features Sony's IMX501 intelligent vision sensor with on-sensor AI for edge inference. The 12.2MP CMOS sensor integrates an image signal processor, DSP and 8MB of on-chip memory, enabling real-time object detection and classification without external processing. The dual-ISP architecture outputs both AI results and original images simultaneously, with up to 30fps at reduced resolution or 8fps at full 4056 x 3040px resolution.

SICK
Lector DWS track and trace

SICK's Lector 83x and 85x camera-based code readers perform dimensioning, measurement and track and trace services using AI segmentation. Lector83x has high-performance CPU and super-resolution imaging, enabling reading of 1D and 2D codes at speeds up to 2.5m/s, while Lector 85x extends coverage to wide conveyors and pallet heights 1.5m-plus. The compact design supports medium-distance object scanning and tracking, robust ambient-light resistance and industrial protocol connectivity.

Onsemi
iToF sensor for machine vision

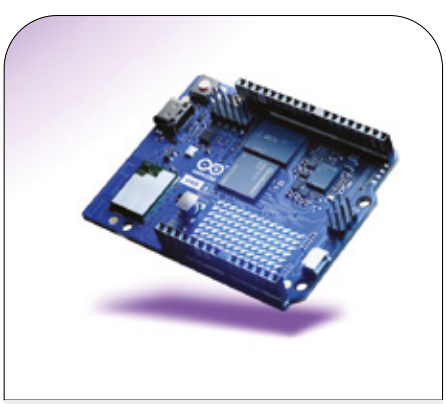
Onsemi's Hyperlux ID is an indirect time-of-flight (iToF) sensor for use in industrial automation and machine vision applications. Back-side illuminated CMOS global shutter sensors provide real-time 3D imaging of fast-moving objects with on-chip dual laser drivers, modulation frequencies up to 200MHz and laser eye-safety compliance. Integrating depth-processing ASIC beneath the pixel array, the AFO13x Hyperlux ID series provides depth, confidence and intensity maps at high speed and in real time.

FLIR
Si2x-Series acoustic imaging camera

Certified to ATEX and IECEx standards, the Si2x-Series acoustic imaging camera from FLIR has been developed to perform industrial inspection tasks in hazardous environments. The system combines a sensitive microphone array with integrated 12MP camera, providing high-resolution imaging for the precise on-device quantification of leak size, severity and cost, and can be safely operated in explosive atmospheres while detecting pressurised gas leaks, mechanical faults and partial discharge.

Mitutoyo
QM-Fit

QM-Fit is a compact, manual visual measuring system for the high-precision inspection of small and thin components. Featuring a 20MP CMOS colour camera with telecentric optics, a 36mm depth of field and up to 100x digital zoom, the system delivers high-resolution imaging for quality control. Automatically detecting features such as circles, lines and edges, the machine provides real-time graphical measurements and pass/fail results via a 15.6-inch touchscreen interface with ±10µm calibrated accuracy.



Arduino
Uno Q

An all-in-one solution that enables integrated machine vision processing for AI-based applications, Uno Q combines a Linux Debian-capable Qualcomm Dragonwing microprocessor with a real-time microcontroller. Including a quad-core 2.0GHz CPU, Adreno GPU, dual ISPs and camera, display and audio interfaces, the system supports object recognition, motion detection and AI-powered vision tasks. Uno Q allows users to integrate machine vision systems quickly and efficiently into embedded projects.

MVTec
MERLIC 5.8

MERLIC is the latest version of MVTec Software's machine vision software for industrial imaging. It enhances process reliability through advanced error detection in the image source manager, allowing it to identify dropped images, missed triggers and connection issues. Recipe management has also been improved by a centralised interface with detailed information on image sources, parameters, results and dependencies to simplify set-up. 5.8 also adds a Siemens IE Database communication plug-in for seamless PLC and industrial edge integration.

Prophesee
Gen X320 event-based vision starter kit for Raspberry Pi 5

Event-based vision enables high-speed, low-latency imaging for embedded vision applications. This starter kit from Prophesee for Raspberry Pi 5 features the GenX320 sensor, a 320 x 320px array that connects via MIPI CSI-2 (D-PHY) and consumes less than 50mW while delivering ultra-fast event-based output equivalent to more than 10,000fps. It also features less than 150µs latency at 1,000 lux and >140dB dynamic range.

Photonics West 2026 preview: the stage is set for vision innovation

From the Vision Tech Expo debut to camera and imaging system finalists at the Prism Awards, **James Wormald** looks at why 2026 will be a key year for imaging, vision and sensing systems at SPIE Photonics West

The world of imaging and machine vision is gearing up for one of its major shows of the year: SPIE Photonics West 2026. Taking over San Francisco's Moscone Center from 17-22 January, SPIE's annual flagship gathering draws thousands of engineers, business leaders and scientists from across the global photonics industry.

This year, organisers say the event will feature more than 100 technical conferences and 150 special events. And that's before mentioning the exhibition floor, with 1,200 companies expected to participate across major application segments.

For the imaging and machine-vision community specifically, this edition carries extra relevance as a new imaging-focused application area – Vision Tech Expo – is introduced. From 20-22 January, Vision Tech Expo will bring together embedded vision, hyperspectral imaging, 3D sensing, AI-driven imaging and other related technologies under one roof.

Photonics West 2026 represents a significant moment for the intersection of optics, sensors, vision systems and machine-vision applications.

Suppliers, integrators and end-users will gather, not only to showcase new technologies, but also to assess market directions, network and align on strategic innovation.

SPIE

SPIE Prism Awards: Imaging & Vision Finalists

Another major highlight of Photonics West 2026 is the SPIE Prism Awards 2026. Celebrating its 18th year, the competition recognises commercialised innovations across multiple photonics sectors. “Rapidly developing technology areas such as biophotonic instruments, lasers (and) quantum tech showcase the range and variety of the finalists,” says SPIE, but there are also categories for Cameras & Imaging, Sensing and Test & Inspection, which feature vision-based applications.

“It’s an honour to recognise the scientists, engineers and companies who are working so hard to bring these products to market,” said SPIE CEO Kent Rochford, “and I’m looking forward to congratulating all the finalists and winners.”

Finalists in the Cameras & Imaging category include Cubert, with a high-resolution hyperspectral camera; HP, with a professional-grade 3D scanning and capture system for digital content creation; and Metalenz, with a compact polarisation-based imaging sensor. Meanwhile, in the Sensing category, ams OSRAM’s multi-zone time-of-flight depth sensor fights it out against NAMUGA and Lumotive’s 3D lidar sensor and Phlux Technology’s Aura APD (avalanche photodiode), which is suitable for performance 3D imaging systems.

One of the finalists in the Test & Inspection category is 4D Technology, with a hand-held gauge that uses 3D vision to measure surface defects, and that’s up against Gamma Scientific’s AR coating reflectance measurement system, which can be used for quality control of vision-based systems.

The SPIE Prism Awards 2026 winners will be announced at a gala evening on 21 January.

What exhibitors are looking forward to at Photonics West 2026

Walking onto the Photonics West exhibition floor, the buzz of new technology is palpable. For attendees with an eye on imaging and machine vision, the show offers a rare chance to see the future in action, with the latest cameras, sensors, optics and vision-AI systems all displayed in a single, immersive space.

For the exhibitors themselves, however, it’s as much about connections as it is about demonstrations.

For IDS Imaging, it’s a place to both impress and absorb, showing off what they can do while taking the pulse of emerging innovations around them. “Photonics West is a great show for seeing some leading-edge technologies in vision and optics,” says David Mayers, IDS Sales Director. “We love the technical aspect of the show as it allows us to truly demonstrate our own technical abilities, while also being able to admire and learn about other new technologies that are of interest.”

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Photonics West 2026 will take place at the Moscone Center, San Francisco, between 17-22 January

Balluff sees the show as an opportunity to gauge where the market is headed. “We are looking forward to seeing the new technologies that customers are using and seeing what they are most interested in,” said Product Marketing Director David Sandner. “I’m curious to see what market trends are emerging and what new things customers are looking for and demanding. We are also looking forward to seeing the new technologies in development from other vendors.”

Balluff’s Frank Jakubec, Head of Global Market Segment Sales for Semicon and Electronics, will give a presentation on Enhancing Vision Systems with Intelligent Industrial Cameras (22 January at 11:30), and the company is excited about the new Vision Tech Expo format.

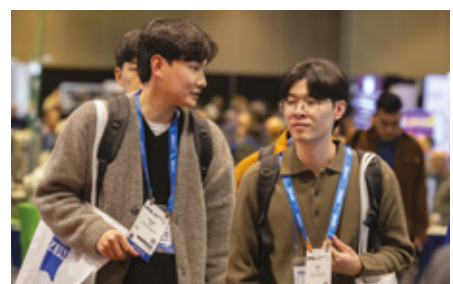
“(It) is more dedicated to focus on cameras, sensors, optics and vision-AI,” said Sandner, “which aligns with our offering and gives us a more ideal platform to showcase what we can offer.”

Optotune Switzerland also enjoys the human connections the show enables. “We are looking forward to meeting our customers and partners,” said Marco Pigozzi, Optotune’s Vice-President of Sales & Marketing.

But the company also wants to pitch its position as an innovation leader in the sector, while still learning from others on both the exhibition floor and presentation stage.

“We are looking forward to demonstrating our technologies, discussing the future trends and discovering the latest innovations in vision systems,” said Haykel Ben Jamaa, Optotune’s Senior Business Development Manager, pointing out Co-Founder Mark Ventura’s presentation, The Latest Advancements Around Liquid Lenses, (21 January at 12:00).

For SWIR specialists such as QDI Systems, Photonics West is a hub for the entire ecosystem. As CEO Artem Shulga explains: “We have the opportunity to connect with existing and future clients, but also meet with suppliers. It basically covers our entire ecosystem, which makes it a very effective meeting to go to. We will also monitor industry trends by watching specific lectures.”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Visitors to Photonics West 2025

Similarly, Duong Hoang of New Imaging Technologies is also looking forward to making new connections. “We look forward to connecting with partners and customers to discuss how advanced SWIR imaging can enhance industrial inspection and scientific applications,” he says. For these companies, the floor is both a marketplace and a window into the technical developments shaping their specialised sector.

“We are looking forward to meeting a diverse range of potential customers,” agrees Samiul Haque, Co-Founding member of Emberion, a company which, he says, “interacts with members across the industry and academia, and PW2026 is a good event at the start of the year to engage with them”.

For innovators, early year exposure at Photonics West offers both visibility and insight, helping them to identify collaborators, customers and trends that will define the months ahead. But even established players such as Chroma are energised by the show’s evolution.

“The expansion of the Vision Tech show itself, and the focus on this particular

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industry, are exciting," says Jennifer Lee from Chroma.

Predictions for stand-out tech

Walking the aisles at Photonics West, it doesn't take long before a pattern starts to form. Themes rise, technologies gain momentum and a few stand-out ideas inevitably dominate the conversations long after the show ends. For many vision exhibitors, this year's front-runners are already taking shape.

"3D Vision, AI and other niche areas of imaging are always interesting," says David Mayers of IDS Imaging, as he looks ahead to the week's breakthrough technologies. "We've also seen some unique and interesting new sensor technologies and imaging techniques being showcased in past years, so we're looking forward to more of that!"

Often tucked into the smaller booths and platform showcases, those new technologies can sometimes end up stealing the spotlight.

AI, unsurprisingly, looms large in almost everyone's predictions. "For sure, AI will take a good part of the discussions over the next few months and years as it did in the past couple of years," says Optotune's Marco Pigozzi. But he also believes "hyperspectral imaging will take more and more space as (there is) clearly a trend there".

That pairing, AI and hyperspectral, is becoming one of the clearest signals of where the field is heading.

Chroma's Jennifer Lee agrees, predicting smarter vision systems will be built on the back of optical engineering. "The breakout trend will be the convergence of AI-driven machine vision (alongside) high-precision spectral engineering," she says, "putting optical filters at the centre of system performance, rather than an afterthought."

Also reinforcing the staying power of AI, Balluff's David Sandner says: "I think any advancements in AI technology and imaging will be something that will be talked about walking away from the show, (and) I (also) think high-speed imaging is a trend that's generating more traction. With advancements in new technologies, I think it will be a hot topic as well."

Data that's getting both smarter and faster is a combination that's poised to dominate technical talks, presentations and booth demos alike.

High-speed imaging also stands out for SWIR players, too, who are preparing for a surge in demand. "We expect strong momentum around high-speed and high-resolution SWIR imaging for more efficient vision systems," says Duong Hoang of New Imaging Technologies, as the sector drives toward faster, more precise SWIR, and aligns with broader industry ambitions around automation and deeper material analysis across industrial environments.

QDI Systems, however, is confident the standout technology of the week will be something even more specific: its own major reveal. "This has to be our CQD sensor portfolio for SWIR," says CEO Artem Shulga. "Knowing the industry is ready and asking it to adopt the technology and have scalable solutions, it is great to deliver on this industry demand. And we won't stop at SWIR. (This is) an open invite to visit us and find out more."

For a sector hungry for scalable, affordable next-generation SWIR sensors, such announcements often end up setting the tone for the year ahead.

Sitting on the fence, somewhat, Emberion's Samiul Haque is spreading his chips and identifying several breakout trends that will emerge together. "High-speed imaging, hyperspectral imaging sensors & machine learning/AI are definitely at the top of the 'stand-out technology' list," he suggests.

"The question is: How will the ecosystem work together to enable the next phase of AI-based sensors/systems and computation that will solve customers' challenges?" It's a question that will be shared by many of the week's exhibitors and non-exhibiting visitors alike, as conversations will shift from individual technologies to integrated, AI-enhanced systems, capable of addressing complex industrial problems.

For Optotune's Haykel Ben Jamaa, the predicted show highlights are almost too many to mention: "AR/VR systems are getting traction in different application fields; microscopy's evolution is enabling the observation of features below the cell size, which drives drug development and diagnostics," he says; and "in industry, robotics are being empowered to interact in non-controlled environments and collaborate with humans thanks to machine vision."

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Demonstration watch list

Many exhibitors are doubling up as presenters and panel speakers, but proving that the show's not all talk, companies have also been tirelessly working behind the scenes to get new products and demonstrations ready for the event, hoping to treat visitors on the hunt for the latest and greatest product offerings to more compact tools with higher data efficiencies and wider spectral reach.

At **Booth #2349**, for example, IDS Imaging says it will fulfil the trend with its ultra-compact uEye XCP-E USB3 camera, intended for real-time motion capture in low light; its uEye XLS-E camera, which uses

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Vision Tech talks & timings

Several talks, forums and sessions will be geared specifically towards imaging, vision and embedded systems as part of the Vision Tech Expo, which, according to organisers, will explore the rapidly evolving landscape of intelligent imaging and sensing.

	20 January	21 January	22 January
8.45	Morning Market Session: learning how to grow and future-proof a machine vision business		
10.30	Scaling Vision for the AI-driven robotic revolution	Enhancing machine vision with optical filters The future of 3D sensing	Constant field-of-view solution for AI-based imaging
11:00	Vision and AI-enabled drones for public safety: (inc. real-world deployments)	Stereo vision in industrial robotics Multispectral and hyperspectral imaging: evaluating benefits and deployment	Intelligent industrial cameras
11:30		Sensor-optics co-design for AI vision systems Dynamic robot guidance in real-time manufacturing	Advanced sensing with SWIR and UV cameras
12:00	Advanced CMOS-based SWIR image sensors	Liquid lenses: latest advancements	Hyperspectral imaging at short wavelengths
12:30	Wafer-level spectral image sensors: turning spectral into a viable industrial option	Demo of embodied AI robotics	Inspect the invisible
13:00	Metasurfaces beyond metasurface lenses: alternatives to traditional colour filter arrays	Improving stereo camera accuracy	
13:30	Applications in farm automation and precision agriculture		
14:00	RGB vision on food processing	Biology-inspired space sensors Building high-fidelity industrial vision with synthetic images	
14:30	How to successfully deploy machine vision	Funding opportunities in vision	
15:00	AI advances in manufacturing vision		
15:30	Video analytics for manual manufacturing process monitoring and defect inspection	VLMs on the edge	
16:00	AI image analytics for manufacturing		

The winners of the 2026 SPIE Prism Awards will be announced at a gala evening

Sony's event-based IMX636 sensor and an iToF-based Nion system built on onsemi's AF0130, used for fast 3D measurements. As well as these, IDS will also highlight its uEye XCP model, which uses Sony's Starvis2 technology, and which the company says offers high sensitivity and low noise in small industrial housings.

Balluff, meanwhile, says it will introduce both 5GigE and 25GigE cameras over at **Booth #6321**. The former is built around a 29x29mm form factor, runs on PoE and maintains backward compatibility with 2.5GigE, while supporting Sony's IMX901/902 and SWIR sensors. The larger 40x40mm 25GigE cameras use RDMA and RoCEv2 protocols to deliver ultra-fast image acquisition, says Balluff, enabling low-latency and high-throughput data transfer for machine vision tasks.

At **Booth #637**, Excilatas says it will demo PCO cameras for both industrial and scientific use, as well as Axsun swept-source laser systems, LINOS and Optem lenses, BlueLight flash disinfection systems and several other detector families including SPCM, APD and IR.

Optotune Switzerland will feature its tunable lens families, 2D mirrors, speckle reducers and pixel shifter, and the event will be the public's first chance to get a look at the company's new focus-tunable lens modules, set up for S- and C-mount cameras. Meanwhile, a free-space communication demo at **Booth #6715** will add context to how its components behave in aligned optical set-ups.

Also making its first outing during the week, QDI Systems' new collodial-quantum-dot (CQD) SWIR sensor portfolio will be "a great opportunity to see the technology in real life", says the company, as it will be supported by a demonstration camera at its **Booth #5210B**, which is part of the Dutch Pavilion.

Another SWIR portfolio, this time built on proprietary InGaAs sensors by New Imaging Technologies (NIT), will be showcased at **Booth #1866**. The range will span line-scan to Full HD models, but the highlight, according to the company, will be LiSaSWIR 2048 v2, a line-scan camera with 2048x1px (at 8µm pitch), under 110kHz full-frame rate, high sensitivity (90e-) and low noise. Sharing the booth, NIT's parent company LYNRED will also present its own infrared imaging solutions from SWIR to MWIR and LWIR options.

SWIR cameras will also be presented at the Finnish Pavilion (**Booth #4229**) by Emberion, which is taking its quantum-dot-based option, which features a spectral range from 400nm to 2,100nm and a dynamic range above 120dB. According to the company, with IWR (integrate-while-read) capabilities, the cameras support high-speed laser pulse monitoring, optical sorting and temperature management applications via calibration.

At **Booth #6403**, Admesy will present its tools for colour and display testing, including a filter-based XYZ 2D imaging colorimeter, a display-mirror goniometer for spectral angular scans to 75°, and what the company describes as the "world's fastest" colorimeter.

Meanwhile, Chroma Technology will present its precision machine vision filters at **Booth #6818**. Designed to achieve consistent spectral performance, Chroma cities industrial use cases ranging from high-speed inspection to advanced robotics and AI-driven systems.

As we pack our sunglasses and most comfortable flip-flops for (hopefully) sunny San Francisco, the message for anyone in machine vision or imaging systems development is clear: Photonics West is too big to miss. The future of vision is taking shape, and it will be revealed on the exhibition floor. **IMVE**

SPIE Prism Awards 2026 – categories and finalists:

Biophotonic Instruments
- DoseOptics LLC, BeamSite
- Helix Surgical, Rx
- Ramona Optics, Vireo

Cameras and Imaging Systems
- Cubert GmbH, ULTRIS XMR Hyperspectral Camera
- HP Inc., HP Z Captis
- Metalenz, Polar ID

Lasers
- Cailabs, CANUNDA-USP PureBeam
- IPG Photonics, YLR-8000-SM
- VALO Innovations GmbH, Hübner Photonics, VALO Tidal-75-1-1100

Optical Materials and Components
- Momentum Optics, Momentum
- Seagate Technology, HAMR Hard Drive
- Silanna Semiconductor, Firepower SL2001 Laser Firing System

Quantum Tech
- CPI TMD Technologies Ltd, gMOT
- Ki3 Photonics Technologies, Ki3 PHASE.FIX
- TOPTICA Photonics AG, TOPTICLOCK

Sensors
- ams OSRAM, TMF8829
- NAMUGA and Lumotive, Stella-2
- Phlux Technology Ltd., Aura Noiseless InGaAs® APD

Test and Measurement
- 4D Technology, 4D InSpec SR
- Gamma Scientific, 191 AR Coating Reflectance Measurement System
- PI (Physik Instrumente), PINovAlign42

XR Tech
- Eulitha, PhableS
- LightTrans International GmbH, VirtualLab Fusion
- Vitrealab, Quantum Light Chip

Catalyst Award
- Cerca Magnetics, Quantum OPM-MEG for Autism
- PicoQuant GmbH, Shaping the Future of Photonics

Other Awards and timings:
- **Startup Challenge Awards & Reception:** 20 Jan - 15:15 – Expo Stage
- **AR | VR | MR Optical Design Challenge:** 20 Jan - 18:00 – Career Hub Stage
- **Innovation Awards in Quantum Sensing and Nano Electronics and Photonics:** 20 Jan – 19:30
- **PRISM Awards Gala:** 21 Jan – 18:00

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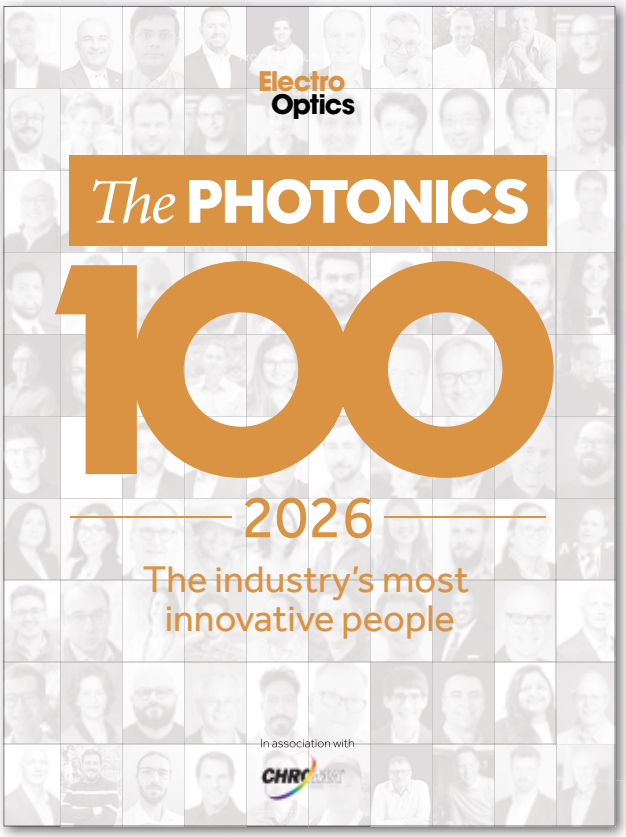

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From start-up to 70-strong team: how Effilux is illuminating the future of machine vision

Alexandre Cottereau, Head of Product & Marketing at Effilux, speaks to Imaging and Machine Vision Europe about the company's remarkable growth journey

Tell us about Effilux's origins?
Effilux started with three young engineers who graduated from the Institut d'Optique Graduate School in France. They had a simple idea: that optics and lenses combined with LEDs would revolutionise machine vision systems, making them more flexible and adjustable on the field.

At the beginning, nobody believed in them as it was during the 2008 financial crisis. To slowly gain trust on the market they had to answer specific needs that no other competitors would be able to manage. This is why making custom and specific products is still one of the core values of Effilux.

Once the company's reputation started to grow, the trio identified a first standard product: the EFFI-FLEX, a modular lighting system with many adaptations. Based on this, they won several awards, such as Machine Vision Product of the Year.

The growth has been remarkable, particularly from 45 to 70 people in just two years. What's driving this?
Our accelerated growth is primarily driven by our long-term investment strategy. Our DNA involves heavily supporting deep tech companies and start-ups. We 'plant seeds' in these smaller companies, and when they succeed, even if it's only 10% of the time, it creates a significant, successful product pipeline for us. For example, we've been working with the space industry in France for several years and are now about to release one of our biggest specific products of all.

How has the 2018 acquisition by CCS Group impacted Effilux's development?
It opened a lot of doors that we couldn't access as a small start-up. Sometimes we were too small as a supplier, not a matter of trust in our products, but more about financial guarantees. The other upside is having someone on-site in different geographies. We had CCS America taking care of customers there, helping us build the right products for the US market. The recent opening of the LightLab in Munich in September is a perfect example of the effort everyone is putting together to make it work.

EFFILUX

For more than 15 years, EFFILUX has produced optical lighting solutions

Machine vision lighting is sometimes called the unsung hero of automation. Why is proper lighting so critical?
First, people are biased with their own eyes. What's harder to understand is that your camera is basically strobing all the time and its exposure time is very short, meaning it doesn't have much light coming in. Imagine you have your eyes closed most of the time and you're just quickly opening them. That's basically what's happening with the camera.

Then you have the notion of optical stability. Imagine you're Amazon on a production line with thousands of parcels per hour. Every time you're choosing between discarding or keeping a parcel, that costs you money, and this decision is all based on what you record with your camera. From one picture to another, if your light makes it impossible to detect whether it's a parcel defect or just a light bug, it's going to be very costly.

What are the biggest misconceptions about machine vision lighting?
We still see customers asking for specifications of intensity in terms of lux or lumens. That's what they learn at school, but 90% of the time if you do so, you're going to make mistakes. When you arrive on site, you have ambient light, contrast issues, foils creating glares that you have to eliminate with polarisers. There are too many things to take into consideration to make it work based on theoretical models. I would recommend just getting some loans from us and trying them on site. We always recommend an on-site, iterative approach rather than relying on theoretical specifications alone.

What sets Effilux apart from competitors?
We're one of the only companies doing lights for machine vision that have three different levels of customisation: standard, custom, and specific.

Standard products fulfil maybe 80% of needs. Custom means small adjustments on standard products. Specific is when we need to start from scratch because nothing is really working.

Second, we have a very large research and development department. A third of all our colleagues are in R&D. We invest around 20% of our turnover in R&D. We also have our own component assembly line, so we're able to do electronic designs ourselves with quick iterations.

Can you give an example of how you've solved a specific customer challenge?
We had an automotive production line that wanted to automate inspections of gaps and flushness on doors. They were not able to find any supplier for their lights because they had to project a geometrical form on the door to make 3D inspections with very high accuracy. We custom-developed it for them. This product became one of our standard products known as the EFFI-SHARP, answering a very specific need that nobody would answer, and it became a bestseller.

Logistics and food and beverage have been at the centre of product development this year. What makes those industries interesting?
For logistics, we started working with very large companies on barcode reading and parcel dimensioning needs. This led us to develop the EFFI-FLEX-LG. Next year we'll be releasing another product for this market addressing the mobility coming inside these warehouses with built-in solutions for parcel and barcode reading.

For food and beverage, it's a very tough market. When we developed the EFFI-FLEX-2-IP69K, we had to make it blue as nothing is blue in food processing lines. If our light is broken, you have to detect the pieces on the line very fast. Also, everything should be washable with very high-pressure water and detergents.

What advice would you give to companies exploring machine vision applications?
Don't go through this misconception that light is an easy thing. Lighting is most of the time underestimated. I would recommend just trying things, asking advice from our experts, and testing everything you can on site.

You need to understand that specifications aren't everything on a product. You're not just investing for the next year. With us, you're going to stay in touch for maybe the next 10 years.

We will grow together and our goal is to make you succeed.

We have a lot of customers that stay with us for 10 years that become friends.

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