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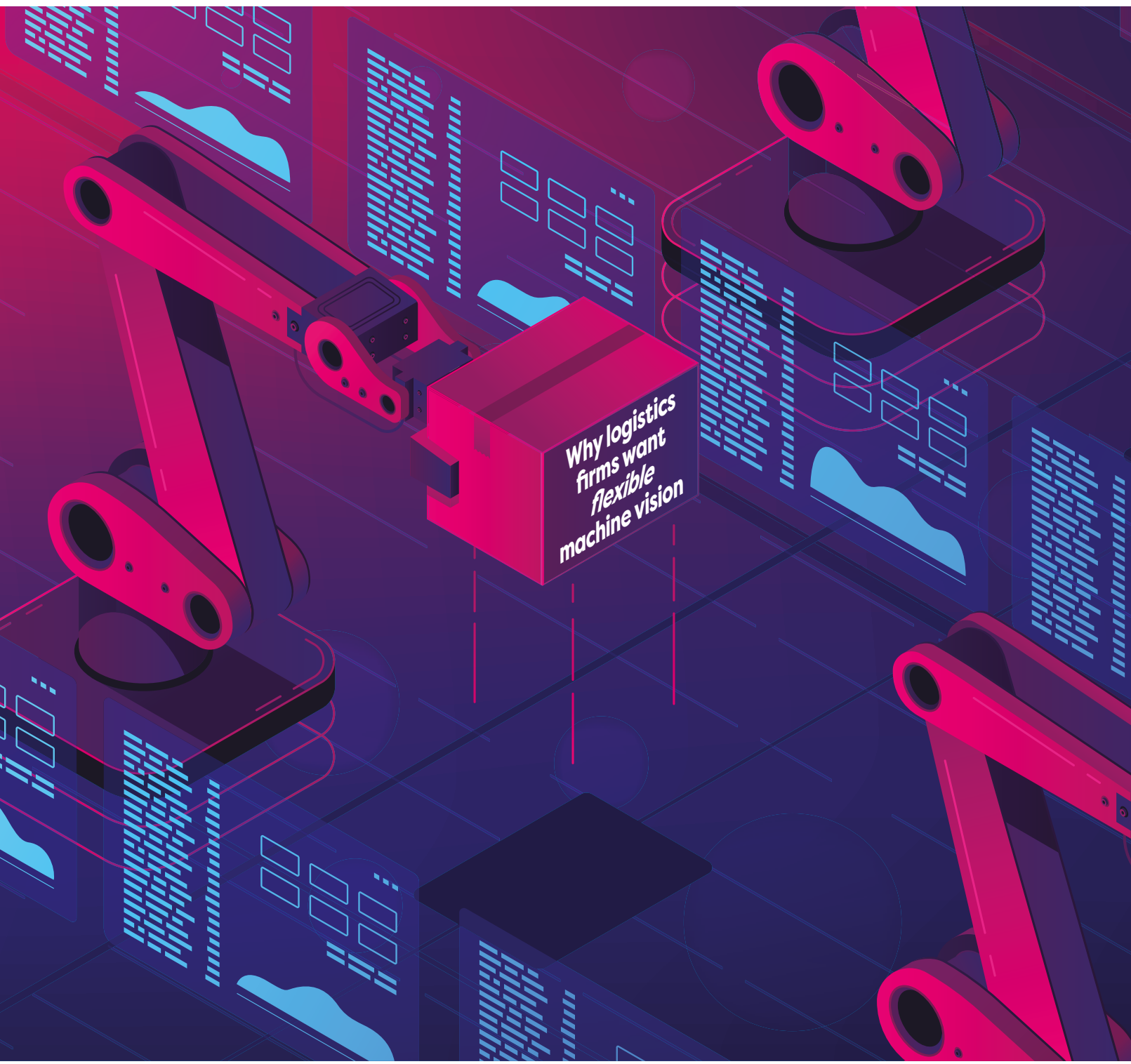
Embedded vision tech round-up



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News

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Researchers patent high-res system that makes normal cameras hyperspectral

Researchers from the Universidad Carlos III de Madrid's (UC3M's) Sensors and Instrumentation Techniques group have patented a new hyperspectral imaging system that they say provides a higher resolution than any other technology.

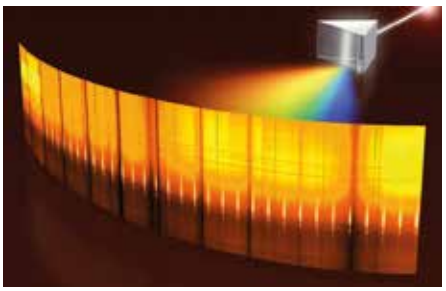
It is made up of a light source that transforms a normal camera into a hyperspectral camera – capable of inspecting the chemical composition of a sample being analysed by measuring the optical absorptions/molecular resonances of each compound.

It relies on an advanced analytical technique known as dual-comb spectroscopy. Here, light is interfered from two optical sources, called optical frequency combs, to generate a signal called an interferogram. This is done at a speed that, until very recently, was too fast to be captured even by very high-speed cameras, according to the UC3M researchers.

To overcome this challenge, they have used a dual-comb electro-optical source made with fibre optic components. The main part is a dual-comb illuminator capable of generating two frequency combs that interfere at much lower frequencies than can be obtained with other systems. This makes it possible to detect the signal with any camera that has sensitivity in the emission range of the dual-comb system used. In addition, it is capable of working in different frequency ranges (near-infrared, mid-infrared and terahertz).

Prior technologies based on frequency combs have been able to analyse a single point of a sample, towards which the light source was sent. The newly patented hyperspectral system is instead able to spectrally analyse an entire sample.

The system can also analyse parameters such as a sample's temperature, pressure and concentration. "The high optical



UC3M

resolution with which we can characterise the entire sample with our technology is essential when we work, for example, with gases", said Pedro Martín Mateos, one of the UC3M researchers.

"We have already demonstrated its usefulness for the study of gaseous samples," he said. "This would be useful for the development of more efficient burners or for safety issues. We have also used it for the analysis of certain foods."

VDMA and VDI create a basis for project success

VDMA
Machine Vision

By Patrick Schwarzkopf, Managing Director, VDMA Robotics + Automation

Industrial image processing can now look back on a success story that has lasted for four decades. It is now indispensable for measuring, testing and positioning tasks in the production cycle in many branches of industry.

The aim of the VDI/VDE/VDMA 2632 series of industrial image processing guidelines (found at www.vdi.de/2632) is to support users and solution providers in the successful implementation of projects. Now a new edition of Sheet 1 has been published.

A key factor for the success of vision projects is a common understanding between users and providers of the requirements, framework conditions and the performance to be provided by the image processing system – right from the start of the project. Misunderstandings due to unclear terms and ambiguities increase the implementation effort or even endanger the success of a project.

Dr Heiko Frohn, Managing Director of Technology at Vitronic and a member of the VDMA Machine Vision board, said: "With the revision of the draft published in 2021, on the one hand the current state of the art was taken into account, on the other hand we have succeeded in making basic terms more specific and selective. This is how the new edition of VDI/VDE/VDMA 2632 Sheet 1, published in January 2023, prevents costly misunderstandings."

Professor Michael Heizmann of KIT, chairman of the responsible technical committee, added: "With this guideline, we have a new fundamental basic document on which we will build when revising the other guidelines in the series of guidelines. An exciting task, because of the use of AI in

Vitronic

industrial image processing it is important."

The VDI/VDE/VDMA 2632 series of guidelines provides suppliers and users of image processing systems with important assistance in successful joint project management. VDI/VDE/VDMA 2632 Sheet 2 has proven itself many times over in the creation of specifications. Sheet 3 gives important tips for the acceptance of image processing systems and Sheet 3.1 presents methods for testing the classification performance of corresponding systems. These guidelines are based on the terminology that is defined and explained in a generally understandable manner in Sheet 1, which has recently been revised.

Hyperspectral imaging helps to serve up a better chicken breast

The University of Arkansas' Agricultural Experiment Station is using hyperspectral imaging to inspect chicken breasts for a defect known as "woody breast", which costs the poultry industry millions of dollars annually and decreases customer satisfaction.

Woody breast meat is harder to the touch as it has less water-holding capacity and less protein content, so the meat doesn't retain marination as well as meat without the defect. It is still a safe product, but can have a crunchier texture that is not appealing to customers

The defect is more common in larger birds. One theory is that these birds may be producing muscle faster than their blood vessels can support them. This possibly leads to muscle fibre damage from collagen deposits.

Woody breast affects up to about 20% of chicken breast meat. Although affected items can be diverted for further processing into products such as chicken nuggets, where the defect is not as noticeable, the loss in premium as a whole-muscle product accounts for a yield loss worth about $200m annually in the United States.

The non-invasive technique being developed by scientists at the University of Arkansas combines a near-infrared sensor with a high-definition colour camera to capture physical and chemical information.

The new method would replace the current evaluation procedure for woody breast, which requires time-consuming sample testing in a laboratory. Hyperspectral imaging would instead take just a few seconds to inspect and grade the meat on the production line.

"Woody breast detection by hand can be labour intensive," said Casey Owens, the Novus International Professor of Poultry Science at the Agricultural Experiment Station. "If hyperspectral imaging can be used in a poultry processing plant, that labour force could be diverted to another area."

The researchers take a hyperspectral image of each breast – taking up about 1 gigabyte of data – and use a computer to correlate it with a texture map (created from Owens' previous research) indicating hardness levels in the fillet. Once calibrated, the system would rely on the images alone to detect woody breast.

According to the researchers, so far the hyperspectral camera has detected woody breast meat with about 84% accuracy.

University of Arkansas

Graduate assistant Chaitanya Kumar Reddy Pallerla investigates the use of hyperspectral imaging to detect a defect in chicken meat

European Machine Vision Association celebrates 20th anniversary

By Thomas Lübkemeier
EMVA General Manager

This year marks a special milestone in EMVA history. Twenty years ago, the association was founded at the first ever EMVA Business Conference on 24 May 2003. Looking back, the foundation of the EMVA has been the result of a great European initiative. By the early 2000s, the machine vision business was already very international with most of the vision companies being small(er) and founder-managed companies. The time was ripe and the industry was ready to join forces cross-border. In 2002, the General Secretary of the Machine Vision Group at VDMA and Gabriele Jansen, then member of the Board of this group, were tasked to take the initiative and gather European support for a truly European vision association. Leading players from all over Europe were invited to send delegates into a European Vision Steering Committee.

This was the start of a successful pan-European collaboration. All aspects of competition were set aside and vision entrepreneurs and leaders from 12 European countries worked together for a year towards the ideation, the structure and the mission of the European Machine Vision Association. In parallel, this team planned the first ever European Vision Business Conference to take place in 2003 in Barcelona, where the EMVA was actually founded by 43 European companies and the first Board of Directors was elected.

From then on, the EMVA Business Conference grew to the pivotal European event of the machine vision community and took place in 19 European cities (including Seville 2023), plus two virtual 'pandemic' conferences.

In 2012, the EMVA became an independent, not-for-profit and member-owned industry association. Since then, membership has grown to currently more than 150 members. The associations' activities to serve the interests of its members have continuously broadened. Standardisation under the G3 initiative became a pillar of its work, paving the way for the breakthrough of machine vision technology in so many industry verticals with globally accepted and widely used standards such as GenICam and EMVA 1288. New initiatives were born, such as the annual European Machine Vision Forum as a meeting platform for research and industry, and during or around trade shows EMVA get-togethers always are among the most popular. Since 2020, Dr Chris Yates is acting EMVA President, and together with General Manager Thomas Lübkemeier and the whole EMVA team they are looking forward to celebrating the 20th EMVA anniversary during the EMVA Business Conference 2023 from 4-6 May in Seville, the country where the association was born two decades ago. More info about the conference can be found at **www.business-conference-emva.org.**

Raspberry Pi launches £50 global shutter camera

Raspberry Pi has introduced a new camera with a global shutter, enabling it to capture rapid motion without creating image artefacts.

Built around Sony's 1.6-megapixel IMX296 sensor, Raspberry Pi said it is well suited to machine vision applications and sports photography.

The company's previous cameras have been based on a rolling shutter sensor. These have a two-dimensional array of light-sensitive pixels that generate an analogue value proportional to the amount of light falling on the pixel during the exposure time. A row of analogue-to-digital converters (ADCs) converts the analogue values into digital values.

The row of ADCs is connected to each row of the pixel array in turn, so each row is sampled at a slightly different time. While this isn't a problem when imaging static scenes, for moving scenes – particularly those moving fast – rolling shutter artefacts are observed. Linear motion results in compression, stretching, or shearing of the moving object, while rotary motion can create even stranger-looking shapes. Such artefacts are difficult to correct and can interfere with the operation of machine vision algorithms.

To eliminate image artefacts, a global shutter sensor is used. This pairs each pixel with an analogue storage element, meaning that when the shutter fires, each pixel immediately copies its analogue value into its storage element, from where it can be read and converted at leisure. The storage element adds complexity and area to each pixel. Global shutter sensors therefore tend to have a lower resolution than rolling shutter sensors of the same size.

The new Raspberry Pi Global Shutter Camera combines the C/CS-mount metalwork of the firm's High Quality Camera with Sony's IMX296 sensor. It can be used with any Raspberry Pi computer that has a CSI camera connector.

Panasonic develops low-light hyperspectral imaging sensor with 'world's highest' sensitivity

Panasonic has developed what it says is the world's most sensitive hyperspectral imaging technology for low-light conditions. Based on a 'compressed' sensor technology previously used in medicine and astronomy, the technology was demonstrated early this year in *Nature Photonics*.

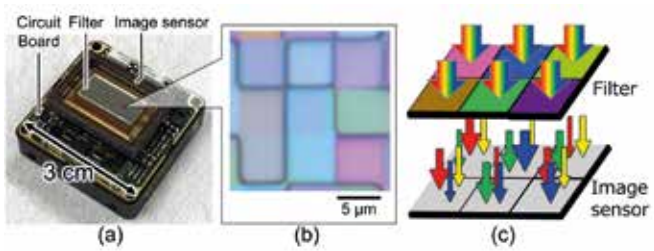
Conventional hyperspectral imaging technologies use optical elements such as prisms and filters to pass and detect light of a specific wavelength assigned to each pixel of the image sensor. However, these technologies have a physical restriction in that light of the non-assigned wavelengths cannot be detected at each pixel, decreasing the sensitivity.

Therefore, they require illumination comparable to a sunny day outdoors (10,000 lux or more), which decreases these technologies' usability and versatility.

The newly developed hyperspectral imaging technology instead employs 'compressed' sensing, which acquires images by "thinning out" the data and then reconstructing it. Such techniques have previously been deployed for MRI examinations, or observing black holes.

A distributed Bragg reflector (DBR) structure that transmits multiple wavelengths of light is implemented on the image sensor. This special filter transmits about 45% of incident light, between 450-650nm, and is divided into 20 wavelengths. It offers a sensitivity about 10 times higher than conventional technologies, which demonstrate a light-use efficiency of less than 5%. The filter is designed to appropriately thin out the captured data by transmitting incident light with randomly changing intensity for each pixel and wavelength. The

Panasonic



A photograph (a) and optical microscope image (b) of the new hyperspectral image sensor and filter. (c) The 'thinning out' light detection method used by the new filter

image data is then reconstructed rapidly using a newly optimised algorithm. By leaving a part of the colour-separating functions to the software, Panasonic has been able to overcome the previous trade-off between the number of wavelengths and sensitivity – the fundamental issue of conventional hyperspectral technologies.

This approach has made it possible to capture hyperspectral images and video with what Panasonic says is the world's highest sensitivity, under indoor levels of illumination (550 lux). This enables a fast shutter speed of more than 30fps, previously unachievable using conventional hyperspectral technologies.

Application examples of the new technology, which was demonstrated alongside Belgian research institute Imec, include inspection of tablets and foods, as this can now be done without the risk of high levels of illumination raising their temperature.

Ford creates automated driving subsidiary

Ford has established a subsidiary dedicated to autonomous driving systems for passenger vehicles. The new firm, Latitude AI, has about 550 employees with expertise across machine learning, robotics, cloud platforms, mapping, sensors, compute systems, test operations, systems and safety engineering.

Most of the new subsidiary's employees previously worked for Argo AI, a Ford-Volkswagen joint venture that closed in 2022. The decision to close Argo AI was made due to growing losses – amounting to billions – hitting both Ford and Volkswagen, as well as ongoing uncertainty surrounding when Level 4 autonomous driving technology would become commercially available.

Through its new wholly-owned subsidiary, Ford seeks to completely automate driving – hands-free, eyes-off-the-road – during particularly tedious and unpleasant situations, such as sitting in bumper-to-bumper traffic, or driving on long stretches of highway. Ford's current hands-free driving technology, BlueCruise, enables drivers to take their hands off the wheel on more than 130,000 miles of prequalified North American roads. The technology – currently available in Ford's Mustang Mach-E SUV, F-150 Truck, F-150 Lightning Truck and Expedition SUV models – has already accumulated more than 50m miles of hands-free driving. It does, however, require the driver to keep their eyes on the road, which is ensured via a driver-facing camera.

"We see automated driving technology as an opportunity to redefine the relationship between people and their vehicles," said Doug Field, chief advanced product development and technology officer at Ford. "Customers using BlueCruise are already experiencing the benefits of hands-off driving. The deep experience and talent in our Latitude team will help us accelerate the development of all-new automated driving technology – with the goal of not only making travel safer, less stressful and more enjoyable, but ultimately over time giving our customers some of their day back."

Sammy Omari, executive director of ADAS Technologies at Ford, will also serve as the CEO of Latitude. "We believe automated driving technology will help improve safety while unlocking all-new customer experiences that reduce stress and in the future will help free up a driver's time to focus on what they choose," he said. "The expertise of the Latitude team will further complement and enhance Ford's in-house global ADAS team in developing future driver assist technologies, ultimately delivering on the many benefits of automation."

Latitude is headquartered in Pittsburgh, Pennsylvania, with engineering hubs in Dearborn, Michigan, and Palo Alto, California. The company will also operate a highway-speed test track in Greenville, South Carolina.

New vision in place for UKIVA council

UKIVA
UK Industrial Vision Association

By Allan Anderson, UKIVA Chairman

UKIVA's new committee, left to right: Simon Hickman (vice-chairman), Paul Wilson, Allan Anderson (chairman), Mark Williamson, Ian Alderton (and Paul Cunningham – not pictured)

As UK manufacturing continues to emerge from the long shadow of Covid, it is vital that the vision sector is able to grow and flourish. With the beginning of my two-year term as UKIVA chairman, the association is embarking on a programme of change to help us achieve this.

As well as announcing a new committee, UKIVA has created a strategy focused on four key areas. Each committee member – supported by the chairman or vice-chairman – will take responsibility for one of these areas. They are: the Machine Vision Conference (MVC); membership; education and training; and the Vision in Action magazine and marketing.

We intend to keep improving MVC by expanding its size and attracting more delegates. We've taken our first step this year by extending it to two days. We want to make MVC the 'go to' event for the industry – and we'll do this by building a diverse audience of OEMs, machine builders, end users and academics. Maintaining a strong conference programme will be vital.

Another key aim is to grow our membership – and we'll do this by extending the benefits it offers: preferential rates to exhibit at MVC; media exposure through Vision in Action; and discounted rates for training. We're also looking to create a machine vision community in which ideas are exchanged in dedicated networking sessions. We're confident these initiatives will help us expand from 50 to 70 core members within two years.

Vision in Action is a key route to market for many members. UKIVA will beef up the magazine by expanding its size and reach. Initiatives such as 'ask the expert' sessions, an increased digital presence and live-streamed discussions will help to lift the magazine – offering an enhanced product to our members. Raising Vision in Action's quality – in both the print and digital versions – will help to expand the readership. Alongside this, enhancing our presence online and through social channels will further boost UKIVA's reach.

Education and training are vital to professional development. It's our intention to explore a UKIVA-certified scheme for vision solution providers. In addition, we will explore options to introduce UKIVA machine vision training courses. Offering these schemes will make membership more attractive, boosting numbers further. Underpinning both certification and training schemes, UKIVA members will offer live online STEM sessions – to create good publicity and highlight the vision industry as an employer.

By focusing on these four critical areas, UKIVA aims to expand the use of machine vision in the UK, and make it easier for members to boost sales of their products and services.

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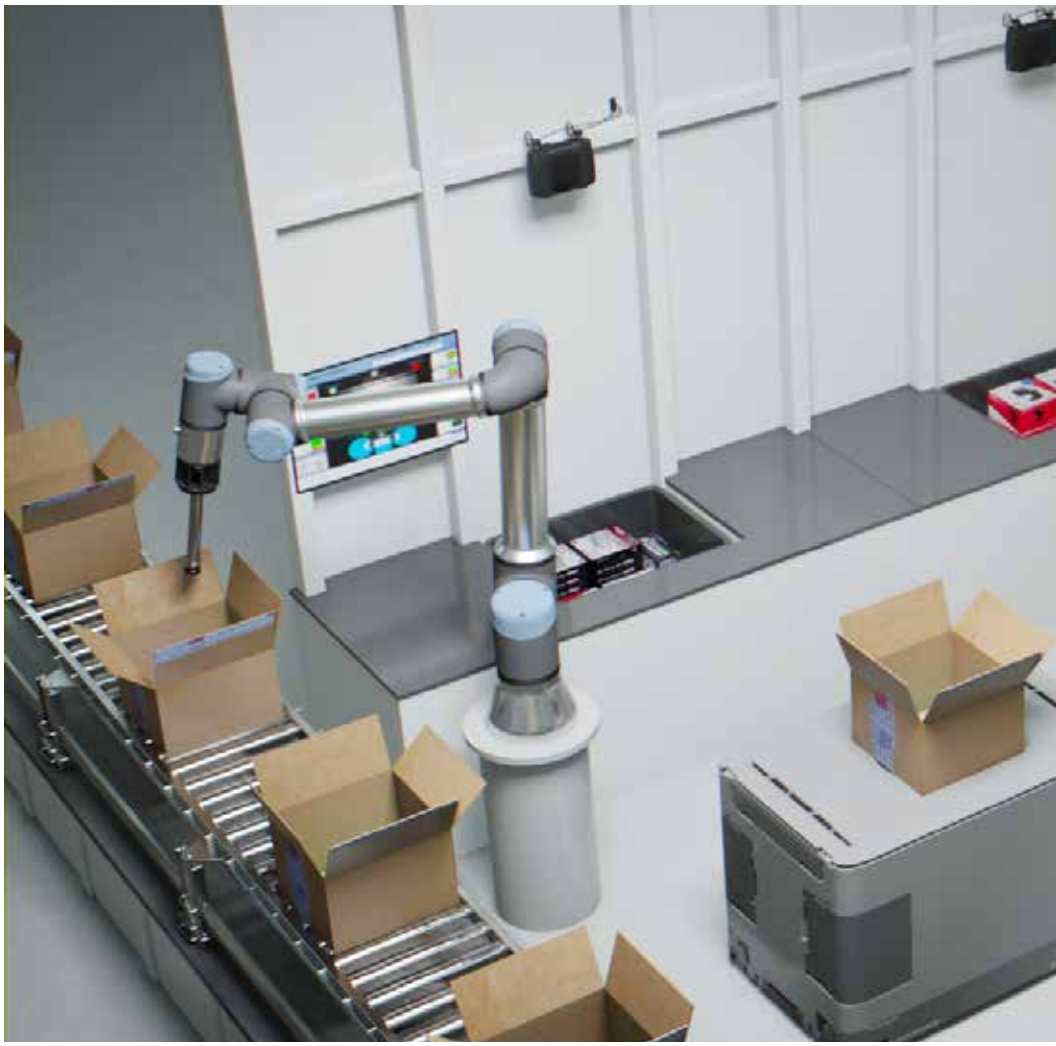
Why logistics firms want flexible machine vision

Facing new pressures and demands, logistics operations are calling for adaptable machine vision solutions to drive efficiency, discovers **Benjamin Skuse**



The global Covid-19 pandemic may be referred to in the past tense in many countries, but its impacts are still felt in a slew of different areas of society, not least logistics. Worldwide supply chain disruption, a drop in international trade, semiconductor and other component shortages, and a severe labour shortage due to freedom of movement restrictions, have conspired to make running a successful logistics operation more difficult than ever.

At the same time, due to the pandemic making online shopping a necessity, consumers and businesses have gone digital, and they are not turning back. E-commerce sales have soared, which for logistics has meant increasing order volumes and more demanding fulfilment speeds.

"This transformation has been so fast, so abrupt, that the only way for e-commerce and logistics companies to be able to fulfil is by automating – and that's what they're all trying to do," says Donato Montanari, Vice President and General Manager of Machine Vision at Zebra Technologies.

Yet for some companies, handheld barcode scanners are the closest they have got to implementing machine vision. Others have expensive legacy management systems and visibility solutions they are reluctant to ditch. For many, a rapidly evolving business means a fit-for-purpose solution today may not pass muster in six months. For all, the very nature of logistics today calls for solutions that can cope with organised chaos. This is why – alongside the imperative to add value – flexibility is at the heart of today's machine vision products for logistics.

Flexible parcel identification

In the 1990s, when Vitronic installed its parcel identification technology at the Worldport in Louisville, USA – UPS's largest parcel distribution centre worldwide – they also installed 160 video coding stations. Workers sat at screens staring at images of parcels, where they manually coded up parcels that had not been read automatically by Vitronic's system of conveyor belts fitted with fixed line scan cameras reading barcodes and address labels.

Today, manual video coding is almost a thing of the past for the company. Vitronic's Vipac identification system achieves a near 100% identification rate, still using line scan cameras, but utilising machine vision to identify codes that can be obscured by foil, damaged in transit or otherwise scrambled, as well as handwritten address information and dangerous goods labels, wherever they may be hidden on a given parcel.

"We're taking images on all six sides – including underneath – viewing a complete 360 degrees and at very high speed (up to 4.5m/s) and then the Vipac system is decoding it using our software," says Gary Young, Vitronic's Head of External Sales for Business Unit Automation and Global Key Account Manager for courier, express and parcel services (CEP). "We also now identify the parcel's shape and size (and in some locations weigh the parcel), where the data can be used to cross-reference that against the customer's database." The result

‘We’re taking images on all six sides – including underneath… and at very high speed up to 4.5m/s’

Zivid

Automation is the only way for e-commerce and logistics firms to fulfil orders since the dramatic uptick in online shopping brought about by the Covid-19 pandemic

Zivid

Zivid

Above: Zivid’s cameras offer less than 0.2% trueness error, enabling it to pick and place with extreme accuracy. Below: The Zivid Two camera can be mounted on a robot for pick-and-place applications

is greater flexibility in the types of parcels CEP providers can accommodate and better visibility across their logistics sequence.

Looking to the future, Young believes the technology for parcel identification is near-optimal. “CEP camera technology is most probably at its peak,” adds Young. “It’s all in the software now – how you capture, decipher and use the image, and how you run and improve your algorithms are where the marginal gains are coming from.”

Customer choice

Outside parcel identification, there are still plenty of areas in which machine vision can provide significant gains for logistics operations. German industrial camera manufacturer Allied Vision is providing flexibility to customers by allowing them to choose their ideal solution from a wide variety of machine vision products.

Introduced three years ago, the company’s Alvium camera series features more than 200 different cameras that all share the same unique system-on-chip ASIC. This shared platform and wide range of camera options, in terms of interface, sensors, spectral sensitivity, housing, lens mounts and camera series, provides all the elements required to develop a vision system according to specific needs, while also simplifying prototyping, upgrading or downgrading the system.

“We are working to really extend and make it easier for our customers to integrate our cameras,” says Claus Haselmeier, Business Development Manager for Embedded at Allied vision. “For example, when the Alvium camera series was launched, initially there were cameras with USB3 and CSI-2 [Camera Serial Interface 2] interfaces. Since then, we have expanded the product portfolio with GigE [Gigabit Ethernet] and 5GigE cameras.”

Allied Vision also offers Vimba and Vimba X software development kits to explore camera features, program applications and connect to third-party libraries. The company also works with partners specialising in embedded and machine vision – such →

'CEP camera technology is most probably at its peak…it's all in the software now'

→ as Connect Tech and Nvidia – to allow customers easy integration of hardware and software systems. "This is key for us to be successful in embedded vision and the logistics market," says Haselmeier.

Zebra Technologies also has a wide portfolio of logistics visibility products providing customers flexibility and choice, though in the form of complete hardware-software packages focused on ease of use. "Ease of use is what we want at all levels," says Montanari. "At the engineering level, where you have control engineers who install the system, but also the operators' level, who have to deal with a product every day."

Zebra is a relatively new entrant in the machine vision industry, rather fortuitously announcing its arrival in 2021 just as the market was seeing an upsurge in interest. "We felt that we had the right know-how, the right go-to-market model to be a significant disruptor in the machine vision industry," says Montanari. "But we realised that internally we needed to build on and expand the portfolio required for machine vision."

Two acquisitions – software company Adaptive Vision and hardware and software supplier Matrox Imaging – changed that picture, bolstering Zebra's fixed industrial scanning and machine vision capabilities and swelling its product portfolio. But the key to Zebra's success (about 40% of its 2022 revenue came from logistics and manufacturing) has been flexible software. With its entire product family run on one simple-to-use platform – Zebra Aurora – customers can easily configure the devices for either fixed industrial scanning or machine vision, or repurpose for either use case, allowing them to meet evolving operational, market and compliance requirements.

Rise of the robots

The next step for Zebra is to add advanced robotics utilising machine vision to its stable. "One of the biggest trends in logistics today is the adoption of robots everywhere – inbound, outbound and sorting," says Montanari. "For us, it's a very significant undertaking that you'll probably see the results of somewhere in 2024, because again we want to make it as simple as reading a barcode."

When Zebra does release its robot machine vision products, they will have stiff competition. The likes of Basler, Yaskawa Motoman Robotics, ABB, Robomotive and others have vision-driven robots on the market for specific logistics tasks now. And there are many more OEMs providing the building blocks for logistics robots with advanced vision systems.

The Zivid Two industrial 3D camera family from Norwegian technology company Zivid is a prime example. Combining performance, flexibility and industrial build quality, Zivid's palm-sized compact camera can be mounted statically or on a robot for pick-and-place applications such as parcel induction, sorting and packing, and (de)palletising. "What we pride ourselves on is what we call 'true to reality point clouds,'" says John Leonard, Product Marketing Manager at Zivid. "And where we really excel is in reliable accuracy and trueness." Accurate (in terms of precision and trueness) positioning and depth information is key to fine pick-and-place operations

Alvium

Allied Vision's Alvium camera series offers options for logistics firms with unique applications

Dexory

Dexory's latest robot can extend up to 12 metres for warehouse scanning applications

where millimetre errors can be costly. "We have less than 0.2% trueness error," says Leonard.

The Zivid Two also offers flexibility in terms of being able to work in any logistics environment. Warehouses are often subject to extreme temperature fluctuations, for example, that can affect the electronics and optics, causing calibration drift. Zivid has introduced internal mechanisms that automatically keep the camera in a high state of calibration, close to that when it left the factory.

A vision for future logistics

Revealing the potential of pairing mobile logistics robots with machine vision is UK company Dexory. The DexoryView data visualisation software platform receives a given warehouse's data from autonomous robots, which collect images and point cloud information to create a 'digital twin' in real time. This means operators can know the status and condition of warehouse racks and items on them at any time.

"From the real-time insights and real-time information, people have the exact view of what's going on at any point in time in any square cubic metre of the warehouse," says Dexory CEO Andrei Danescu.

"We're operating like an OEM full stack solution provider," he continues. "We build everything from hardware, all the way to the cloud platform and APIs, and integration with customers." This means its solutions are flexible to the needs of the client. For example, the robots are modular and bespoke for each application, adapted to the environment which they will patrol. The latest robot can extend up to 12m, ensuring it can scan warehouses of any shape or size.

At the base of each robot is a lidar system and stereo cameras for navigation, allowing object and obstacle detection so that it can navigate autonomously and safely through the space. Further up is a range of machine vision cameras, whose makeup depends on individual customer requirements.

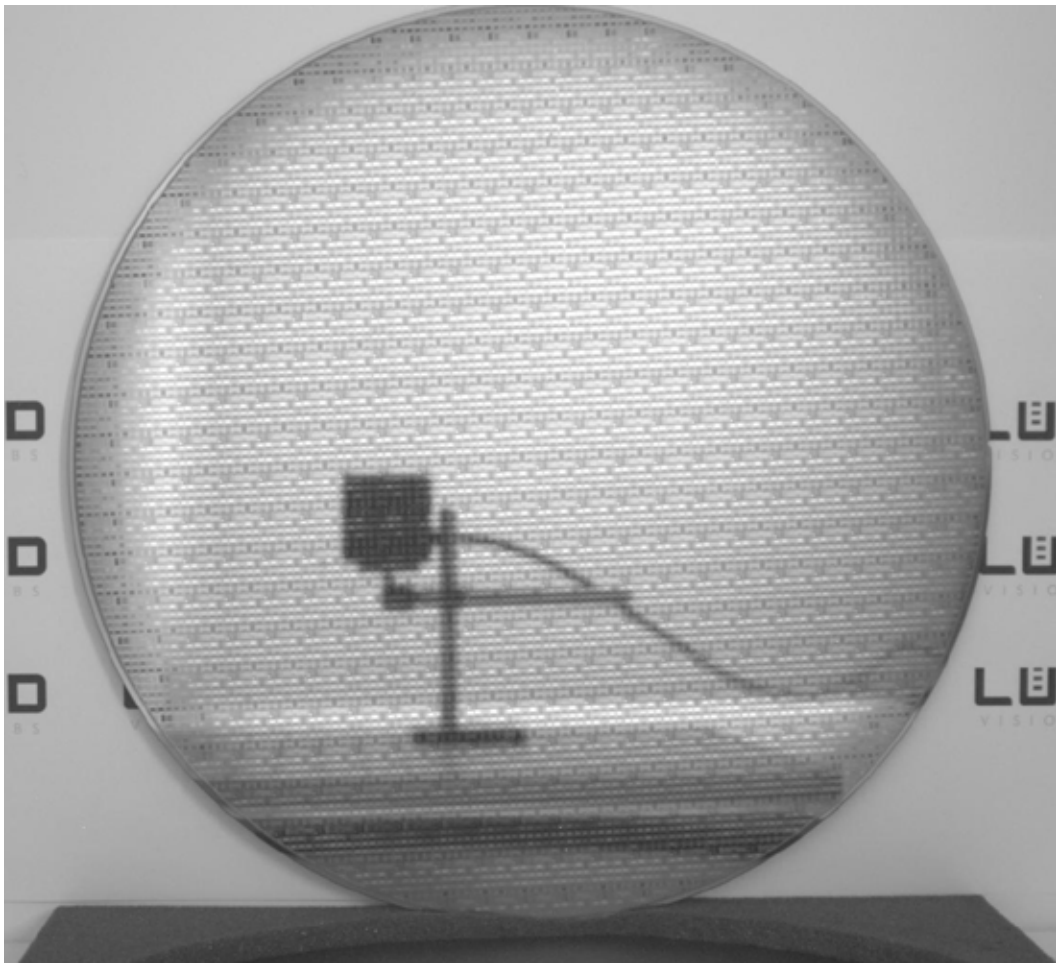
"As an example, a robot could be operating for eight hours during a complete warehouse scan, taking 20 to 30 frames per second with anything between six and 16 cameras, including standard monochrome cameras, colour cameras and stereo cameras," says Danescu. "So there are a lot of images that are being taken of the state of the racks and the state of the warehouse to allow us to do this real-time visibility and reconstruction."

Already deployed at a Maersk warehouse in Kettering, UK, Dexory's solution is helping Maersk measure, track and locate goods across every logistics step, from inbound to storage to outbound in order to drive zero errors and operational efficiency. "The warehouse managers and warehouse operators use it to make sure they have the exact view of what's going on on the warehouse floor," says Danescu. "At the same time, business intelligence teams look at this information to understand and analyse warehouse utilisation to see if they can accommodate another customer in that warehouse and how they can best optimise the general operation at the country level and European level."

Next up for Dexory is enhancing its offering through the newly introduced DexoryView platform. It plans to add historic data analysis, predictive modules and even simulation facilities: "This will allow our customers to make changes in a virtual world so they can assess what implications those might have on their operations without disrupting any actual operations," says Danescu. "There's a lot coming out of the DexoryView technology stack over the next six to eight months."

SWIR-crazy: a look at the latest wafer testing tech

Hunting defects in the soon-to-be trillion-dollar semiconductor industry is big business. **Anita Chandran** explores the latest wafer inspection technology



Integrated circuits based on semiconductor platforms underpin much of our current technology: everything from electronic devices and sensors to solar panels.

The demand for such platforms is ever increasing, with consultancy firm McKinsey anticipating that the semiconductor industry will be worth more than $1tn by 2030[1], up from about $600bn in 2021. It is estimated that about 70% of this growth will be driven by applications in electric vehicles, data storage, and wireless communications.

The need for high-yield, reliable manufacturing processes has pushed the need for excellent semiconductor wafer inspection technologies. Wafer inspection involves imaging semiconductor chips throughout the fabrication process to spot defects. But the inspection process is costly and time-consuming, with hundreds of steps involved in manufacturing a single chip – a process that can take up to two months. The growing need to address such issues has led to the semiconductor inspection industry itself becoming significant – currently valued at $5bn, and expected to grow to $8.9bn by 2031, according to Allied Market Research[2].

Manufacturers continually seek faster, higher-resolution imaging solutions for chip inspection to help boost the rate of fabrication. State-of-the-art cameras are therefore being developed and blue skies research undertaken in a bid to increase yield and efficiency in one of the world's most important industries.

Short-wave infrared machine vision

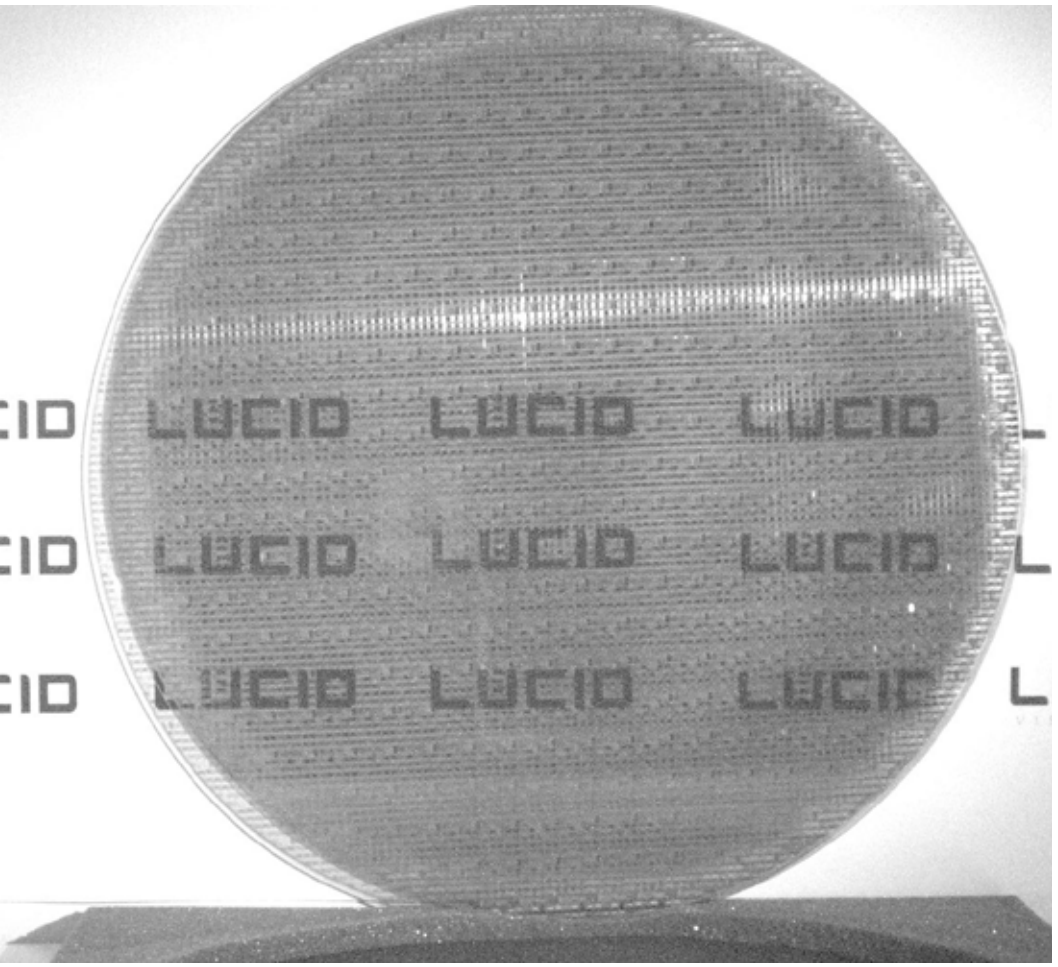
Most semiconductor devices are made from silicon wafers. Silicon is largely opaque to visible light, but its transmissivity to light in the short-wave infrared (SWIR) spectrum is much higher, rendering it transparent at wavelengths greater than 1,050nm. As a result, many camera technologies used for chip inspection are based on SWIR sensors. Most of these systems utilise indium gallium arsenide (InGaAs) sensors with a sensitivity range from 900 to 1,700nm. By illuminating silicon semiconductor chips with SWIR light, these cameras can detect tiny features such as micro-cracks or contaminant particles.

"To see small features and failures you need a good signal-to-noise ratio. In order for that, you need a camera that is highly sensitive," says Marc Larive, Strategic Marketing Manager of Xenics, a sensor and camera developer for semiconductor wafer inspection in chip fabrication.

Xenics' cameras aim to achieve the vital trade-off between the high sensitivity required for SWIR detectors in semiconductor inspection, and pixel resolution. While the sensitivity of a camera is directly proportional to pixel size, going to smaller pixel sizes is not always the best solution.

"In visible cameras, the aim is to get the smallest pixel size possible, because you can obtain high resolutions," says Larive. "But in SWIR this isn't so because you don't have a lot of natural light. You're looking for tiny defects, so light budget is an issue. At Xenics, we found a very good trade-off with a pixel size of 20 microns – you can detect very small items, small failures with it."

‘We found a very good trade-off with a pixel size of 20 microns – you can detect very small failures with it’



Lucid Vision Labs

Far left: A semiconductor wafer shown to be opaque to white visible light. Left: the wafer is mostly transparent to SWIR light at a wavelength of 1,200nm, making it a suitable wavelength for semiconductor inspection. Above: Lucid Vision Lab’s Atlas and Triton SWIR cameras

The SWIR cameras offered by Xenics are its Wildcat+ 640 series, which use in-house-made InGaAs photodiode detector arrays, 20-micron pixel diameters, and offer speeds of up to 300Hz full frame. Larive says the Wildcat+ 640 offers the highest “normalised sensitivity” (a measure of pixel surface compared with detector noise) available on the market, with high dynamic range. It also comes with a standard industrial interface and triggering abilities – functions that are invaluable to manufacturing clients. Xenics claims to get a normalised sensitivity about 20% higher than most market competitors that use smaller pixel sizes.

While resolution and speed are important metrics, Xenics emphasises that easy integration and compatibility with existing manufacturing infrastructure are also very important. “It’s not rocket science,” says Larive. “But it’s very important for manufacturers so they don’t have to spend years redeveloping technology. It should be something plug-and-play.”

Xenics adds that its products do not just cover SWIR. It also targets long-wave infrared (LWIR) through its Dione CAM product series. LWIR cameras are also of great interest to semiconductor wafer manufacturers, in particular because of their ability to look for thermal defects. The Dione series uses commercially available microbolometers for its sensors.

Lucid Vision Labs is another company making big strides in camera technology for semiconductor inspection. Lucid’s Triton and Atlas ranges both offer SWIR cameras that use Sony 0.3 megapixel IMX 991 and 1.3 megapixel IMX 990 InGaAs sensors. Triton SWIR was launched by Lucid at the beginning of 2023, affording customers a lower-cost alternative to its powerful Atlas series. The Atlas SWIR camera, unlike the Triton range, offers in-camera cooling for decreasing thermal noise in SWIR detection.

Lucid offers a wide range of products for wafer inspection, up to 10 Gigabit Ethernet (10GigE) at resolutions of up to 47 megapixels. Its Atlas model cameras, with up to 31 megapixel resolution, are widely sold, delivering over 5GigE. Lucid is working on pushing the resolution of its cameras even further, aiming to release a 65 megapixel version of the Atlas (Atlas10) camera in Q2 2023. This camera will be Lucid’s highest-resolution model, featuring Gpixel’s GMAX3265 CMOS sensor.

Like other competitors in the industry, Lucid says SWIR cameras are in high demand for semiconductor inspection, but it also produces UV cameras that are used in other parts of the chip-manufacturing process. In December 2022, Lucid launched a UV model of its Atlas10 GigE camera with an 8.1 megapixel Sony IMX487 sensor, capable of imaging between 200 and 400nm.

The bandwidth barrier

While both sensor and camera development are important to Lucid’s technology, the company states that aside from increases in imaging resolution or →

SWIR Vision Systems & Emberion

SWIR Vision Systems' Acuros camera, above, and Emberion's VS20 Vis-SWIR, right, are both based on sensors utilising quantum dot technology

→ frame rates, managing bandwidth and data transfer are becoming important areas of growth. In device inspection, for the most efficient defect detection, cameras need high frame rates and high imaging resolution. This creates a huge amount of data. The challenge is then getting this data into a processing computer or GPU, requiring a high bandwidth interface.

"The big question is 'how should you process all this incoming data?'," says Alexis Teissie, Senior Product Manager of Lucid Vision Labs. "On the interfacing side, we are looking at a global view of not just pushing everything to the central CPU, but trying to work closely with our customers to scale with the technology."

Teissie says it is about leveraging the network standard used in high-performance computing clusters, but applying it to machine vision. "And making sure that we can reliably transfer 10Gigabits from multiple cameras with no CPU involvement," he continues. "Because we are working with high-frame-rate cameras and we need the highest reliability – and so, high bandwidth – we're developing special network transfer technology: a Remote DMA technology."

> 'CEP camera technology is most probably at its peak…it's all in the software now'

Remote DMA (RDMA) is a technology that allows networked computers to exchange information without relying on the operating systems or processors of the computers themselves. This technology allows for low latency in the data transfer process, meaning that data packets do not take long to be stored or retrieved. Using RDMA, then, data can be transferred quickly without any burden to the CPU of the processors involved.

"This is a building block to make sure we have reliable transfer so that we can ensure that whenever a frame is required, it will be delivered with certainty," says Teissie.

"There is this move to go to higher speeds and just getting higher bandwidths – this is just the first step," Teissie adds. "25GigE is coming."

Lucid's upcoming Atlas10 camera with RDMA is aimed to be released by the end of Q2 2023, and it notes that "one of the target markets for this is definitely semiconductor wafer inspection".

Quantum vision

One limiting factor surrounding SWIR cameras based on InGaAs sensors is their price point, which can stretch to thousands of euros per sensor chip because of their fabrication process. SWIR sensors utilising quantum dots (QDs) have, in the past few years, provided a potential route to lowering costs. These sensors, which are based on thin films, use QDs as a detection mechanism for SWIR radiation.

QDs are now disrupting the marketplace for SWIR cameras, being deployed in products such as SWIR Vision Systems' Acuros series and Emberion's VS20 Vis-SWIR camera. The Acuros cameras use a 15 micron pixel size in their detectors, as well as offering camera cooling technology to reduce the impact of thermal noise. Emberion is also developing a version of its VS20 series with a GigE interface, potentially offering a framerate of up to 400fps.

"QD-based SWIR cameras are already on the market, costing around half the price of conventional alternatives," says Adam Button, spokesman for Quantum Science, a specialist nanomaterials developer that uses a new fabrication technique to push down the price of QD-based SWIR sensors even further. Its in-house-developed INFIQ QDs are produced at scale using a synthetic process that facilitates control and production. This enables them, in Button's words, to manufacture SWIR sensors "at a fraction of the price of existing technologies".

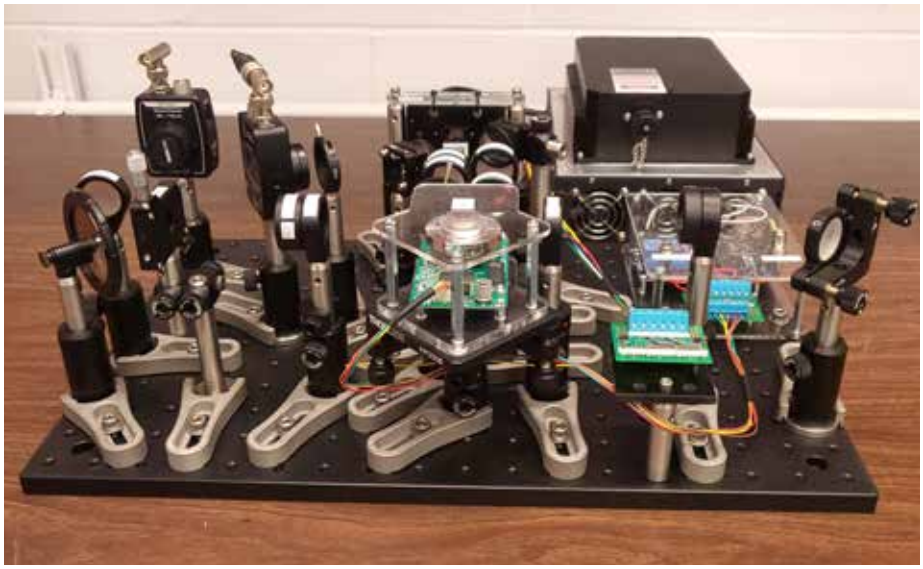
"Traditional formation processes involve the deposition of 14-16 thin film layers, which introduce multiple opportunities for manufacturing errors to occur. INFIQ QDs can be deposited in a single layer. This minimises the risk of defects forming and accelerates the manufacturing process."

Quantum Science's QD fabrication also circumvents another barrier to the wide adoption of QDs: the toxicity of heavy metal components used in their manufacture. The company is already partnering with sensor design companies and large semiconductor businesses with the aim of bringing its QDs to market quickly.

Blue skies ahead

Promising advances for potential applications in semiconductor inspection are also happening in academia. Jinyang

Liang et al



Liang et al.'s setup for combining single-pixel and terahertz imaging techniques, which could offer an excellent solution for non-invasive semiconductor inspection

Liang's team at INRS at the Université du Québec, Canada, has recently released a new camera based on single-pixel imaging technology, described in *Nature Communications*[3].

Single-pixel imaging is a computational imaging technology that relies not only on the optical image collected by a detector, but the use of a computer to reconstruct the image: technology that brings together both optical engineering and computer science.

"The marriage of these two fields can give you many unique aspects that allow imaging systems to exceed the technical capabilities of conventional imaging systems," says Liang. "The focus of our research is towards the high-speed [imaging] aspect."

Liang's research is describing cameras that operate with frame rates of up to one million frames a second. At the moment, the technology exists only in the visible, but Liang and his team are looking at commercialising their cameras for applications to long-wave infrared and terahertz imaging – potentially of interest to semiconductor wafer inspection.

'Combining single-pixel imaging with terahertz imaging could have great potential for non-invasive semiconductor inspection'

"Combining this [single-pixel imaging] technique with terahertz imaging could be a very nice potential technique for non-invasive semiconductor inspection because it's sensitive to the flow of charges," he says. "We may be able to see the flow of charges to see where there might be a broken wire or malfunctioning chip."

This kind of inspection is currently done by first capturing an image and then extracting positional information on a shot-by-shot basis, which is time-consuming. However, Liang sees single-pixel imaging as a technique for potentially dramatically increasing inspection speed. "The advantage would be that you have much faster image rates," he said.

Liang's research is still in its development phase, though the team has partnered with Agile Light Industries to work on applying their research to existing commercial sensors.

"For the technique we've developed, the technological readiness level is rather high," says Liang. "Right now, we are working on jointly developing this technology further, to turn it into a compact and turnkey device."

The wafer inspection industry is one where research such as Liang's is filtering quickly into commercial products, mirroring a dynamic and uncompromising manufacturing environment. With others such as Lucid, Xenics and Quantum Science bringing new, blue-skies innovation into their own product lines, the future of chip inspection certainly looks bright.

[1] McKinsey & Company – 'The semiconductor decade: A trillion-dollar industry'
[2] Allied Market Research – 'Semiconductor Inspection System Market Research, 2031'
[3] Kilcullen, P., Ozaki, T. & Liang, J. 'Compressed ultrahigh-speed single-pixel imaging by swept aggregate patterns', *Nature Communications* 13, 7879 (2022). https://doi.org/10.1038/s41467-022-35585-8

Meeting the demands of high-throughput semiconductor inspection

Maximilian Klammer and **Klaus Riemer** share how colour line scan CMOS cameras are enabling high-throughput inspection for semiconductor and PCB manufacturing

Semiconductor geometries and printed circuit board (PCB) components are becoming smaller, while the demands on quality testing and control are growing.

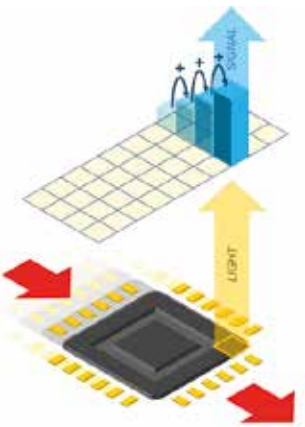
Because of the minute structures involved, optical inspection in modern semiconductor manufacturing occurs in the micrometre range. The need to detect defects and contamination at this scale and at high throughput places the highest demands on inspection systems. Extremely high-resolution colour line scan cameras with CMOS technology have been developed to accomplish this.

CMOS technology

Line scan cameras are suitable for image-capturing tasks where fast-moving large areas or flat objects must be captured and analysed with high optical resolution. In a CCD line scan camera, the pixels of the sensor are arranged in a single line. The readout cycle is adapted to the throughput speed of the inspected objects or surface areas. The whole two-dimensional image is then created by joining the individual lines together.

CCD sensors have long been the technology of choice in line scan imaging because of their image quality, high sensitivity, low noise, low photo-response non-uniformity (PRNU), high dynamic range, and signal-to-noise ratio. These benefits are essential in line scanning because of the high-speed image acquisition and reduced number of photosensitive cells, which means exposure is limited.

New-generation CMOS line scan sensors now offer similar image quality to CCDs, coupled with benefits such as higher readout speed and flexible readout modes. Unlike single-line CCDs, these sensors have several lines of pixels, allowing for different operation modes depending on an application's requirements. One key benefit of a multiline sensor is time delay integration (TDI). TDI consists of adding up the values of adjacent pixel lines synchronously with the motion of the object below the camera. The same section of the object is imaged by several lines, and adding up the signals of all these lines increases the signal intensity compared with a single line sensor. This solution has a much better signal-to-noise ratio than an equal increase in gain.



With time delay integration, the same point on the object is captured by all pixels of the same column as the object passes below the sensor. The signals of all pixels are added up to increase sensitivity

The combination of specially adapted line illumination with CMOS line scan cameras results in a powerful system optimally matched to the application. The illumination system homogeneously illuminates a line on the object with a very high luminosity, whereby the light colour and the illumination geometry can be precisely adapted to the image capture requirements.

Profitability in semiconductor manufacturing relies on the level of flawless product yield. Therefore, manufacturers test products multiple times, starting with bare wafers and ending with inserting the chips into the IC packages.

As the wafer moves along the production line, components are added, increasing its complexity. Yield-reducing defects must therefore be identified as quickly and as early as possible while also reducing overall inspection time. This results in more inspection points at each process step in the production line, with the inspection system required to produce the scan results more quickly. Inspection throughput is critical to the fab's overall production.

Faster semiconductor inspection

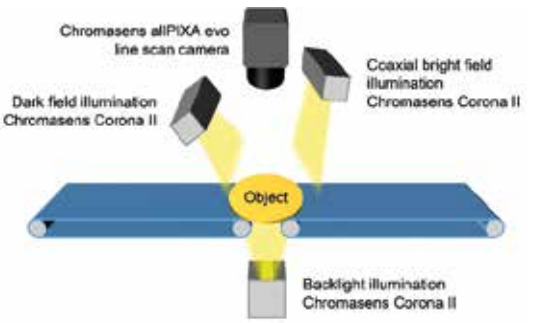
Scanning and illumination techniques offer a solution by providing faster and more efficient semiconductor inspection. As a rule, wafer inspection is performed with dark-field illumination and coaxial bright-field illumination. PCBs can be inspected using a combination of diffuse light and bright-field illumination – the diffuse light is used primarily for 3D-shaped components to eliminate gloss and reflections while the bright-field lighting is used to inspect the substrate itself.

New-generation cameras feature multichannel illumination functionalities that enable different types of illumination in one scan. Acquiring up to four different images in one scan provides much more information and improves defect detection. Multifield imaging enables the generation of HDR images from up to four lines captured with different settings. This allows details to be detected in both bright and dark areas in the image. Both can be combined to increase detection reliability and shorten inspection time.

The trend toward miniaturisation continues for PCBs and the components mounted on them. This leads to so-called panelisation, whereby several PCBs are manufactured on one panel. Each PCB on the panel is identified by a unique barcode, and thus rapidly inspecting the PCBs is correspondingly complex and demanding. For example, during the visual inspection, existing solder defects, such as interruptions, solder bridges, solder short circuits, or excess solder, must be identified, in addition to component defects such as lifted solder and missing or misplaced components. A colour line scan camera system can perform these inspection tasks with great accuracy because of its high operating speed and lateral resolution. Oxidised copper wires on PCBs must also be detected, yet monochrome systems cannot reliably identify oxidised areas. However, high-performance colour line scan cameras such as the allPIXA evo from Chromasens, combined with high-performance illumination, excel at this task.

Examples from semiconductor and PCB manufacturing show that high-performance colour line scan cameras can play an important role as central components in 100% real-time inspection processes. The image quality and resolution performance of multiline full-colour CMOS line sensors result in a particularly high application potential for camera systems. Fast and accurate colour measurements and rapid 3D inspection are additional future applications.

***Maximilian Klammer** is an R&D Manager and **Klaus Riemer** a Project Manager at Chromasens*



Chromasens' allPIXA evo allows up to four lighting configurations to be combined in one scan. Three different light configurations are shown here

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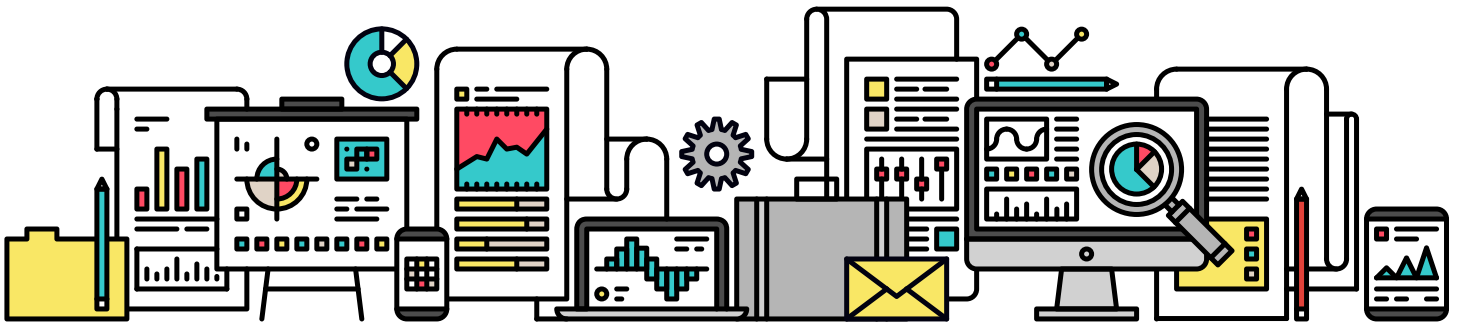

Streamlining development and implementation of Deep Learning Machine Vision applications with data centric tool

EURESYS

This White Paper details why data is the core of any deep learning-based application, and that the tools for managing data and working with the deep learning algorithm are paramount to obtaining good results.

RoCEv2 for GigE Vision

EURESYS

A proposal to break the speed ceiling of GigE Vision in a standardised and reliable way to meet the next generation of sensor sizes and speeds.

The needle in the haystack: Rare Traces in forensics

EXCELITAS, AURA OPTIK

This white paper presents a first-ever automated approach to digitalize spectral properties found on forensic trace carriers. By using high-performance Excelitas lenses and AI-driven software the few deviating traces on a trace carrier can be identified which can be decisive to solve a crime. Such traces are called rare traces in forensics.

Liquid lenses for machine vision: innovative solutions to get the best out of your system

OPTO ENGINEERING

Liquid lenses are arguably among the most interesting technological innovations in the field of optics and have also attracted a lot of attention in machine vision. In this white paper, we will discuss how Opto Engineering integrates liquid lenses into different types of optics to give them particular characteristics.

Optimizing machine vision lighting for your application

PROPHOTONIX

In this new whitepaper, Optimizing Machine Vision Lighting for your Application, ProPhotonix's experts discuss optics, mechanics, electronics, firmware, and GUI options in detail providing application examples throughout.

Accessible hyperspectral imaging: how can it be achieved?

PHOTON LINES, UNISPECTRAL

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

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Event cameras have their moment at MWC 2023: enabling a new era of photography in consumer devices

Luca Verre, Co-founder and CEO of Prophesee, as well as a Photonics100 honoree, highlights how event-based vision is set to revolutionise mobile photography

The recent Mobile World Congress (MWC), the annual showcase for the newest model smartphones and other mobile devices, reinforced the most significant trend in how this massive consumer product sector is evolving. Driven by the TikTok/Snapchat/Instagram generation – enabled by more AI-enriched capabilities – and shaped by generational shifts in how humans communicate, the camera has become the centrepiece of the modern mobile device. Eye-catching industrial designs; bigger, brighter displays and higher-bandwidth 5G connectivity all take a backseat in the relentless quest to capture, manipulate and share visual information more effectively.

Undeniably, the camera is the lead feature in every new flagship model introduction. It is clear that the prophecy that has been percolating for several years has taken hold in a very real way: "the camera is the new keyboard".

All of which makes the pace and type of camera innovations in mobile devices even more critical. Yet the not-so-talked-about secret of the industry is that we have been relying on concepts that are more than 100 years old to drive improvements in each new generation of device. Yes, there have been steady and impressive advancements in adding multiple cameras and sensors to phones, as well as incrementally higher pixel counts to improve still picture clarity, improvements in low-light performance and HDR, better autofocus features, and computational photography to improve depth of field and colour reproduction. The industry has not stood still in this regard, and today's newest models are getting closer to rivalling expensive traditional cameras in terms of quality and performance. But nagging concerns about the potential of smaller sensors and a reliance on software correction techniques still keep smartphone cameras from being in the same class as pro models.

Underlying this is the fact that most, if not all, enhancements rely on techniques pioneered by Eadweard Muybridge in the 1880s and that trace their roots back as far as Leonardo Da Vinci's *camera obscura*. Frame-based photography – a means to capture static images – is inextricably embedded in the camera mindset and continues to serve us well. But it was never meant to address some of the challenges introduced by today's ultra-mobile use of photography, which demands new levels of capability to efficiently capture motion and operate in challenging lighting conditions. In frame-based image capture, an entire image (i.e. the light intensity at each pixel) is recorded at a pre-assigned interval, known as the frame rate. While this works well in representing the 'real world' when displayed on a screen, recording the entire image at every time increment oversamples all the parts of the image that have not changed.

In other words, because these traditional camera techniques capture everything going on in a scene all the time, they create far too much unnecessary data – up to 90% or more in many applications. This taxes computing resources and complicates data analysis. On top of that, motion blur can occur because of the relatively open-and-shut exposure times with frame-based cameras that causes them to 'miss' things between frames.

The fundamental nature of frame-based photography as a way to capture images therefore prevents it from being able to operate effectively in certain scenes and for specific needs in a way that represents how humans actually see the world. Therein lies a key to how the technology can evolve – the human eye samples changes at up to 1,000 times per second, however does not record the primarily static background at such high frequencies.

Bio-inspired event cameras emerge as a viable solution

Over the past several years, event cameras that leverage neuromorphic techniques to operate more like the human eye and brain have gained a strong foothold in machine vision applications in industrial automation, robotics, automotive and other areas – all applications where better performance in dynamic scenes, capturing fast-moving subjects and operating in low light conditions are critical *(Read 'Why you will be seeing much more from event cameras' in IMVE Feb/Mar 2023*). Now, thanks to improvements in size, power and cost, event-based sensors have emerged as a viable option to complement frame-based methods in more consumer-facing products. These products have a different set of constraints and feature needs, including smartphones, but also in wearables such as AR headsets.

A quick primer on event-based vision: Instead of capturing individual frames at a fixed rate, event cameras detect individual

Qualcomm/Prophesee

Prophesee's Metavision sensor has been optimised for use with Qualcomm's Snapdragon mobile platforms to enhance smartphone photography

pixel change in brightness – which we call events – through intelligent pixels, and process these as they occur. This means they can capture motions with a much higher temporal resolution and lower latency – and with less data processed (meaning less power consumption) than traditional cameras. It's the way our eyes and brains – the most efficient vision sensing systems of them all – work to process scenes.

Event-based vision addresses a fundamental limitation of traditional camera techniques: how light is captured. In a camera, the sensor needs to open to capture light. The lower the light, the longer it has to stay open. But the world does not stop when you take a picture and the motion information happening while the sensor is open generates motion blur that cannot be fixed properly today. And faster frame rates or shutter speeds actually worsen low-light performance for conventional cameras. Software-based computational photography techniques have helped modify this problem, but artefacts still remain, and blurring occurs even in the most high-end cameras.

The practical result of applying this biological technique is the ability to capture fast-moving objects with much greater clarity and detail. And, importantly, they don't suffer from motion blur. By combining an event-based sensor with a frame-based system, effective deblurring can be achieved, making photography and video capture more precise and lifelike.

Inherently, event cameras are well suited to power-sensitive and bandwidth-constrained technologies such as mobile phones. Because data is captured only when the scene changes, independent of a conventional camera's frame rate setting, they can provide power savings and higher bandwidth, which a mobile phone can use to actively monitor the scene. While not meant to be a standalone alternative, by working in tandem with frame-based cameras, data from event sensors can be combined with that generated by frame-based cameras to effectively deblur images.

'MWC 2023 was a breakout moment for this trend, and the consumer market has taken notice'

MWC 2023 was a breakout moment for this trend, and the consumer market has taken notice. As Robert Triggs at Android Authority says: "Farewell, blurry pet photos, unusable sports action shots, and smudged low-light snaps." He was referencing the fact that my company announced a relationship with Qualcomm to enable native compatibility of our event-based sensors and software with its widely-used Snapdragon platform. This follows our on-going partnership with Sony, the world's leading supplier of CMOS sensors to the smartphone market, with whom we have collaborated to make the size and power of event sensors more suitable to mobile applications.

Having two such critical suppliers to the consumer market segment aligned around event-based vision as a pathway to improved mobile photography experiences is a significant step forward. While the immediate impact will be first seen in deblurring and better low-light performance, this new sensing modality opens the door to a wide range of new use cases in mobile devices and wearables.

Does embedded have the edge?

A round-up of some of the latest cameras, modules and other embedded vision technology on the market

In some respects, the industrial vision market has provided embedded vision products for many years – from smart cameras to self-contained vision devices with onboard image processing. A new wave of products now follows the development of computer processors powerful enough to run vision algorithms, board-level system-on-modules from NXP, for example, or GPUs and FPGAs.

Embedded computer hardware is small, inexpensive, powerful and energy-efficient. Some chips are being designed specifically to work with neural networks. Attaching a sensor module brings image processing closer to the sensor; this is known as 'edge processing,' as opposed to processing in the cloud or sending the feed from the camera to a separate computer.

Embedded computing opens the door to many more uses of vision technology. Even in factories where machine vision is already established and successful, there are areas where embedded vision can play a role.

The downside to developing products on embedded boards is that integration complexity and cost is higher in a relatively new market. The Khronos Group, together with the European Machine Vision Association, is working on an open API standard for controlling embedded cameras across mobile, industrial, XR, automotive and scientific markets. This new standard aims to help companies building embedded vision devices. The design of the API is making significant progress and will include loadable layers and multiple language bindings as well as flexible, low-level control over camera functionality.

Commercial products

Vendors offering products for embedded vision include **Advantech**, which recently released the AIMB-522, an industrial Micro-ATX motherboard for AI image processing in automation and surveillance. AIMB-522 leverages **AMD**'s desktop processor, the Ryzen Embedded 5000, which provides 16 high-performance Zen 3 cores. The motherboard also features several technologies designed to empower efficient high-performance computing. These include PCIe Gen 4 expandability, 4 x Gigabit Ethernet ports, and 8 x USB 3.2. This combination of features and functions produces an excellent solution for factory automation, smart logistics, and intelligent surveillance applications.

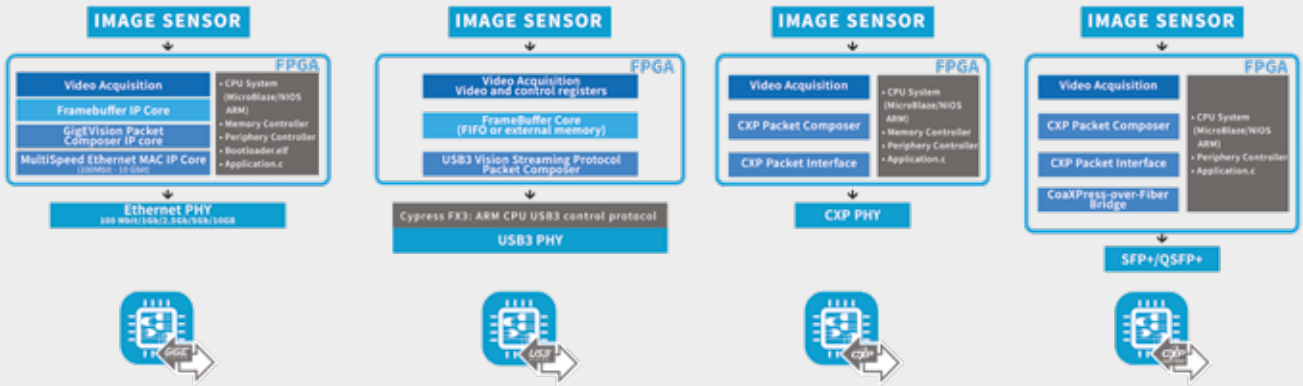
Congatec offers 12th-generation **Intel** Core mobile and desktop processors (formerly Alder Lake) on 10 of its COM-HPC and COM Express computer-on-modules. COM Express type six form factors and the modules in COM-HPC size A and C provide major performance gains and improvements based on Intel's performance hybrid architecture.

Basler's latest addition is a range of add-on camera kits with 5 and 13 megapixels to support the **Nvidia** Jetson Orin Nano system-on-modules, for entry-level edge AI and robotics. The kits are ready-to-use vision extensions that include an adapter board, camera, lens, and cables. The Basler Camera Enablement Package is designed to enable smooth integration of its Camera Software pylon with the Nvidia JetPack software development kit. A Camera Enablement Package includes a Basler camera kernel driver, device-tree overlays for the supported boards, GenTL Producer and the pylon Viewer application.

Framos offers a range of fully embedded solutions for OEMs, industrial customers and users. The company recently launched the FSM-IMX547 Camera Accessory for the Kria KR260 Robotics Starter Kit from AMD (also recently introduced). The FSM-IMX547 is capable of streaming high-quality colour or monochrome images to the Kria KR260 robotics starter kit. Fully integrated, the camera kit is compatible with the 10GigE Vision Camera App, available for free evaluation and download at the AMD-Xilinx App Store. It is designed to allow developers to design their own high-performance, high-speed, and high-resolution machine vision applications.

Gidel recently added the Nvidia Jetson Orin NX 16GB system-on-module to its FantoVision range of high-bandwidth compact computers for vision on the edge. Paired

Euresys SA Featured product



Machine vision camera suppliers reduce time to market with transport layer IP Cores. The core competency of engineers designing machine vision cameras and systems is usually configuring the core camera features to provide the best possible image while meeting size, weight, power budget and others. But they also have to devote considerable time and effort to successfully streaming the images from the camera to the host.

Leading edge vision transport layer standards such as GigE Vision, USB3 Vision and CoaXPress are complex and evolving, so several months of work by experienced protocol engineers are typically required for interface design. S2I's Vision Standard IP Cores solutions are delivered as a working reference design, alongside compact FPGA IP cores fully tested against a wide range of popular frame grabbers and image acquisition libraries. IP Cores enable machine vision companies to build FPGA-based products following these standards, delivering the highest possible performance in a small footprint while minimising development time.

More information: www.euresys.com/en/Products/IP-Cores/Vision-Standard-IP-Cores-for-FPGA

with Gidel's high-speed camera interfaces and FPGA-based frame grabbing and processing technology, the processor can open up possibilities for real-time, low-latency image processing on the edge for industrial machine vision and other applications. It includes 10GigE, CoaXPress 12 and camera link interfaces for image acquisition, processing and compression at over 1 gigapixel per second.

OEM embedded camera firm **e-con Systems**' most recent launch for embedded vision is the NeduCAM25, a full HD global shutter FPD-LINK III camera module. This is the first product to be launched in the NeduCAM series – a portfolio of FPD-Link III cameras. NeduCAM25 is based on **onsemi**'s AR0234 sensor. The global shutter feature helps to capture fast-moving objects without any rolling shutter artefacts. It uses the FPD-LINK III interface with shielded coaxial cable for reliable transmission of both power and data up to a distance of 15m with low latency.

Available from **Innodisk** is the EXMU-X261, an FPGA machine vision platform. Powered by AMD's Xilinx Kria K26 SOM, the platform was designed for industrial system integrators looking to develop machine vision applications. The new platform comes with 1GbE LAN, 4 x USB 3.1 Gen1 ports, 2 x M.2 slots, and other expansion and connectivity options. In addition, its operational temperature support, and optional industrial temperature support, is designed to be tough enough for harsh industrial environments.

The Quartet TX2 carrier board from **Teledyne Flir** enables streaming from four USB3 board-level cameras simultaneously and at full bandwidth. It is ideally placed for space-constrained applications, eliminating the need for peripheral hardware and host systems. The Quartet TX2 embedded solution comes pre-integrated with the company's Spinnaker SDK.

Variscite is a system-on-module designer, developer and manufacturer. Most recently, the company launched the VAR-SOM-AM62, powered by the **Texas Instruments** AM62x.

The module was designed to provide a solution for embedded industrial products that require high performance and low power. It runs on 1.4 GHz Quad-core Cortex-A53 with 400MHz Cortex-M4F and additional 333 MHz PRU real-time co-processors. The latest module offers camera interfaces MIPI-CSI2, integrated 3D GPU along with dual LVDS display. Another recent offering from the company is the VAR-SOM-MX93 system-on-module. This module is designed to accelerate machine learning and offers an energy-flex architecture for efficient processing.

Vecow offers a robust edge AI platform. The ECX-3000 PEG, ECX-3000 and IVX-1000 Series powered by the latest 13th-gen Intel Core i9/i7/i5/i3 processor (Codename: Raptor Lake-S). The platform is in line with the company's well recognised embedded computing system design principle of combining high performance with rugged and industrial-grade reliability. It is well suited for IoT use cases in machine vision, robotic control, advanced driver assistance system (ADAS), mobile communication, smart manufacturing, in-vehicle computing, public security, and any edge AI applications.

Vision Components provides a number of MIPI camera modules and components designed to make the integration of embedded vision faster, easier and more cost-efficient. Most recent is the FPGA-based hardware accelerator VC Power SoM, which completes complex image processing calculations and transfers the results directly to a processor board. The tiny, 28 x 24mm module facilitates development of embedded vision systems. OEMs benefit from mature FPGA technology and comprehensive image processing functionalities and can, at the same time, freely choose the embedded processor board and use its full computing power for the main application.

This is not an exhaustive list. If you provide embedded vision products and would like your company to be included, please email **editor.imaging@europascience.com**.

Striving for perfection

Susan Fourtané on the increasing demands being placed on web inspection solutions to achieve zero-defect manufacturing

Industrial web inspection systems enable the improvement of manufacturing efficiency and product quality by helping to detect, minimise and eliminate defects and process errors. Such systems are increasingly being automated, enabling manufacturers to more easily react to defects as they occur in real time.

According to the authors of 'Application of automation for in-line quality inspection, a zero-defect manufacturing approach', recently published in the *Journal of Manufacturing Systems,* poor product quality can increase firms' financial losses, environmental impact, and waste of resources. Poor quality can also have a negative social impact, affecting the reputation of a company through its substandard products and unsatisfied clients. The authors of the research show that sustainable manufacturing can be achieved through the implementation of zero-defect manufacturing. "Making things right on the first try is the central tenet of zero-defect manufacturing," they say. "In doing so, quality is enhanced and sustainability is raised, which ultimately results in higher customer satisfaction, which is crucial for a manufacturing company's success."

Through new system launches and industry case studies, *Imaging and Machine Vision Europe* recently learnt from vision firms how the automation of web inspection is bringing manufacturers closer to achieving the ultimate goal of zero-defect manufacturing.

New print inspection systems respond to quality demands

One of the main requests and imminent pressures from manufacturers when requesting web inspection technology is around quality, especially when their business serves high-end clients. "Customers' demands on quality have

A glass inspection system must distinguish between flawless and waste products to achieve automotive glass wafers free of optical distortions

Alexey Ryazanov/Shutterstock

risen continuously, especially for highly refined materials, brand owners, and luxury packaging," says Dr André Schwarz, Marketing and Documentation Director at inspection system firm EyeC. "But, 'normal' fast-moving consumer goods (FMCG) packaging in the customer sector has also become increasingly high-quality. No compromises can be made, especially for customers working for companies in regulated industries – 100% quality and flawless products are essential."

Staying on top of the game in order to meet the ever-growing demands of manufacturers requires a combination of integrated intelligence and innovative technology, meaning continuous R&D updates and launching the best products to meet customers' expectations.

In response to customer demands, EyeC has recently launched a new web print inspection system, the EyeC ProofRunner Wide Web. Using an 8k colour line scan camera, the system offers ultrafast and precise 100% real-time print inspection in wide web applications ranging from 900-1,700mm. It compares the print image with a print-ready PDF file and automatically inspects texts, graphics, colour deviations, variable data as well as 1D and 2D codes reliably, providing documentation on the results.

The smart technology embedded in the ProofRunner Wide Web for labels, leaflets, and flexible packaging automatically detects defective areas, warning the operator in real time in the event of significant deviations. "With ProofRunner Wide Web's real-time error detection, the operator at the press can immediately detect deviations from the artwork during the printing process, thus avoiding overproduction and misprints," says Schwarz. Errors that can be identified immediately save expensive consumables and valuable machine time. "Our system prevents entire rolls from being produced incorrectly and directly helps the customer to produce more resource-efficiently and sustainably."

Bettering battery inspection

Improving defect detection is crucial even in the most demanding applications, such as battery manufacturing – which, due to the rapid electrification of the mobility sector, is increasing rapidly – as noted by imaging firm Teledyne Dalsa's Senior Product Manager Xing-Fei He.

He explains that in battery manufacturing, there are certain material types that require special inspection: "Anode (e.g. carbon) and cathode (lithium metal oxide) are coated on metal foils separately. These coated films are important parts of the battery cells and need to be inspected for thickness and related defects before moving into the next steps." Defects such as thickness variation, blowholes, and particle contamination all need to be identified and prevented to ensure good yield, high product quality and safety.

> 'Customers' demands on quality have risen continuously, especially for highly refined materials'

Responding to such demands, Teledyne Dalsa recently launched AxCIS, a new family of high-speed and high-resolution fully integrated line scan imaging modules. These contact image sensors (CIS) combine sensors, lenses, and lights. This all-in-one combination offers a lower-cost inspection system for many demanding machine vision applications – including battery inspection.

"AxCIS offers a fully integrated, easy-to- →

‘Glass producers are developing the high-scale industrialisation of new ultra-thin glasses for foldable applications or wafer applications’

Isra Vision

Imaging solutions are increasingly being used to inspect thin glass materials for defects, which are used in the manufacture of automotive and smartphone displays

→ use, cost-effective line scan imaging solution to meet the requirements of space-limited systems, such as print, printed circuit board, and web inspection,” explains Xing-Fei. The new systems are powered by Teledyne’s new quadrilinear CMOS image sensor technology, which delivers up to 120kHz line rates for mono and 60kHz x 3 for colour, at 900 dpi resolution. This enables errors to be detected with exceptional precision, contributing towards the zero-defect manufacturing strategy.

Xing-Fei says AxCIS is targeting the increasing demands being placed on vision technology for automatic inspection with improved detectability, particularly in battery manufacturing. Through its 900 dpi high-resolution and HDR mode, the system is well positioned to deliver high-accuracy inspection of anode and cathode coatings.

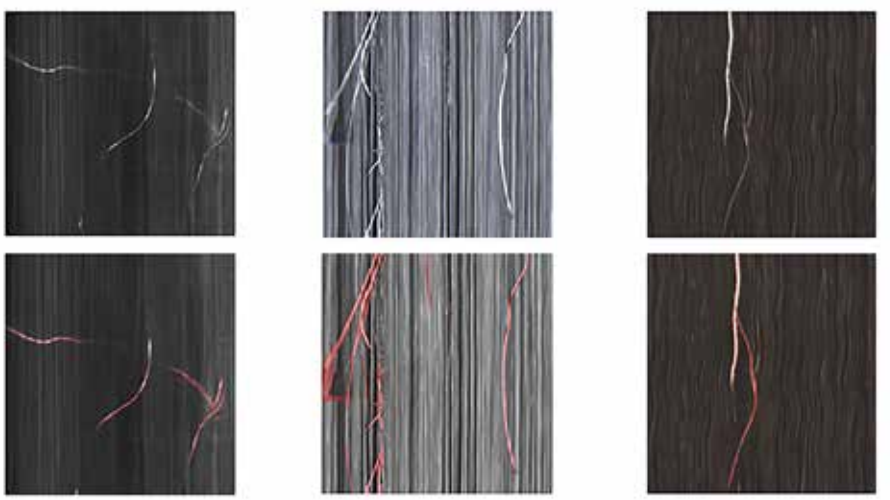
Powering up paper production

Also striving for a future of automated, zero-defect manufacturing are vision firms Matrox Imaging and Active Inspection (AI), which through a case study share how one of AI’s web inspection systems can enable 100% inspection of surfaces, printing, and labels. The system includes, among other components, multiple Piranha monochrome line-scan cameras from Teledyne Dalsa, Lotus LED line lights from Prophotonix, and Matrox’s Imaging Library (MIL) and Camera Link frame grabbers.

The study covers paper mill Knowlton Technologies’ instalment of the AI Surface system, and how this enabled it to improve its product quality while significantly reducing labour costs. “AI Surface let us remove three workers from a 100% manual inspection procedure and place them in higher, value-added positions as soon as the system was installed, which allowed us to realise a quick return on our investment,” says Richard Barlow, Advanced Materials Engineer at Knowlton Technologies. “Also, the user interface is set up so that it is simple to create multiple custom classifiers for various customer needs and link to their specific grades. And our machine operators are very pleased with how easy it is to operate the inspection system.”

The images are processed using MIL’s image processing, blob analysis and calibration modules. Processing operations used include convolution, binarisation, morphology (dilate and erode), flat-field correction and projection. The overall system inspects a web that is 330cm wide at a rate of 204m/min, detecting defects as small as 0.2mm x 0.2mm. It includes access to a built-in classifier complete with a decision matrix, with no limit to the number of recipes that can be stored – specialised quality settings may be applied according to product, job, order or substrate.

AI plans to develop inspection systems using CMOS cameras that support higher line speeds, with the firm looking to offer support for up to 16 cameras – twice the amount that can currently be supported.



Fraunhofer IGCV

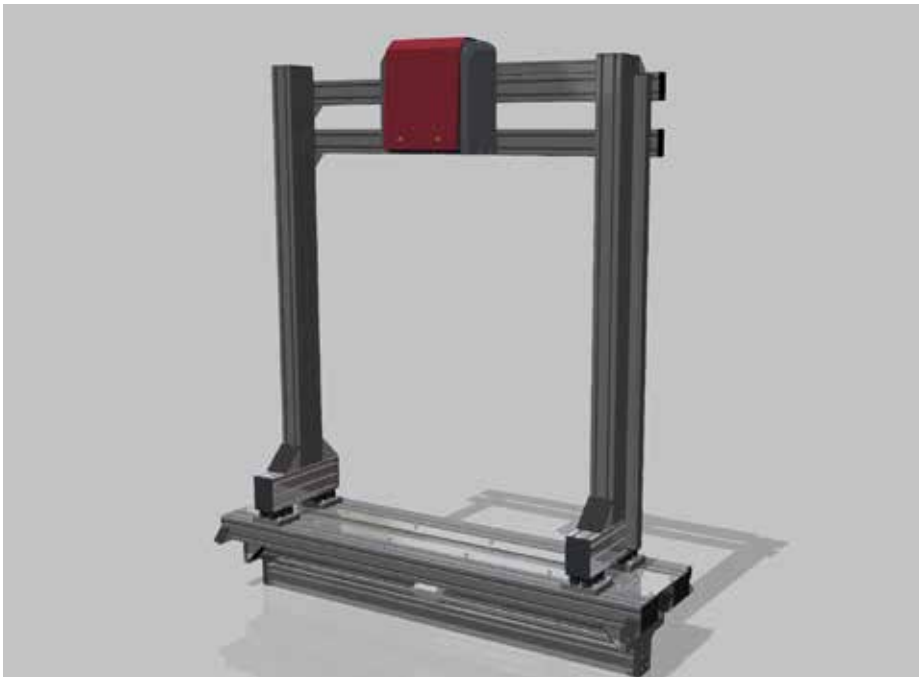
Imaging systems are being developed for detecting transverse filaments and fibre bundles (lint) during carbon fibre manufacturing

Capitalising on carbon fibre inspection

The quality of aerospace-grade carbon fibre is still, in many cases, assessed manually, leading to a process that shows an abundance of human errors. This leaves potential for the process to become one of the many currently being optimised via automated web inspection systems.

Imaging firm Chromasens and its partners capitalised on this opportunity with the development of the AirCarbon II automatic inspection system in 2016.

EyeC



EyeC's ProofRunner Wide Web system uses an 8k colour line scan camera to deliver ultrafast and precise 100% real-time print inspection in wide web applications ranging from 900-1,700mm

Since then, the partners (consisting of Chromasens, the Fraunhofer Institute for Casting, Composite and Processing Technology IGCV and SGL Carbon) have gone on to develop the Air Carbon III to achieve improved automatic monitoring of carbon fibre production.

The new system relies on Chromasens' allPIXA wave line scan camera and Corona II LED line scan light to achieve seamless and continuous surface monitoring. The Corona II is capable of delivering up to 3,500,000 lux, which is essential for producing high-contrast images of deep-black materials such as carbon fibre. The Air Carbon III can detect protruding filaments, lint, and similar foreign bodies, and distinguish each type of defect.

The significantly higher resolution of the CMOS colour line sensor, rather than conventional CCD sensors, is what makes the detection of protruding filaments possible, which range from 7-12µm in diameter. Since the sensors are limited in their measurement width, a novel optical concept was designed and implemented that triples the camera's field of view while keeping the data volume the same. The system was designed primarily for large-format line sensors (up to 85mm), but it is easily transferable to smaller sensors or area sensors. This makes the solution particularly suitable for scaling, as additional hardware costs on the camera side and for computing capacity can be avoided.

Overall, the partners succeeded in developing an inline monitoring system with which carbon fibre production can be continuously and automatically monitored. As of August 2022, the partners were in the final phase of development, carrying out tests in the pilot plant of SGL Carbon and evaluating the data.

Teledyne Dalsa

Teledyne Dalsa recently launched AxCIS, a new family of high-speed, high-resolution fully integrated line scan imaging modules suited for web inspection

Ultra-thin glass manufacturing on the rise

In the glass industry, the demand for glass wafer material – the production of which can be monitored using web inspection solutions – is rising rapidly across a range of industries.

Glass wafers are very thin sections of glass material. They can be made from a range of materials including quartz, borosilicate glass, or fused silica, and are used in a wide variety of applications, such as 3D imaging and sensing; wafer-level packaging; micro-electromechanical systems (MEMS); microfluidics; automotive displays and electronics; microdisplays; and the fabrication of integrated circuits.

> 'Coated films are important parts of the battery cells and need to be inspected for thickness and related defects before moving into the next steps'

"Glass producers are developing the high-scale industrialisation of new ultra-thin glasses for foldable applications or wafer applications," says Bertrand Mercier, Vice President of Isra Vision's Glass Business Unit. "Roll-to-roll glass processes are becoming more and more a reality and could open up new markets. Complex shapes are also increasingly required, such as for automotive displays."

Taking this last example, attractive automotive glass can only be achieved when there are no optical distortions in the glass wafer. A glass inspection system, such as those offered by Isra Vision, must therefore distinguish between flawless and waste products in order to guarantee the highest level of quality.

"Beside the detection of typical 'visible defects', functional defects such as surface contamination or microscopic defects are gaining in importance," says Mercier. "In addition, measurement of physical properties such as curvature, thickness and stress are becoming standard in modern factories."

The use of glass wafers with new and advanced optical properties is also increasing in the production of TVs and smartphones. Here the wafers offer high transparency, high heat resistance and low thermal expansion. For smartphones in particular, glass wafers are often used to protect the sensors, electronics and semiconductors present in the device.

Isra Vision's Flat Panel Master is an example of the firm's systems seeing successful adoption in the inline inspection of thin glass substrates. The system can detect and classify even the tiniest of defects on the surface or edge of glass substrates, while also monitoring particle contamination. At the same time, it collects and analyses inspection data to provide insights into defect causes, allowing users to improve their production processes. In addition to thin glass, the Flat Panel Master can also be used for inspecting float glass, pattern glass, automotive glass and solar glass.

Products

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Embedded vision

DepthVista_MIPI_IRD ToF MIPI camera

E-con Systems, an embedded camera manufacturer and solution provider, has launched DepthVista_MIPI_IRD, a 3D time-of-flight (ToF) camera for deploying with Nvidia Jetson AGX Orin/AGX Xavier processors.

Last year, e-con Systems launched a 3D USB camera solution powered by ToF technology, specifically designed for applications that operate in indoor environments. The firm has since received several requests for a 3D depth camera suitable for outdoor environments that can also work with the Nvidia Jetson processor family through a MIPI-CSI2 interface. This was the motivation behind the DepthVista_MIPI_IRD.

The camera uses a wide spectral range (940nm/850nm) to deliver precise, 3D imaging in outdoor as well as indoor embedded vision applications. It indeed uses the MIPI CSI 2 interface to connect to the Nvidia processors, and has a scalable depth range up to 12m (6m by default). Multiple cameras can be used without interference noise to provide reliable depth data. On-camera depth processing is used to avoid complications such as running depth matching algorithms on the host platform.
www.e-consystems.com

Optimom 1.5M module

Teledyne e2v has released the Optimom 1.5M, a complete board-level vision extension designed to accelerate development time, reduce R&D investment, and scale down manufacturing costs for embedded and AI vision solutions.

The optical module comprises an image sensor, a 25mm square board with lens mount, and an optional lens in various options. Featuring a native MIPI CSI-2 protocol, the Optimom 1.5M module is provided with a complete development kit, which includes an adapter board, cabling, and Linux drivers for instant integration with MIPI-based processing units such as Nvidia Jetson or NXP i.MX solutions.

With its 1.5MP CMOS image sensor, Optimom 1.5M provides a wide 1,920 x 800 format ideal for scanning applications such as handheld scanners, auto ID systems, laboratory equipment, or drones. The module comes with an adapted price point for 1.5MP solutions, while ensuring full compatibility with the higher resolution Optimom 2M module.
https://imaging.teledyne-e2v.com

iPort NTx-Deca embedded interface

Pleora Technologies has released a new embedded interface that seamlessly transmits low latency GigE Vision video and data at 10Gbps over flexible Copper Cat 6A Ethernet cabling for distances up to 100m. The iPort NTx-Deca interface provides an off-the-shelf GigE Vision 2.0 standard-compliant solution that ensures interoperability in multi-vendor systems and applications.

The iPort NTx-Deca integrates Image Management Database features to enhance system reliability. For applications such as medical and dental imaging, end users can store video frames with associated metadata for patient identification, video replay, and traceability. In the event of a power or network failure, image management allows a user to retrieve data to ensure continuous and reliable inspection.

The embedded interface supports IEEE 1588 Precision Time Protocol (PTP) to synchronise image capture and imaging system elements, with programmable logic controller (PLC) integration to seamlessly connect to and control critical manufacturing or inspection system components.

Lead customers are already designing the embedded interface into X-ray flat panel detectors (FPDs) for medical, dental, and industrial applications, contact image sensors, and high-performance machine vision cameras.
www.pleora.com

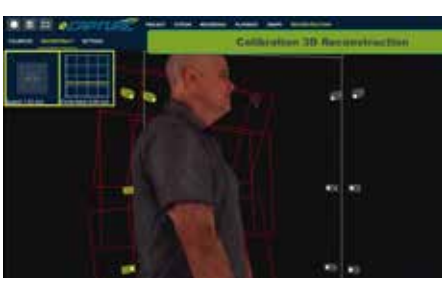
Software

eCapture Pro

Emergent Vision Technologies has introduced eCapture Pro, a comprehensive piece of development software for applications ranging from machine vision to volumetric capture and the metaverse.

The software provides an intuitive graphical interface for complete and easy system integration, camera setting flexibility, advanced preview and recording, synchronised capture with microsecond accuracy, as well as calibration, background, and production management capabilities. In addition, eCapture Pro enables the use of the industry's fastest frame rates.

The software delivers advanced playback functionality for spatial and time domains, camera calibration with auto camera position detection, integrated 3D reconstruction and texturing, an Unreal/Unity plugin for streaming models, and more. In addition, it offers a control centre from power-up all the way to 3D model asset generation – a complete geometric representation of the scene. Models can be loaded into metaverse software such as Blender and Unreal Engine as a starting point for any kind



of 3D production, with assets repurposed for multiple scenarios. eCapture Pro supports GPUs, Windows, and Linux operating systems, and multi-camera and multi-server setups.
www.emergentvisiontec.com

Cameras

EoSens 10CCX12-FM 10MP area scan camera

The latest addition to Mikrotron's EoSens portfolio, the EoSens 10CCX12-FM 10MP area scan camera, with global shutter, offers an exceptional price/performance ratio that makes it suited to a variety of demanding vision applications in industrial inspection, life science imaging, and 4K video applications, including motion analysis.

By incorporating the continuous bandwidth of CoaXPress 2.0, the EoSens 10CCX12-FM fully exploits the maximum performance of the latest Gsprint 4510 CMOS sensor featuring 4.5 x 4.5µm pixels, allowing it to capture 4,608 x 2,176 resolution colour images at speeds of 478fps. Even with longer cable lengths, the CXP-12 interface enables the EoSens 10CCX12-FM to transmit 12.5Gbps per channel. It is scalable up to 50Gbps using the camera's four channels, helping reduce imaging system complexity, maximise interface bandwidth, and expand the operational range without increasing latency or jitter.

The new camera is ruggedly engineered to withstand the shock, vibration, and thermal demands of industrial environments, despite measuring only 80 x 80 x 92mm in its IP30-rated metal housing. It also features extensive functions for image and shading correction, multiple binning modes, and trigger modes.

www.mikrotron.de

Compact 3D camera for guiding mobile robots

Sick has launched the safeVisionary2, a compact 3D camera for increasing productivity and enabling safety during the operation of autonomous mobile robots.

The new time-of-flight (ToF) camera is certified for Performance Level c. The addition of the third dimension enables a new level of safety that enables autonomous and intelligent mobile robot navigation.

Based on the same ToF platform used by Sick's Visionary-T Mini system, the safeVisionary2 is suited to a wide range of applications. With actively modulated laser technology, it can also be used in environments with extraneous light. In addition, due to having no moving parts in the body, the camera provides excellent shock and vibration resistance.

The camera can be used in many tasks, from detecting empty pallets to object localisation and measurement. This combination of safety and automation reduces the implementation effort for additional components – saving users costs and time.

www.sick.com

Phantom T4040 high-speed camera

Vision Research has introduced the Phantom T4040 high-speed camera. The new device features a back-side illuminated 2,560 x 1,664 sensor that maximises light sensitivity with a peak quantum efficiency over 90%.

Thanks to its 4MP sensor, the T4040 can capture fine detail and movement over larger areas. Its other standout features include extreme dynamic range (EDR), which mitigates the effects of bright flashes, and binning mode, which expands the camera's use as a 1MP camera. Binning mode combines pixels to achieve 39,000fps at 1MP and up to 444,000fps at 1,280 x 64 resolution.

The new system is suited to applications including:

- Material impact tests – improving the accuracy required for tracking elements and debris after the collision.
- Explosives research – using its EDR feature to capture particle trajectories and key data contained in the bright flash.

- Particle imaging, with its high resolution improving data accuracy when processed into a 3D model for time-resolved particle image velocimetry.
- Small objects imaging, with its 9.27-micron pixel size being ideal for subjects requiring high magnification, e.g. insect wings and computer microchips.

www.phantomhighspeed.com

Sensors

IRS2976C ToF VGA sensor

Infineon Technologies, in collaboration with 3D time-of-flight (ToF) specialist Pmdtechnologies, has launched the IRS2976C ToF VGA sensor.

Infineon's advanced pixel technology enables the pixels to achieve a quantum efficiency of 30% or more, a level so far only attained by back-side illumination sensors. This is accomplished while maintaining the cost advantage of front-side illumination sensors.

The IRS2976C supports long-range, low-power applications that enable a measurement range of 10m and further. Pmdtechnologies' patented Suppression of Background Illumination (SBI) technology is integrated into each pixel, providing robust data in high dynamic range (HDR) and sunlight scenes.

The IRS2976C offers system VGA resolution of 640 x 480 depth points. With a compact form factor of 23mm^2, the imager sensor is drop-in compatible with previous IRS2877C imagers and allows an easy upgrade path. In combination with IRS9102C, Infineon's latest VCSEL driver, the new IRS2976C enables the design of compact 3D camera systems at optimised costs.

www.infineon.com

IF200 Dual Channel sensors

Baumer has introduced a new range of compact inductive sensors for automated manufacturing applications, capable of detecting objects and distance within a 10mm range and at up to 3µm resolution.

Though miniature in size (W 20mm x L 42mm x H 15mm) the IF200 Dual Channel sensors provide ultra-precise linearised measured values via either IO-Link or as analogue voltage signals. The fully digital variant is compact and cost-effective as it removes the need for shielded cables and high-resolution A/D converter cards. There is also a retrofit option available with the same pinout, which ensures easy connectivity when replacing Baumer's existing conductive measuring IWFK sensors. A robust plastic housing means the sensors can withstand increased ambient temperatures up to 75ºC. Also they provide exceptionally low temperature drift of just 2% across the entire sensing range.

www.baumer.com

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MATRIX VISION GmbH
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XIMEA GmbH

Complete vision systems
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Basler AG
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Euresys SA
Matrox Imaging
The Imaging Source Europe GmbH

Illumination
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TPL Vision

Lasers for machine vision and inspection
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Frankfurt Laser Company
Laser Components (UK) Ltd

Lenses
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Navitar
Opto Engineering®
Sill Optics GmbH & Co. KG
Theia Technologies
The Imaging Source Europe GmbH

Sensors
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