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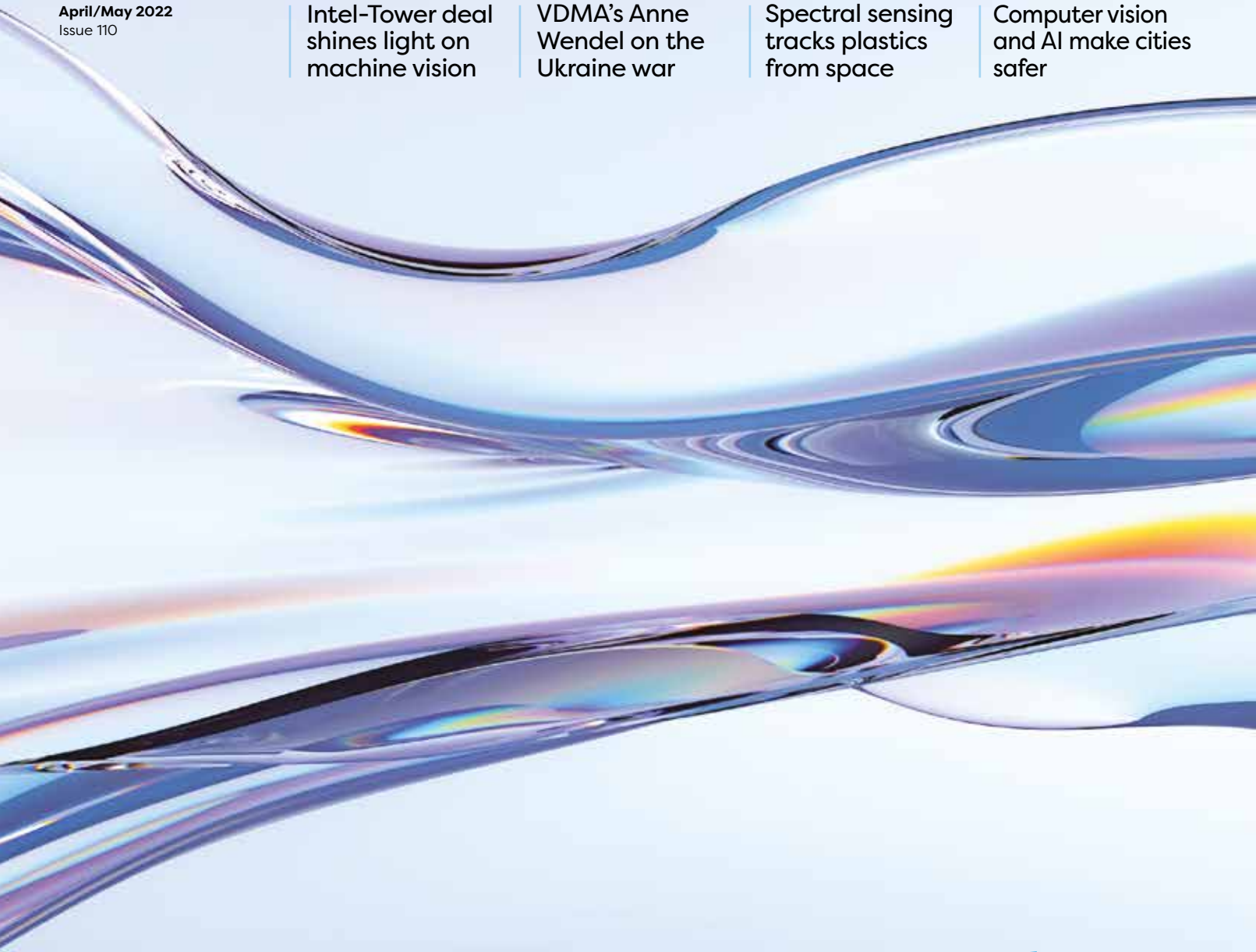

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Leader
Greg Blackman

All change

Two company acquisitions have altered the landscape of the machine vision market recently. The first, and the one that has a direct impact, is Zebra Technologies buying Matrox Imaging. The second, where the impact is a little more unknown, is Intel buying Tower Semiconductor.

Matrox Imaging is one of the oldest machine vision companies out there, while Zebra is a slightly larger technology firm that announced its arrival on the industrial vision scene last year when it bought Adaptive Vision and released a line of industrial imagers. The addition of Matrox Imaging's technology – a heritage that stretches back to the 1970s and includes the established Matrox Imaging Library software, complete with deep learning capabilities, along with 3D cameras, frame grabbers, and vision controllers – will certainly bolster Zebra's machine vision capabilities and make it a much more significant force in the vision market.

The other acquisition, Intel buying Tower to strengthen its foundry services, could be even more significant because it affects various industrial image sensor firms. Outside of Sony, many fabless sensor firms rely on Tower, companies like Gpixel, Teledyne e2v and Teledyne Dalsa. According to Yole Développement, one quarter of industrial CMOS image sensors are manufactured in Tower fabs.

There's more on the Matrox Imaging acquisition on page 4, while analysis of the Tower deal can be found on page 11. We will wait to see what impact these deals will have on the vision sector.

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News

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Zebra buys Matrox Imaging for $875m

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Zebra Technologies has furthered its expansion into machine vision by acquiring Matrox Imaging for $875m.

Last year, Zebra bought Adaptive Vision and Fetch Robotics, and introduced a line of fixed industrial scanning and machine vision systems. Matrox Imaging's technology will add to Zebra's vision portfolio significantly.

Zebra, which has around 8,200 employees, provides technology for retail and e-commerce, manufacturing, transportation and logistics, healthcare and the public sector.

The acquisition is only for Matrox's imaging division; Matrox's video division, Matrox Graphics, is not part of the transaction and will remain under the ownership of Matrox president and co-founder, Lorne Trottier.

'The combination of Matrox Imaging's technical expertise with the global footprint of Zebra Technologies presents an opportunity for Matrox Imaging to accelerate its long-term strategic plan,' Trottier said.

He added: 'At the same time, this transaction will enable us to continue to invest heavily in Matrox Video's successful growth path, its award-winning products and its ongoing process of innovation. We are fully committed to the future of Matrox Video.'

Matrox Imaging offers platform-independent software, software development kits, smart cameras, 3D sensors, vision controllers, I/O cards and frame grabbers.

The firm generates annual sales of approximately $100m, with a higher profit margin profile than Zebra.

Matrox Imaging's solutions complement Zebra's recently launched vision portfolio, as well as significantly augmenting Zebra's expertise in software, machine learning and deep learning.

Anders Gustafsson, chief executive officer of Zebra Technologies, said the acquisition will help Zebra meet its customers' automation needs, whether that's capturing and analysing data to facilitate decision-making, or deploying automation solutions for production and movement of goods and materials.

Matrox has an impressive heritage in machine vision. The firm celebrated its 45th anniversary last year, and designed its first frame grabber in the late 1970s, before the PC.

In the early 1990s, the company split into three divisions: Matrox Graphics, delivering graphics solutions; Matrox Video, for the broadcast industry and digital video editing; and Matrox Imaging, focusing on component-level solutions for machine vision applications. Trottier acquired full ownership of Matrox in 2019.

One of the newer cameras from Matrox Imaging is the Matrox AltiZ 3D profile sensor, with a dual optical sensor design and data fusion capability. The firm's flagship product is the Matrox Imaging Library, which was released in 1993.

The transaction is subject to customary closing conditions, including regulatory approval, and is expected to close in 2022. The head offices of the Matrox Video division and the Matrox Imaging division will remain in Montreal, Canada.

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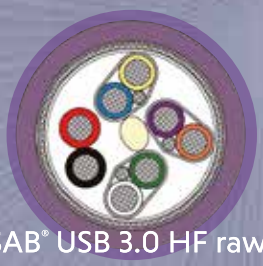

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nLight acquires Plasmo for weld inspection tech

Fibre laser provider, nLight, has bought Plasmo Industrietechnik to add Plasmo's machine vision and analysis products to nLight's manufacturing solutions. Plasmo is an Austrian-based provider of automated quality assurance and diagnostic solutions, primarily for the welding and additive manufacturing markets. The solutions will complement nLight's industrial laser portfolio.

Jake Bell, general manager for industrial lasers at nLight, commented: 'Combining lasers with Plasmo's real-time process monitoring solutions provides customers with a significant advantage as they develop, qualify and produce increasingly complex laser-printed or welded parts, particularly for high volume electric vehicle production.'

Laser welding is expected to play a role in battery production, as well as other manufacturing steps in electric vehicle production plants. Plasmo includes in-line triangulation cameras for inspecting weld seams at a processing speed of 30kHz, as well as sensors incorporated directly into welding optics for seam inspection. nLight will expand its European footprint with the addition of Plasmo's Germany and Austrian sites.

UKIVA conference eagerly anticipated

UKIVA
UK Industrial Vision Association

By Allan Anderson, UKIVA vice chairman

UKIVA

Denis Bulgin (centre), who retires after 23 years working for UKIVA, and former UKIVA chairmen (from left) Ian Alderton, Paul Wilson, Mark Williamson and Allan Anderson

The UKIVA AGM, which took place recently in Milton Keynes, provided a welcome opportunity for members to get together in person for the first time in two years. The meeting covered a wide range of topics, including an update on preparations for the Machine Vision Conference and Exhibition (MVC 2022), scheduled to take place on 28 April at the Marshall Arena, Milton Keynes.

Seven companies: Gardasoft Vision, GeT Cameras, LMI Technologies, Smart Vision Lights, Teledyne Dalsa, TPL Vision and Zebra Technologies were welcomed as new UKIVA members, all seven of which are participating in MVC 2022.

The updated UKIVA governance document and committee charter, introduced during 2021, were discussed prior to the election of the UKIVA committee for 2022. A representative from Smart Vision Lights was voted onto the committee. Delegates from Acrovision, Alrad Imaging, Bytronic Vision Automation, ClearView Imaging, Edmund Optics, IDS Imaging Development Systems, Jenton Dimaco, Mettler Toledo, Multipix Imaging, Scorpion Vision, Sick (UK) and Stemmer Imaging, were all re-elected. Neil Sandhu has entered his second year of office as UKIVA chairman, and will be succeeded in January 2023 by current vice chairman, Allan Anderson. A new vice chairman will be elected in January 2023.

A very positive report was presented on the preparations for MVC 2022. A strong conference programme is supported by a keynote presentation, entitled: 'From trash to cash' presented by Seb Millar, machine learning engineering manager at Recycleye. Recycleye specialises in the application of advanced machine learning, computer vision and robotics to improve waste recycling efficiencies at materials recycling or recovery facilities. The exhibition will feature a number of first-time exhibitors, providing added interest. The combination of these factors has attracted an extremely encouraging number of visitor pre-registrations.

Now entering its sixth year, MVC (www.machinevisionconference.co.uk) is an integral part of UKIVA's mission to promote the use of machine vision and image processing throughout UK industry. During the height of the pandemic, the online programmes of presentations in 2020 and 2021 through the MVC technology hub proved very popular, with a significant proportion of visitors in 2021 in particular being completely new registrations. The return of the live event in 2022 is eagerly anticipated.

The key objectives set out in the UKIVA mid-term strategy were then reviewed, including a stimulating discussion on ways to enhance pathways into working within the vision industry, as well as other training initiatives that could benefit the industry as a whole. Members were reminded of the opportunities in education, training and support offered by PPMA Best to encourage young people to enter and develop a career in engineering in the processing, packaging, robotics, automation and industrial vision supply industries. PPMA Best is a completely independent charitable trust, funded by the Processing and Packaging Machinery Association (PPMA).

The meeting closed with a presentation to Denis Bulgin, who retires after 23 years of helping UKIVA with its publicity.

Novel camera lowers cost of high-speed imaging

Scientists at Heriot-Watt University in the UK are working to commercialise an experimental high-speed camera.

The compressive coded rotating mirror (CCRM) camera achieves full colour, HD resolution at millions of frames per second. The work is published in *Scientific Reports*.

Dr Xu Wang, the inventor of the technology and an associate professor in the Institute of Photonics and Quantum Sciences at Heriot-Watt University, commented: 'The most significant limit of existing high-speed cameras is poor resolution at high frame rate, coupled with high cost. Our ground-breaking camera technology provides an affordable market solution that delivers ultra high speed without compromising high resolution, thanks to its superior design and lower manufacturing cost.'

The camera is being commercialised with funding from Scottish Enterprise's High Growth Spinout Programme. Dr Xu Wang added: 'This funding will accelerate the commercialisation of our research to create a product capable of disrupting existing and new markets. The support of the enterprise team provides an incredible opportunity to build a profitable, industry-leading business at pace that is focused on driving further innovation in the field of camera technology.'

The team at Heriot-Watt has identified applications in scientific research – in biomedical science, engineering and combustion research – and in industries such as rail transportation, manufacturing, medicine and quantum photonics.

The paper's authors state the camera's integrated optical encoding and compression functions add a strong layer of data encryption, making it suitable for capturing highly sensitive data, or for those with limited transmission and storage capacities.

Cognex tops $1bn in 2021, with logistics key

Cognex recorded revenue of $1.037bn last year, the first time the company has exceeded a billion dollars in annual revenue. The result represents an increase of 28 per cent over 2020, and 43 per cent over 2019.

Logistics was particularly important for Cognex last year, growing by approximately 65 per cent year-on-year, becoming the company's largest end market for the first time.

Cognex's business also recovered in the broader factory automation market, most noticeably the automotive industry. An exception was consumer electronics, where revenue was modestly lower following a substantial investment year in 2020.

Robert Willett, CEO of Cognex, commented: 'We believe the trends driving the adoption of machine vision technology are stronger than ever as manufacturers look to automate a broadening range of industrial tasks.'

Operating income on a GAAP basis was 30 per cent of revenue compared to 21 per cent for 2020. Cognex also invested a record $135m, or 13 per cent of revenue, in RD&E during 2021.

The company continued to expand its sales force and invested in business systems related to its sales process to help it scale for future growth.

The firm's fourth quarter 2021 revenue was $244m, up by 9 per cent from Q4-20 and down 14 per cent from Q3-21.

Cognex believes revenue in Q1-22 will be between $265m and $285m, which at the mid-point represents low double-digit growth over Q4-21.

Arrival of ST and Sony to transform SWIR market, Yole says

Shortwave infrared imaging in the automotive and consumer sectors could generate $21m and $3.2bn respectively by 2027, according to market research firm, Yole Développement.

The analysts at Yole also said the industrial vision market for SWIR could reach $360m in 2027, up from $94m in 2021. This is faster growth than the defence sector, traditionally the larger market for SWIR imaging – defence was worth $189m in 2021 for SWIR imaging.

Yole pointed to STMicroelectronics and Sony – two leaders in the consumer imaging industry – joining the SWIR scene as a reason to expect growth in SWIR in the future.

Late last year, at the IEDM conference, STMicroelectronics announced details of its new quantum dot SWIR global shutter sensor, with a 1.62µm pixel pitch and a quantum efficiency of 60 per cent at 1,400nm.

Meanwhile, Sony's SenSWIR InGaAs products, which reduce the pixel pitch down to 5µm, are now finding their way into machine vision cameras.

Yole stated: 'Their [ST and Sony] entrance might be explained by the growing demand from consumer OEM for new integration designs, such as under-display 3D sensing in smartphones.'

OLED displays are more transparent to SWIR wavelengths than the near-infrared currently used for smartphone under-display 3D sensing.

Yole said the first commercial products based on SWIR could be released by 2023. Also, because eye safety regulations are less stringent in SWIR than in NIR, SWIR would allow the use of more powerful illumination and generally increase the range and reliability of 3D sensing solutions compared to NIR.

Yole added: 'If SWIR imagers reach a low price point, shipments could skyrocket to hundreds of millions within a few years. The SWIR industry could emulate the current 3D imaging industry, where STMicroelectronics and Sony share nearly 95 per cent of the 225 million shipments (2020 data).'

Yole believes that automotive driver assistance applications for SWIR – infrared imaging has advantages when sensing in difficult conditions, such as in fog, snow, through sun glare, and at night – could begin by 2024 at $4m, reaching $21m by 2027.

In 2021, SCD, Sensors Unlimited and Teledyne Flir shared more than 50 per cent of the 11,000 units shipped in the year, according to Yole. These are subsidiaries of defence companies that started developing SWIR technology with the support of governments for strategic purposes – the legacy side of the industry. New quantum dot SWIR technology, not only from STMicroelectronics, but also SWIR Vision Systems and Emberion, could lower costs of SWIR imaging substantially.

In brief

Euresys grew 29 per cent in 2021 to reach €20.3m turnover. The company saw 32 per cent growth in Asia and EMEA, and 10 per cent growth in America.

Wenglor reached a record annual turnover of more than €100m euros in 2021. The firm delivered more than two million products last year.

Edmund Optics now offers optical design services out of its German office in Mainz. This is in response to increasing demand, complexity and diversity of applications in imaging and machine vision.

Fernando Colás has been named CEO of Omron's industrial automation business in EMEA. Colás has been with the company for 37 years.

EMVA to meet in Brussels

By Thomas Lübkemeier, EMVA general manager

After two years of not being able to meet in person, the EMVA business conference is back for its 20th edition from 12 to 14 May in Brussels. Conference participants can expect a balance of top-notch presentations mixed with plenty of time for networking – the latter being even more attractive after a period when meeting face to face has been rare.

The opening keynote, titled: 'The changing face of geopolitics in the 2020s', could not be more relevant in this new moment in European and world history. The technical part of the conference will look at what lies ahead for vision AI and machine learning. Furthermore, image sensor development will be addressed in several parts of the programme, such as in the panel discussion on the role of non-visible image sensors. Cybersecurity and cybercrime are a focus in a presentation, as well as in the closing keynote of the conference, which is given by crime and intelligence analyst and business psychologist, Mark Hofmann. More information and registration can be found at www.business-conference-emva.org.

New members

Since the end of January, four companies have chosen to become members of the EMVA. We warmly welcome Cretec Cybernetics, a system integrator headquartered in Germany, which aims to offer industrial machine vision automation in Europe by connecting machine vision, robotics and control technologies.

Our second new member is Theia Technologies, a US-based provider of a wide range of megapixel lenses, including: ultra-wide angle lenses; mid-focal range lenses; telephoto lenses; and machine vision lenses.

Pixilm is another new member based in Tallinn, Estonia. It focuses on bespoke imaging system development and production covering a wide area of services and consultancy, and a product range including multi-sensor and multi-camera systems.

Last but not least, EMVA welcomes John Bean Technologies (JBT), headquartered in Chicago, USA. JBT is a global technology solutions provider to high-value segments of the food processing and air transportation industries.

VDMA backs Russia sanctions

Anne Wendel, director of VDMA Machine Vision, on how the mechanical engineering sector could be affected by the war in Ukraine

Who is Danny/Shutterstock

With the invasion of Ukraine by the Russian army in violation of international law, we find ourselves confronted with a new, bitter reality: war in Europe. We all know of someone affected – family members, friends, colleagues, esteemed business partners in Ukraine, Belarus and Russia. My thoughts are with the victims of this aggression, but also with those who suffer from oppression and a digital dictatorship.

Part of the new reality is that global trade will face unforeseen restrictions. VDMA is committed to an open world market and free trade; it stands for peace, freedom and prosperity. It's precisely because of this that VDMA supports the sanctions against Russia that the EU has recently adopted, even though they will undoubtedly have an impact on the European mechanical engineering industry. The wellbeing of the people in Ukraine is our first and foremost concern.

Effective and consistent sanctions will hopefully contribute to the end of the Russian aggression. The VDMA president Karl Haeusgen has spoken publicly about the invasion: 'The VDMA and its members are stunned that Russia has started a war in Europe. In the past, Russia had committed itself to the inviolability of European borders and to refraining from the use of force by treaty and under international law. We strongly condemn this breach of international law! VDMA supports the decision to impose tough sanctions on the aggression.'

Impact on mechanical engineering

The sanctions imposed by the European Union will, of course, have an impact on the European machinery and plant engineering industry, as they represent a fundamental reassessment of economic and trade relations with Russia, if not worldwide. The new supply bans on various goods to Russia affect exports worth several hundred million euros. According to VDMA statistics, the average export share to Russia across all sectors of German machinery exports is three per cent. Agricultural machinery and material handling technology are the strongest sectors by value, with exports of around €561m and €466m respectively in 2021.

Looking at machine vision, sales to Russia accounted for less than one per cent of total sales. For the VDMA, it is important to monitor the sanction conditions and their effects on members in detail. Counter-sanctions are also possible from the Russian side, yet it remains right to impose tough sanctions on the aggression against Ukraine. According to VDMA statistics and experience, Russian manufacturers play a largely subordinate role in the technology and capital goods sector.

Conflict info-portal

The VDMA has set up an info-portal on the conflict to support its members, covering questions such as: what is sanctioned and what does it mean for my company? And what countries (Russia, Belarus, etc) are affected? The VDMA foreign trade department gives up-to-date information on all issues related to export controls, tariffs and sanctions. They do not only help with documentation, but also with understanding and interpreting these documents. Questions are answered regarding logistics to Russia, Belarus or Ukraine; legal aspects; and export financing and insurance.

> 'The supply bans on various goods to Russia affect exports worth several hundred million euros'

VDMA's legal department provides information and consultation on current legal issues, such as: what does this mean for my contracts, open payments and deliveries?

The VDMA insurance team is available to check member companies' insurance contracts, while the VDMA taxes department guides members through tax issues and has practical information on diverse and complex tax topics, not only related to the Ukraine-Russia crisis.

There's support from the VDMA statistics and economics department, with consultations and surveys about the impact of the war. Finally, the VDMA office in Russia gives updates on the situation in Moscow, as well as information about the Russian market and the economic policy framework.

The different VDMA departments and sector associations also organise meetings to provide a platform for discussion and information exchange for members. Topics covered include: what comes next and how to master the many challenges, such as rising energy costs, supply chain disruption, increasing non-tariff barriers to trade, political pressure and buy-national tendencies.

Intel-Tower deal shines light on machine vision

Greg Blackman examines the importance of Tower foundries to machine vision sensor firms, following Intel's acquisition

Intel

The news that Intel had bought Tower Semiconductor for $5.4bn sparked plenty of discussion about the reasons behind the deal and the strategy Intel might employ. Intel stated the acquisition is to help meet growing semiconductor demand, and to accelerate Intel's path to becoming a major provider of foundry services. Industrial image sensors might not have been high on Intel's priority list, but, for the machine vision sector, the deal is significant.

According to Yole Développement, one quarter of industrial CMOS image sensors (CIS) are manufactured in Tower fabs. Sony is a key supplier of image sensors for industrial vision, but outside of Sony many fabless sensor firms serving industrial vision rely on Tower.

Gpixel, Teledyne e2v and Teledyne Dalsa all have sensors made by Tower; Guy Meynants, one of the founders of Fillfactory and Cmosis, now at Photolitics, told *Imaging and Machine Vision Europe* that Fillfactory and Cmosis used Tower foundries 'nearly all the time.' Cmosis is now owned by Ams, while Fillfactory was bought by On Semiconductor.

Speaking to *Imaging and Machine Vision Europe*, Pierre Cambou, principal analyst for imaging and displays at Yole Développement, noted that Tower also serves the design houses of Forza Silicon, Pyxalis and Caeleste. He added that Panasonic imaging products, and more recently some Nikon products, are made by Tower's TPSCo foundries in Japan.

Cambou estimated that sensors make up 16 per cent of Tower's business, or around $200m – Tower's revenue was $1.3bn in 2020. As well as accounting for a quarter of the industrial CMOS sensor market, Cambou said that Tower had around one third of the medical CIS market, along with a significant share of the aerospace and defence CIS market.

Meynants, who has been using Tower fabs since working for Imec in the 1990s, recalled that when he was at Fillfactory and Cmosis, 'what was nice about Tower was that it was very accessible for companies like us [Cmosis and Fillfactory].' He added that Tower had the flexibility to work with different sensor products, potentially at low volumes, which is the nature of the industrial vision sector.

Meynants said the fact that TPSCo foundries in Japan offer global shutter pixels – as well as trying to be competitive with Sony – is important for machine vision sensor designers. At the 2018 Vision trade fair in Stuttgart, Dr Avi Strum, senior vice president at Tower, told *Imaging and Machine Vision Europe* that offering small global shutter pixels was Tower's strategy for competing with Sony. At the start of 2019, Tower released a global shutter CMOS sensor with a pixel size of 2.5µm, which at the time was the smallest global shutter pixel in the world.

> **'It will be interesting to see what the reactions of Tower customers – and Tower competitors – will be'**

Advanced technology nodes

The Tower acquisition bolsters Intel's Foundry Services (IFS), which Intel founded in March 2021 to help meet demand for semiconductor manufacturing capacity. Cambou said that one of the benefits of the deal is it could give the Tower foundries the ability to pursue advanced technology developments, such as hybrid stacking and single photon and quantum imaging. Machine vision sensor makers could therefore have access to more advanced technology nodes through Intel.

'The addition of Tower brings in products such as radio frequency, image sensors and power management ICs to the Intel portfolio,' Cambou said, adding that it is Tower's established foundry operations and specialty tech IP that will accelerate the Intel Foundry Service.

'We heard "customer focus" and "foundry DNA" a few times when talking about the acquisition,' he continued, 'so Intel was probably seeing IFS as lacking that foundry pedigree that comes with being in the foundry business for many years. Another interesting comment was it takes three years of engagement to turn a new foundry customer into foundry revenue.'

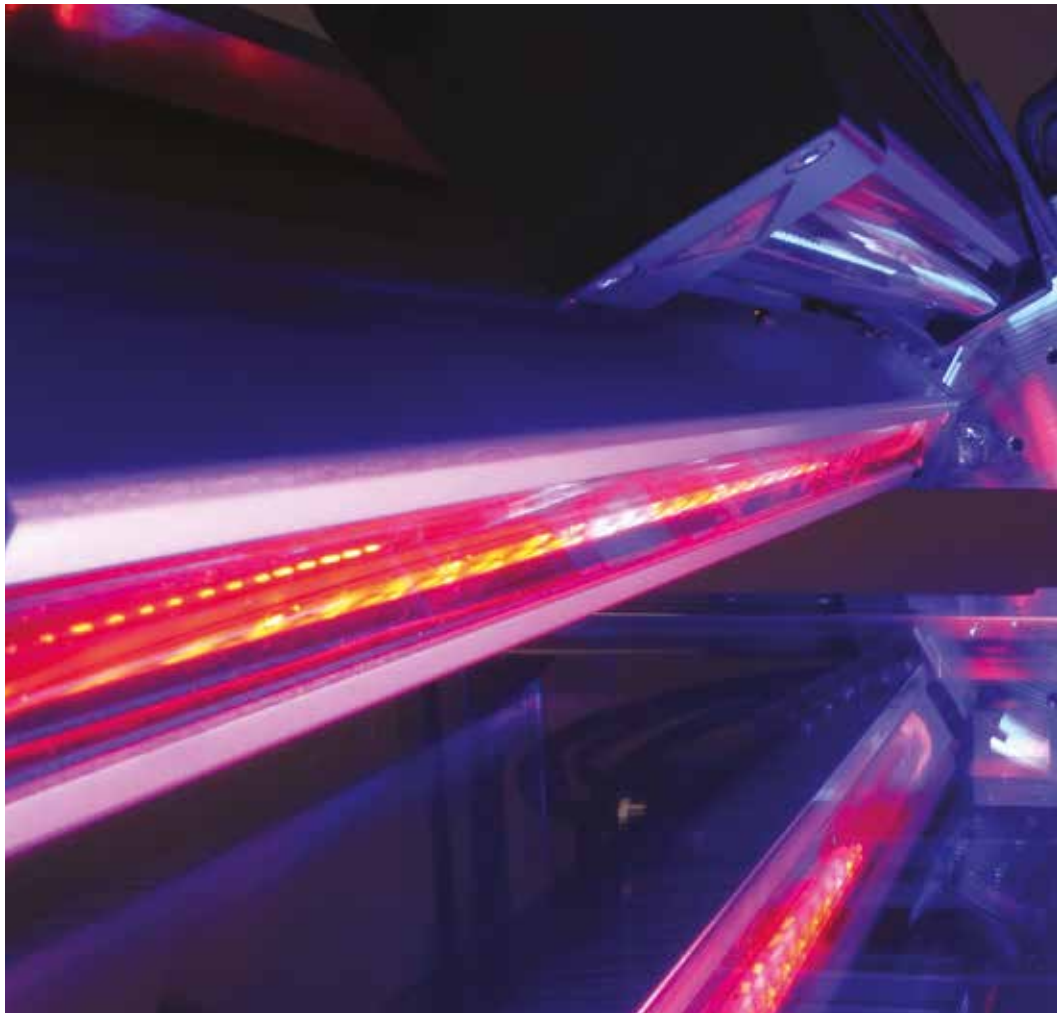
It's difficult to say what Intel's plans are for Tower fabs; Intel could streamline and improve some of the processes, which could be an advantage in terms of wafer throughput. However, if Intel has capacity issues – and most semiconductor fabs are experiencing capacity issues in one way or another at the moment – will that constrain machine vision sensor providers?

Meynants made the point that one of the benefits of the industrial imaging market is it is less influenced by cycles than the consumer business. Industrial imaging is still small compared to other sectors Intel serves, and there are bigger reasons behind the move – Cambou noted the acquisition might be, in part, an answer to the acquisition of Xilinx by AMD to provide computer chips.

Cambou commented: 'Now that Tower is a part of Intel, it will be interesting to see what the reactions of Tower customers – and Tower competitors – will be.'

Heart of glass

Tim Hayes provides a window into how to find defects in glass



Glass inspection normally involves different illumination methods

Glass is everywhere, from glazed buildings to smartphone displays. More than 65 million tonnes of float glass – the form most widely used in construction and consumer products – was manufactured in 2021, to support a market currently estimated at $265bn and expected to hit $352bn by 2028.

Technically speaking, only good quality glass is everywhere. Any sub-standard material is weeded out before it reaches the consumer, with the glass industry going to great lengths to inspect its product for encapsulated defects, surface flaws and manufacturing errors.

This process originally involved mechanical measuring gauges and the gaze of skilled human experts, but now exploits a range of sophisticated optical processes and high-performance machine vision systems.

'Defects can take a multitude of different forms, including bubbles, chips, scratches and defects in thin film coatings or in ceramic print,' said Angus Duncan, global R&D portfolio manager for process control and digitalisation at Pilkington, the long-established UK glass manufacturing company that forms part of Japan's NSG Group.

'We typically need to detect discrete defects in glass at sizes below 0.5mm. But in some cases, the defects can be considerably smaller. Tin defects down to a few microns on coated glass can cause functional issues. And the resolution of the measurement systems involved usually needs to be a factor of 10 better than these tolerances.'

Making light work

Spotting these tiny flaws means bringing a range of optical techniques to bear. Today's basic armoury of inspection tools includes focused laser scanners, moiré line scanners, bright and dark field platforms, and line scan cameras. And for specific cases, a manufacturer such as Pilkington can also deploy confocal chromatics, polarisation, fringe analysis and interferometry.

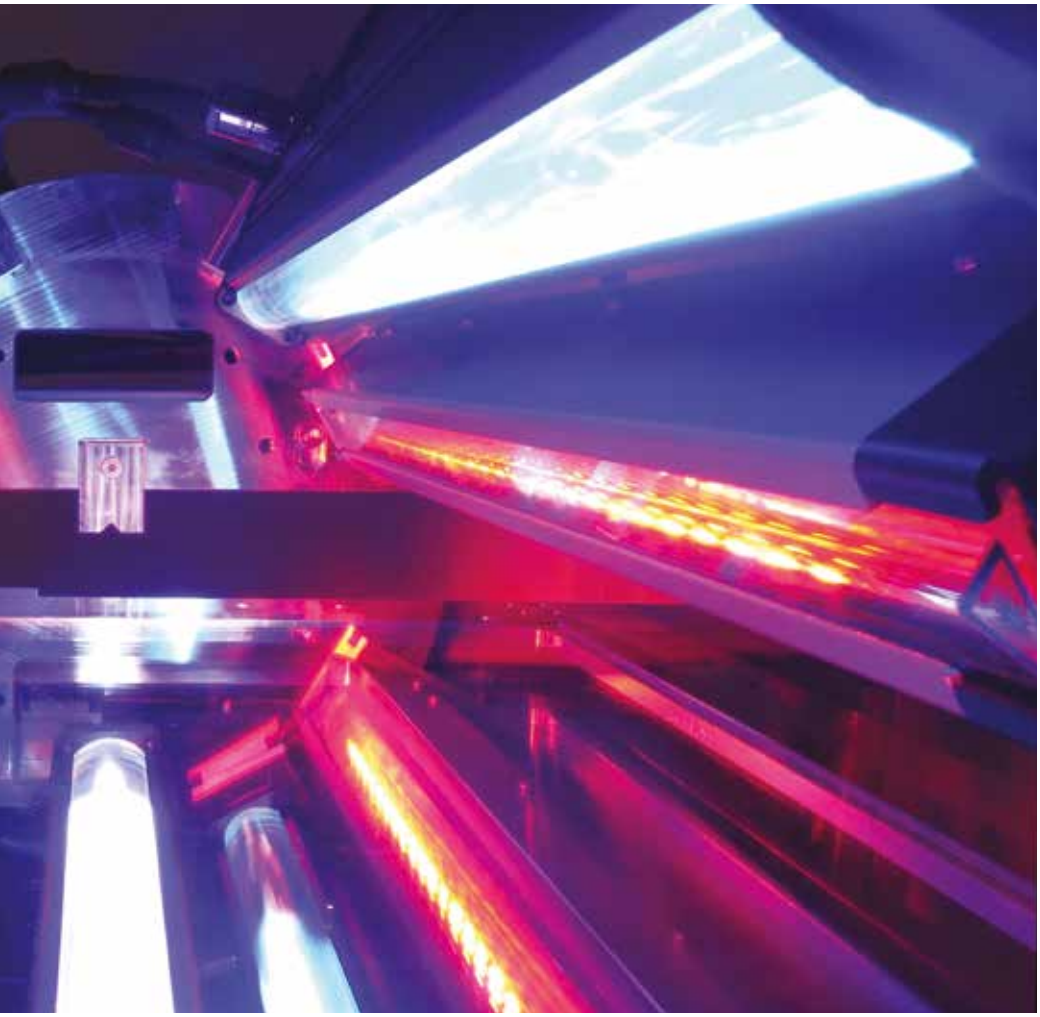
Spectrometry is also important for measuring spectral properties of thin film coatings, according to Duncan, while deflectometry is becoming widely used to assess reflective distortion, curvature and flatness, all of which influence the aesthetic effects of glass.

Since any one of these imaging techniques is rarely sufficient to visualise different defect types with the high contrast necessary, optical inspection usually involves a number of different modalities working in harness.

In principle, even a basic optical inspection approach for glass is likely to need three illumination approaches. A dark field arrangement will highlight scattering defects, like scratches or bubbles, with a low angle illumination close to the inspected object. This means that only light scattered from a defect is detected by a watching camera positioned appropriately.

In addition, direct reflected light may be essential for registering the presence of defects in surface layers. And light transmitted through the material from back lighting sources on the opposite side of the glass will reveal material inclusions and contaminants.

The basic rules of physics still apply, however, with image resolution limited by diffraction even as new and improved lenses come along. And adding more pixels to a camera does not necessarily equate to the detection of more defects.



MSTVision

Numbers game

If light manipulation is a key aspect of the inspection operation, it is not the only one. Equally critical are the imaging devices used to capture the visual information, and the data processing operations that then interpret those signals and yield concrete results.

'Optical inspection today represents a huge market for industrial machine vision across different industries,' said Bertrand Mercier BU Glass vice president at Germany's Isra Vision. 'But glass inspection poses its own significant challenges.'

Correctly identifying glass defects from the signals captured by a machine vision platform, like the ones developed by Isra Vision, involves the system in a sequence of decisions: distinguishing between a real defect and some other class of incoming signal; classifying the severity of the defect against the predetermined requirements of a particular application; and assessing precisely where those defects are located.

Making these fine distinctions might require different illumination angles, perhaps with a high-speed switchable LED as the single light source and using it to illuminate multiple individual views. But this in turn has implications for the quantity of data that must be processed.

'Tin defects down to a few microns on coated glass can cause functional issues. And resolution… needs to be a factor of 10 better'

'We have to face a huge quantity of data and processing it can only be done today with (FPGA) processors,' commented Mercier.

Isra Vision developed its own FPGA boards, as Mercier said there was nothing on the market that fulfilled the needs of the company's multi-view operation. In 2019, Isra Vision acquired Photonfocus, a Swiss specialist developer of CMOS image sensors, OEM camera modules and industrial cameras. 'These steps are needed

→

→ because the standards we work to can only be met with the right techniques, the right hardware and the right algorithms,' Mercier added. 'The market is very difficult to enter for this reason.'

AI-spy

The glass inspection sector, like several others in manufacturing, has found continual performance improvements lead directly to these data processing challenges: how to crunch the numbers more effectively. It might even be said that the focus of attention has now shifted away from the purely optical aspects, and towards these computational and decision-making ones.

Artificial intelligence could be a route forward, not least since companies with interests in AI, such as Google and Amazon, are pushing hard for it to enter new markets and penetrate deeper into existing ones.

'My feeling is that the optical side is now relatively stable, and has been for a few years,' commented Michael Stelzl, founder of MSTVision.

'The basic principles behind collection of scattered light from glass, or seeing where absorption or distortion takes place, are well established,' he continued. 'The interesting questions today are how much data you can process, how the defects are sorted or classified, and how much the process of doing so will cost. That is where the fight is going on now.'

But Stelzl said it can be a mistake to think AI will automatically lead to glass inspection becoming more straightforward, or allow the use of just a simple imaging camera with AI then able to do the rest of the job.

Training AI successfully is vital to success, but not an easy task, while the complexity of glass inspection adds to the challenges of creating reliable AI systems. And if the defects of interest are not encoded in some way within the original data, then no amount of investment in AI will reveal them.

Glass of the future

All these challenges now go hand-in-hand with the development of specialised glass materials targeted at new applications, bringing with them fresh obligations for inspection and quality control.

Manufacturing the conductive substrates Pilkington supplies for active electronic products, such as solar cells, requires automatic inspection of coatings with highly uniform optical and functional properties, explained Duncan. Elsewhere, the glass associated with automotive head-up displays and autonomous driving systems must be checked against demanding customer – and sometimes also legal – specifications.

Pilkington Technology Management Limited

Inspection system at glass manufacturer, Pilkington

'The interesting questions today are how much data you can process, how the defects are sorted or classified'

In consumer products, ultra-thin glass represents another growth sector, a market projected to reach $16.6bn by 2027. Although in principle the kinds of flexible folding glass envisaged by smartphone developers, such as Samsung, can be achieved by driving the glass thickness down to ever smaller values, the practical consequences for inspection of that glass become considerable.

Mercier said that Isra Vision is currently working on ways to inspect glass thicknesses measured in a few tens of microns – glass intended to bend like paper for next-generation smartphones and foldable displays.

'This is certainly challenging,' he commented. 'If you are inspecting a 10µm material then the depth of focus is extremely narrow, and the material is very delicate. Tackling this challenge involves working with our customers, sharing knowledge alongside an investment of time and finance.'

Money matters

Glass production is characteristically, perhaps understandably, conservative when it comes to adopting new approaches to inspection, or moving away from systems with which the industry is comfortable, not least because of the costs involved.

A full-width, four-metre defect scanner for a float glass line typically costs around £250,000, according to Duncan of

Pilkington, and on production lines where particularly complex measurement systems or more stringent end uses are involved, the costs can be significantly higher.

'We invest in the equipment because of the fundamental requirements of our customer or as a tool for process control,' he commented. 'By detecting defects at the point of creation, we can more quickly address the cause and prevent the defects from passing to the next stage of our process. As an example, detecting defects or contamination of the inner and outer shaped glass plies of a windscreen before lamination is highly desirable, as the cost of the plastic interlayer we add at that stage of the process can be more than half of the final windscreen production cost.'

These cumulative costs and challenges have also led to the adoption of different business models by the companies developing the optical inspection equipment. Stelzl of MSTVision has positioned his Germany-based company as a solutions provider, rather than a hardware developer.

'We are not primarily system vendors,' explained Stelzl. 'Instead, we sell development services, bringing technical know-how to the table. This means we work with both software and hardware, as well as with broader industrial aspects, such as the development of agreed standards for optical inspection.'

MSTVision has developed a time-domain multiplexing product named MultiChannel, which allows images to be captured from multiple lighting setups in one pass with a monochrome line scan camera. But rather than using bespoke optical components, the company's platform can employ off-the-shelf line scan cameras, LEDs and frame grabbers running on standard computer software.

This is a reflection of the ultimate driver today for all glass producers, according to Stelzl: downward pressure on costs and a wish for the inspection systems to become less expensive.

'Ten years ago, the demand was centred on increasing image resolution and achieving faster speeds, and then subsequently on the development of increasingly complex algorithms for the classification of defects,' he said.

'But since the inspection speeds are now fast enough to satisfy most applications, even the more demanding ones, the current impetus is for prices to come down and for cheaper inspection systems to become available.'

Isra Vision

Defect scanners have to handle large sheets of glass

The hyperspectral view from space

Abigail Williams speaks to scientists tracking marine plastic using satellite spectral imagery

Mathias Bochow/GFZ

Mathias Bochow, GFZ Helmholtz Centre, Potsdam, is working on the Trace project to track marine plastic

Hyperspectral imaging and remote sensing are emerging as key tools for tracking plastic pollution in the world's oceans. There's a lot of scientific research using satellite images, and the European Space Agency is supporting a number of remote sensing projects in this area.

Projects like Trace, which uses hyperspectral data from the Italian Space Agency's Prisma satellite (see the glossary for a list of satellites mentioned in this piece), along with other satellite imagery, to develop a system to track large marine litter and accumulation zones in oceans.

Mathias Bochow, environmental scientist at the Helmholtz Centre, Potsdam, part of the GFZ German Research Centre for Geosciences, is working on the project. He said: 'While high-resolution, multispectral data enables tracking of floating objects, only hyperspectral data enables material identification. We need to capture a hyperspectral image of a location that allows us to assume where floating litter will be over the next few days to be able to say it is really marine litter and not drifting algae or wood.'

In addition to the Prisma images – and EnMap images once launched – data from multispectral satellites in the PlanetScope constellation were used, alongside the Tiresias oceanographic forecasting model developed by CNR-ISMAR.

Bochow noted the ability to track floating objects has only become possible following the launch of the PlanetScope satellite fleet, which captures images from locations around the Earth every day. Although the fleet is typically only used to obtain images over land and coastal zones, images were recorded over the Adriatic Sea for this project.

'High frequent imaging over time enables tracking of floating objects when linked with an oceanographic forecasting system. We are about to find out how well this works over the next month,' said Bochow.

Spectral capabilities in the shortwave infrared (SWIR), between around 1,000nm and 2,500nm, are important for identifying plastics, because of the material's spectral fingerprint at these wavelengths. According to András Jung, co-founder of spectral camera firm Cubert, hyperspectral imaging can be used to sort plastic at a macroscopic level, such as everyday waste products from household or industry. He said there are many successful applications between 400nm and 1,000nm for this. But hyperspectral imaging can also be used to detect microplastics in water, and in this case the SWIR region is more useful.

Professor Jonathan Chan, ETRO guest professor at the Vrije Universiteit Brussel, noted that the ideal sensor to detect marine plastic should possess more spectral measurement capabilities at SWIR wavelengths.

Chan is working on the Muss2 project, which is using spectral and spatial enhancement methods to generate simulated Earth orbit hyperspectral shortwave infrared images and data from the Copernicus Sentinel 2 satellite using spectral response function modelling.

Hyperspectral images taken from Earth orbit are not always available and their coverage is not as large as conventional missions, such as Landsat and Sentinel. To overcome these limitations, Chan said the Muss2 team will apply a sparse theory-based method to enhance multispectral images from the Sentinel 2 satellite. The expected results are what he described as synthetic Sentinel 2 hyperspectral images at a spatial resolution of 10m, with the same coverage as Sentinel 2 multispectral images.

'So far, we have been able to generate such images based on Hyperion and Prisma spectral configurations, [and] quantitative assessments are promising,' he said. 'In addition, we apply a deep learning-based

method for the spatial enhancement of Prisma images to assist in the detection of smaller objects.'

Chan added: 'All the data inputs for the project are from open sources, including Sentinel 2, Hyperion and Prisma. The launch of Prisma in 2019 was a major milestone, and soon EnMap will be launched. These are full stretch hyperspectral images at 400-2,500nm with hundreds of spectral bands and represent the most powerful Earth orbit data source for environmental monitoring. The potential is not yet fully understood nor exploited, and scientific communities are just beginning to understand all the pre-processing protocols and data quality issues.'

Signed, sealed, delivered

Another interesting initiative is the Spots project, which aims to study the hyperspectral signature of floating plastic debris under less-than-ideal circumstances. As Robin de Vries, geospatial analyst at The Ocean Cleanup non-profit organisation, explained, hyperspectral satellite data has the potential to be a key component in the remote sensing of floating plastic debris.

He said: 'The hyperspectral signature is affected when plastic is submerged, or when it becomes covered by biological growth over time, known as biofouling. The Spots project is important because many studies have only investigated the detection of floating plastic under ideal conditions.'

The key objectives of the Spots project are to gather a spectral library of different plastics under varying water depth and biofouling scenarios, and to explore predictive models to estimate depth of water, material type and degree of biofouling from the hyperspectral signature.

According to de Vries, the project team has already collected most of the laboratory and field data and, although it is too early to share any definite results, he said the scientists are already finding that material thickness and water depth have profound and sometimes unexpected effects on the hyperspectral signature of plastics.

> 'The potential is not yet fully exploited; scientific communities are just beginning to understand all the pre-processing protocols'

Throughout the project the Spots team will make use of a range of hyperspectral imaging technology, including a Bayspec OCI-F imager, a Spectral Evolution SR-3501 spectrophotometer, and a Specim IQ snapshot hyperspectral camera.

'This equipment is only suitable for use in controlled environments,' de Vries explained. 'This means that we collect data of plastic in a controlled environment, to learn how we can best extrapolate it to applied remote sensing in the future.'

He added: 'At this stage, it is challenging to apply multispectral and hyperspectral sensors in the field for applied remote sensing for dispersed marine litter. The main reasons for this are the relatively high cost of the equipment and the limited spatial resolution, as well as the long sensor integration times, compared with a dynamic environment such as flowing rivers or ocean waves.'

Polarised potential

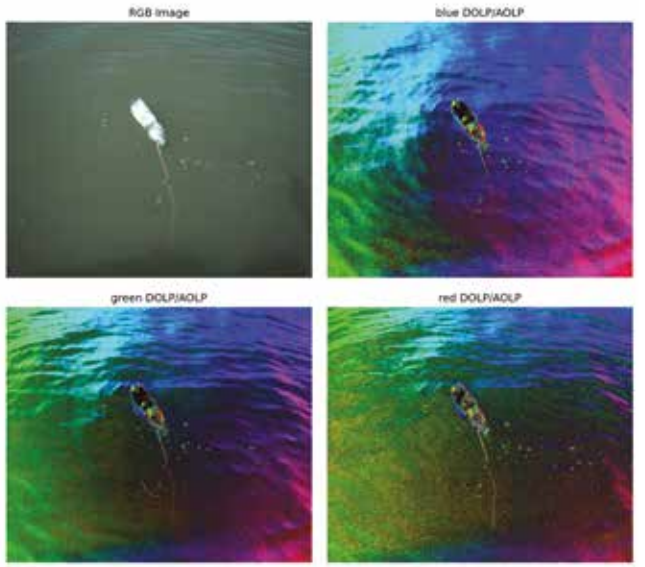
Elsewhere, the Ocean Plastics Polarisation Properties (OP^3) project is focused on obtaining fully characterised polarisation signatures of plastic marine litter in relation to other natural seawater constituents. This is through a combination of laboratory experimentation, in situ measurements and existing polarisation data from satellite missions, such as Parasol.

As Tristan Harmel, research scientist at Géosciences Environnement Toulouse, explained, remote sensing of plastic marine litter can be challenging because of the very high water absorption in the NIR-SWIR range, and the signal being masked during atmospheric correction.

Harmel said that complementary optical information is needed to detect plastics in the oceans. The polarisation state of light leaving water has been shown to be a significant tool to disentangle complex marine signals to retrieve water constituents.

To sense the two important elements of polarisation and directionality, Harmel explained that specific setups are needed in the laboratory, as well as in the field and from satellite platforms. For the latter, he said the historical French mission, Parasol, which contained the Polder instrument, was of particular interest because Polder sensors provided polarisation at three spectral bands (blue, red and near infrared) for up to 16 different viewing directions.

Moving forward, he said the next generation of satellite polarimeters will also provide a much more refined dataset encompassing the visible, NIR and SWIR bands. These include the 3MI instrument, to be launched on the Eumetsat Metop-SG series of satellites, which will provide multispectral (410-2,130nm), multi-polarised (-60°, 0°, and +60°) and multi-angular images of outgoing radiance at the top of the atmosphere. In addition, →



OP³

Image from the Ocean Plastics Polarisation Properties project, which aims to characterise polarisation signatures of plastic marine litter

→ the SpexOne instrument, to be launched on the Nasa Pace platform, will provide polarisation parameters within the spectral range of 350nm to 770nm, with a 10-40nm spectral resolution in five angular directions. The Harp2 instrument, also to be launched on Pace, will provide polarisation parameters for four visible-NIR spectral bands at up to 60 viewing angles.

Harmel said the main limitation for proper implementation of these instruments for plastic litter monitoring is their coarse spatial resolution, which is more than a kilometre. Harmel's project also investigates using portable or drone polarimeters.

Beyond plastic

Professor Chan noted that it is only a matter of time before the new types of data captured and used as part of plastic marine litter monitoring projects will be disseminated and applied to areas never thought of before.

'Due to its powerful spectral information, there should be enormous potential. More detailed mapping of land surface materials will be possible and temporal hyperspectral analysis will become more conventional – even though it is a big challenge due to the high dimensionality of the data sets,' he said.

'There are already motivations to incorporate such sensors in cubesats to deepen understanding of real-time emissions, temperature and so on. These are very active areas. There will certainly also be new applications related to climate change, green environment and sustainability related topics,' he added.

Elsewhere, Harmel observed a deeper understanding of the way that light – and polarisation – interacts with plastic in the natural environment is a first step for global monitoring of polluted waters, from lakes and rivers to oceans.

'I can imagine our library will be useful for industrial waste sorting… [to make it] more robust'

De Vries said it is likely that ongoing research into hyperspectral imaging technology will contribute to the improved atmospheric correction of spectral satellite data over water bodies, which can also benefit other environmental monitoring domains, such as ocean colour sensing.

'The outcomes of the Spots study and all its data will be made open access, so that industrial parties can also make use of it. I can imagine our library will be useful for industrial waste sorting, in that it could make industrial waste sorting more robust against dirty or wet plastics,' he remarked.

Jung at Cubert noted that, in terms of the general translation of research moving forward, most of Cubert's customers are scientists or researchers, but he definitely sees a growing share of OEM or industrial applications.

'We see potential applications in life sciences – including medicine, agriculture and food – because they need fast and spectrally accurate cameras,' Jung added. 'We are good at the identification of randomly moving objects from a randomly moving camera position; this is something which cannot be done by scanners.'

Glossary

- **EnMap:** Environmental mapping and analysis programme, a German hyperspectral satellite mission set to launch this year.
- **Hyperion:** a hyperspectral imager (220 channels from visible to SWIR) onboard the Earth-Observing One satellite, which was decommissioned in 2017.
- **Landsat:** Nasa's Landsat programme provides the longest continuous space-based record of Earth's land in existence.
- **Metop-SG:** Meteorological Operational, Second Generation series of satellites, set to launch over the next two decades. The **3MI** instrument, developed by Eumetsat as an improvement on Polder, will be onboard.
- **Muss2 project:** Multi-model synthetic S2-HS (Sentinel 2-hyperspectral) data for marine-plastic debris characterisation.
- **OP³ project:** Ocean plastics polarisation properties, led by Carl von Ossietzky Universität Oldenburg.
- **Pace satellite:** Plankton, aerosol, cloud, ocean, ecosystem. A Nasa mission due to launch in 2023. It will house the **SpexOne** instrument, a multi-angle polarimeter, as well as the **Harp2 polarimeter**.
- **Parasol microsatellite:** Polarisation and anisotropy of reflectances for atmospheric science, coupled with observations from a lidar. Launched by French agency CNES to look at how clouds and aerosols impact climate. Contains the **Polder** instrument: Polarisation and directionality of the Earth's reflectances. The mission ended in 2013.
- **PlanetScope**: a constellation of approximately 130 satellites, able to image the entire land surface of the Earth every day (a daily collection capacity of 200 million km²/day).
- **Prisma:** Italian Space Agency medium-resolution hyperspectral imaging mission, launched in 2019.
- **Sentinel-2:** a constellation of two polar-orbiting satellites housing a multispectral instrument. It is part of the European Earth observation programme, Copernicus, overseen by the European Space Agency. Seven Sentinel missions are in operation.
- **Spots project:** Spectral properties of submerged and biofouled marine plastic litter.
- **Trace project:** Detection and tracking of large marine litter based on high-resolution remote sensing time series, machine learning and ocean current modelling.

Predictive cities

Tim Reynolds finds out how vision and AI algorithms are making cities safer

In cities, around seven out of 10 traffic fatalities are cyclists and pedestrians. Speed kills, but human error also remains a common cause of accidents, from vehicles turning, reversing and pulling out, or failing to give right of way. Globally, more than half of the 1.3 million people who die in road accidents are road users who aren't in a vehicle.

Speed and red-light camera systems have helped prevent accidents and protect vulnerable road users for many years, but now there are projects making use of artificial intelligence (AI) to improve safety on roads. For example, the Dubai police are trialling AI technology from Vitronic Middle East to prosecute traffic violations at pedestrian crossings. The Pedestrian Safety Enforcement System is able to distinguish between different road users in real time, to control traffic lights when a pedestrian is waiting to cross, or to document drivers running a red light.

But what more is possible? Can AI be used to predict traffic and road user behaviour? Computer vision specialist Amritpal Singh, CEO of Viscando, is developing technology to support smart cities, autonomous driving and industrial needs. Viscando's 3D and AI-sensing solutions enable clients to better understand movements and interaction to enable data-driven traffic safety.

The company is based in Gothenburg, the automotive capital of Sweden, so it has natural contact with the sector. Viscando also works closely with regional authorities on traffic management projects and local information communication technology (ICT) development.

Singh believes that prediction of close future scenarios – not minutes ahead of time, but seconds – is within reach with the technology. Singh is working on projects to understand the intentions of people

jamesteohart /shutterstock

before they act; to predict if, say, a bike or pedestrian will cross the road or continue along it up to five seconds before the decision is made. 'We are not at 100 per cent accuracy, but 82 per cent,' he said. 'The data is there; we just need to be better at extracting it.'

There is plenty to do from the tech side in terms of pure data analysis. 'It's very much in line with what you need to have if you are applying machine learning,' commented Singh. 'There is room for other disciplines to contribute here, such as with behavioural insights, but the data on what the pedestrians and cyclists are doing is already there and the information available.'

This leads to two entangled loops in terms of decision-making. 'There is a low latency for decision-making in traffic. You have perhaps 50 to 100 milliseconds to make a warning and ensure appropriate actions are taken to avoid an accident. This may require more intelligence in the vehicles, and local processing of data and decision-making in the local infrastructure.

'The data is there; we just need to be better at extracting it'

'And there is a longer loop using the full data collected to extract insights,' he added. These insights could, for example, help design intersections and crossings to reduce conflict between users.

The same data could be used to generate scenarios for autonomous vehicle testing. To prove the safety of autonomous vehicles will require billions of kilometres on roads, but that data may not be useful for understanding more complex interactions, such as urban traffic, lane merging and other potential conflict scenarios. 'Interactions are more important than kilometres,' said Singh.

Both quality and quantity of data are required. Singh believes that use of the passive data captured on camera infrastructure could be used here, especially as they observe real-world situations and more complex interactions. 'We can collect billions of kilometres passively,' he said.

'What more is possible? Can AI be used to predict traffic and road user behaviour?'

Talking to the city

Image processing onboard the camera, close to the sensor, opens up the potential to capture more data that is ultimately going to make cities or transport smarter. NTT Smart Solutions has a focus on Internet of Things-enabled edge analytics, and vision is one important input into its systems.

Current clients use NTT solutions to predict, for example, train occupancy 24 hours ahead, or the movement of people into and around large venues for crowd control, with a 20-minute forward horizon.

NTT is developing the potential of connected vehicle systems, working with Toyota to investigate how vehicles can communicate with infrastructure, such as data centres and 5G networks. Currently, these research systems can detect an obstacle and warn a moving car within around five seconds. Other key applications of such a connected vehicle infrastructure include generating accurate, real-time maps and rapid detection of congestion.

Bill Baver, vice president of NTT Smart Solutions, noted that optical sensors will need to be capable of doing some of the analytics within the device itself. 'We don't want to be pushing video back to the core data centres,' he said. 'The vision side should have more configurable capabilities. This would be helpful for multiple use cases.'

He also argued that imaging technologies need to be adaptable to multiple data highways and provide application programming interfaces to integrate easily into solutions.

With vehicles now being developed incorporating a battery of sensors – lidar, radar and image sensors across the visible and infrared – it's only a matter of time before vehicles start to communicate with the city streets they are driving through.

Answering AI's imaging issues

Gemma Church looks at how finding the right AI-assisted software can benefit specific vision tasks

The advent of artificial intelligence (AI) technology has helped multiple industries and the imaging and machine vision market is no exception.

AI-assisted imaging is currently used in areas such as machine vision, manufacturing, agriculture and smart cities. Brandon Hunt, product manager at Teledyne Dalsa, explained: 'Smart cities are an emerging application area as Industry 4.0 and 5G take charge. The resulting IoT infrastructure starts to enable more data and connectivity than ever before. All this extra data is rocket fuel for AI models to perform well.'

From food packages to flat panel displays, automotive parts and medical x-rays, AI-assisted inspection tools are now entering those markets where standard algorithms have challenges, from high variation rates to changes in shapes or lighting levels. Hunt defines these cases as 'any area where the logic is fuzzy and requires a human's judgement.'

However, AI is still fairly new to the imaging industry. Hunt explained: 'There are still many companies out there who rely on humans for applications like defect inspection and they often are not even aware of what AI can do for them.'

As such, AI-assisted imaging still faces challenges surrounding managing user expectations. 'One of the biggest challenges is communicating what AI can or cannot do and explaining the process,' Hunt continued. 'There is often a gap between the technology and the customer's expectations.'

AI models follow a different workflow, for example, which is iterative in nature. As a result, users must repeatedly run the workflow and analyse the results that are returned. 'Some customers want specific levels of accuracy, but it's hard to get that kind of information without trying it out first,' Hunt added.

Different coloured licence plates

'Then, if something goes wrong in the AI model, it's not a straightforward fix. It usually requires experimentation and trying out different parameters, datasets – and requires an engineer to look into those areas.'

This is where the right platform can help, providing users with an intuitive interface and the tools to understand both how AI works and how it can benefit specific imaging applications.

Working together

The user experience is a key factor to increase adoption rates and help everyone understand the benefits of AI-assisted imaging tools.

To achieve this, these tools must integrate with existing, traditional image processing software. This provides users with the best of both worlds, allowing them to cater to their needs while also lowering the barrier to entry, streamlining the user experience and learning process.

The latest developments in tools such as Teledyne Dalsa's Sapera Vision Software can provide field-proven image acquisition, control, image processing and artificial intelligence functions to help users design, develop and deploy high-performance machine vision applications. Sapera Vision Software includes Astrocyte, a GUI-based tool for training AI models.

Users can, for example, use the GUI-based Sherlock machine vision in conjunction with Astrocyte. This provides them with a no-code environment, democratising these AI models for everyone. Visualisation is another important means to help users understand the AI-assisted tools with which they are working. When dealing with anomaly detection, such data visualisations can help users intuitively understand any detected defects, presenting the size and location of those defects in an intuitive manner.

An anomaly detection algorithm can robustly locate defects while generating output heatmaps. The provision of

heatmaps at runtime is also a useful feature, helping users obtain the location and shape of defects without the need for graphical annotations at training.

Teledyne Dalsa is also developing a tiling feature to allow users to work with larger image sizes and identify smaller defects. Previously, these smaller defects were often reduced in size and lost when they were passed into the neural network.

Time savings

By their very nature, AI-assisted image processing tools perform many of the repetitive, low-skill activities within image processing, providing users with more time to focus on value-added or more complex tasks. The resulting time savings are a key benefit for many users and businesses.

When it comes to discussing how AI-assisted imaging tools actually work, a system such as the Sapera Vision Software offers continual learning – where the deployed AI model learns in the field. In other words, the user does not need to retrain and redeploy the model if any new cases occur after initial training is complete. The model can continuously adapt, even after it has already been deployed to runtime.

As a result, the AI models are able to train themselves quickly. With a sufficient amount of data, users can get a model up and running in as little as a few minutes.

A licence plate obscured by dirt

'This is a huge time saver for customers,' Hunt explained. 'One of the biggest issues in AI is that when a model is ineffective or new images are presented, then you must retrain the model. This replaces any previous work done and does not guarantee an improvement in the results. With continual learning, users can optimise the existing model with new information. This both saves a lot of time and keeps any previously saved efforts.'

Time is a critical consideration, not just when running these AI models but also when labelling the images.

Using this type of software, for example, users can import a folder of images and group them all with a single label. The semi-supervised object detection (SSOD) functionality allows users to start with a certain number of images, label a few and then the software automatically labels the rest.

Data quality

When training any AI system, the quality of the data used is another crucial factor. For example, you may want to train an automatic number plate recognition (ANPR) imaging system to read the plates passing by on a motorway.

If the licence plate images are clear and can be easily identified by a human, then the AI system can also be easily trained. But if there is ambiguity in this data from, for example, faded number plates or those partially obscured by dirt, then there needs to be an agreement between the humans classifying those images. 'If the humans can't agree, then the AI model won't do well,' Hunt added.

In its latest whitepaper *The Importance of Data Quality When Training AI*, Teledyne Dalsa examines this data quality issue in more detail, examining the impact data quality has on the quality of the training for an AI-assisted imaging tool.

Under control

Keely Portway finds out how combining AI with visual inspection in manufacturing can help to reduce errors and increase efficiency

Artificial intelligence (AI) is increasingly being used in manufacturing and production as a way to help automate a number of processes, ensuring maximum efficiency, minimum errors and a reduction of costs.

One application is in quality control, particularly in industries where the consequences of errors could be particularly high – examples include defence, aero, food production, medicine and automotive.

A recent example of such an investment came in the form of a new Nissan production line at its Tochigi Plant in Japan, which features what the company calls the 'Nissan Intelligent Factory initiative'. Visual inspection is one of the many processes that will be automated, with 11 robots inspecting the body and bumper in order to achieve 100 per cent detection of dust and debris on the paint work. Another six robots conduct inspections of specifications to identify flaws. Results are stored on a centralised management system for maximum traceability.

Pleora Technologies

Electronic component manufacturer, DICA has incorporated the image compare plug-in from Pleora to incorporate AI into its visual inspection process

Working together

Of course, every inspection process differs depending on company size and product type, among many other factors. Additionally, though challenges to AI adoption have historically centred on the perception that it will replace human workers, it is accurate to say that in many quality control scenarios, visual inspection by human workers combined with AI technologies actually produces the best results.

This is the view held by Ed Goffin, marketing manager at Pleora Technologies, a company that provides AI for manual and automated inspection across a wide range of industries. He said: 'We have good relationships with a number of customers in different types of markets – we ask them about their manufacturing processes and where they see areas in which they could use technology to help. One thing that consistently comes back to us is that there's still a heavy reliance on visual inspection in a lot of different areas of manufacturing. No matter how much manufacturers incorporate automation and machine vision, there's clearly still a pretty big role for humans in the inspection process.'

This is because humans have many skills that lend themselves perfectly to performing visual inspection. Humans can also use their senses to aid visual inspection- in food and beverage manufacture, for example – and we have the ability to learn what sorts of things to look out for from other humans and make subjective decisions. Continued Goffin: 'Many of the advances in machine vision and now AI aim to replicate what we as humans do really well. But at the same time, we can get tired or distracted, particularly after an eight- or twelve-hour shift. Attention to detail can start to slip.'

In Goffin's experience, one of the greatest advantages of using AI is to add decision support to visual inspection. 'It's not looking to replace humans because we bring a lot of value in those types of manufacturing processes, particularly for lower volume but higher value products,' he said. 'The intent is to provide an inspector or operator with the decision support tools that highlight product differences or deviations, or guide them through the manufacturing process to ensure they're using the right components at the right time.'

This is particularly the case when it comes to visual inspection tasks for

consumer goods, food and beverage, print and packaging and manufactured parts (for example, for automotive assemblies). Electronics assembly lines present a particularly big opportunity for AI assistance. 'One of the areas where AI visual inspection is used the most is for incoming, in-process and final inspection for electronics manufacturing,' revealed Goffin. 'In particular, the system is used for higher value, lower volume products not well-suited to full automation, or to help catch errors commonly missed by automated optical inspection.'

Efficient integration

The latest advances in no-code algorithm development and edge processing platforms have made it more feasible for manufacturers of products like those detailed above to incorporate AI decision-support. 'Pre-packaged and easily trained plug-in applications around common use cases mean manufacturers can get up and running quickly,' said Goffin.

The added advantage is that it helps to overcome some of the other perceived challenges of incorporating AI into manufacturing processes, in terms of time and expense. Goffin continued: 'Typically when manufacturers think about AI, there's a perception that it takes a lot of images and training time, or external expertise is required. There's also terminology that comes with the technology which can be confusing. So it could be a little bit daunting – especially for a smaller manufacturer who is reading about the advantages of AI, but then trying to understand how to deploy it. Some companies see the advantages of AI, but they also have proven processes that they don't want to risk. However, today's systems are designed to be user friendly. So even with just one good image, a manufacturer can start incorporating AI into its existing processes.'

One company that has taken advantage of the benefits of such a system is electronic component manufacturer DICA, which manufactures high-quality electronic assembly services for a small-to-medium volume market. Not all of the company's products are suited to automation; human inspection is still very important, ensuring that the right components are being used in the right places and that nothing has changed or become defective since the previous step.

DICA has adopted the image compare plug-in from Pleora Technologies to incorporate AI into its visual inspection process. The tool is a visual application that is 'trained' to make errors obvious to a human inspector. All that is needed is a single image of a known good product to which all future products can be compared.

> 'There's a perception that it [AI] takes a lot of images and training time, or [needs] external expertise'

The plug-in's AI capabilities are used to match the approved layout and final production – it compares the placement of components on the circuit board, highlighting any differences for the human inspection before moving on to the next step in the manufacturing process or to final packaging. The plug-in also learns and is continuously trained as the operator accepts or rejects possible detected errors, allowing the system to make more accurate suggestions.

The plug-in is also used for quality checks on incoming components from suppliers and for batch tracking. With an image save application, the operator captures an image of the final board, the barcode and can add any notes on the product. 'Visual inspection is often a "data black hole" in manufacturing processes,' said Goffin. 'This application lets them know a product has left the manufacturing sites in good working order and can speed up the resolution process if there's an issue in the field.'

Embedded gets the edge

A roundup of some of the latest embedded vision technology

Shutterstock.com/Sergey Nivens

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

'Embedded computing opens the door to many more uses of vision technology'

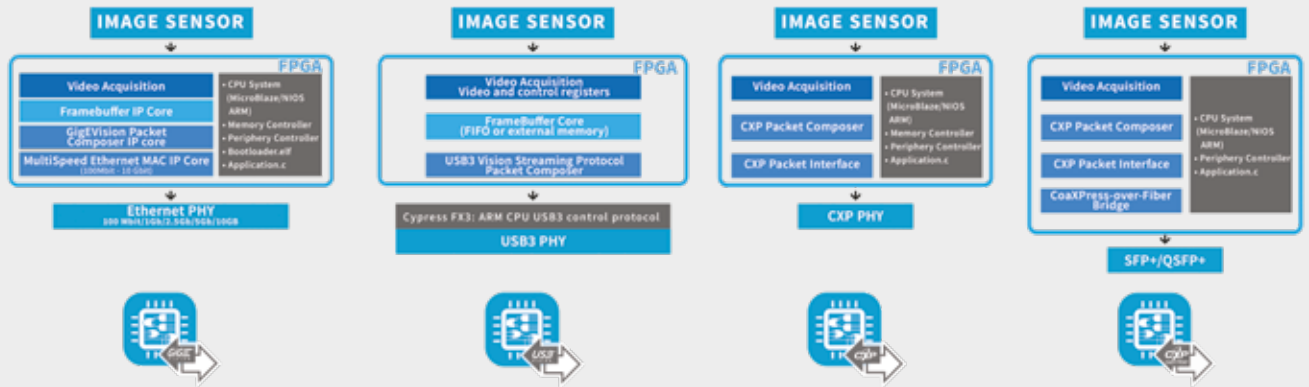
Khronos Group, together with the European Machine Vision Association, are working on an open API standard for controlling embedded cameras across mobile, industrial, XR, automotive and scientific markets. This new standard aims to help companies building embedded vision devices.

Commercial products

Among the camera vendors offering embedded vision products, **Framos**' sensor module ecosystem now supports Maxim's Gigabit Multimedia Serial Link, GMSL2, protocol. Cameras up to 8-megapixel resolution at 30fps can be connected over 15m of cable.

GMSL2 has a data rate of 6Gb/s with low cabling costs and low power consumption. Low latency can be realised at distances of up to 15m. Framos has integrated with Connect Tech's GMSL camera platform. The expansion board allows up to four Framos cameras to be connected to the Jetson Xavier

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 like 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

module interfacing with the GMSL2 protocol. The cameras are powered by Power over Coax - data, control signals and power are sent through a single coaxial cable. The ability to connect any Framos image sensor to the Nvidia Jetson platform via GMSL2 over long distances enables new possibilities and applications.

Vision Components has released a SerDes adapter board so that coax cables up to 10m and longer can now be used with the Mipi interface. The company's Flexible Printed Circuit (FPC) cable is available in three standard versions with 15, 22 or 24 pins, in lengths of 60mm, 100mm or 200mm. Transfer rates of 6Gb/s are possible, corresponding to 750MB/s at an 8-bit pixel resolution.

The FPC cables have a trigger input and a flash output. These enable both video streams and single image acquisition; they do not affect the host system. Settings such as shutter speed, position and binning, gain and image size can be individually adjusted for each image. Using the cables with an external trigger, very fast processes can be detected and synchronised. Vision Components has also developed repeater boards that enable up to five times longer transmission paths.

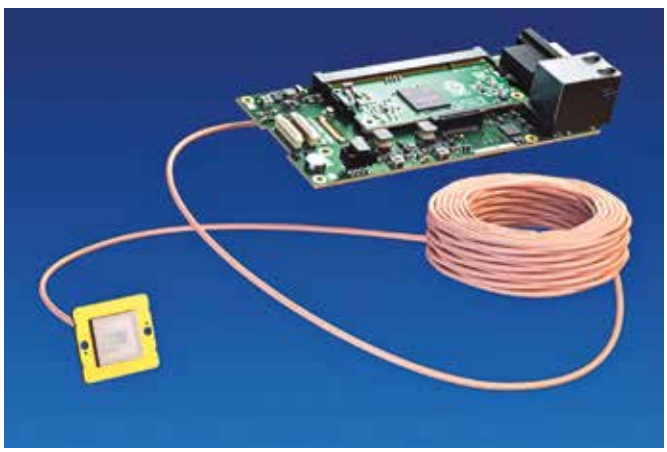
Vision Components also now offers an FPGA-based accelerator for edge preprocessing of image data. It has multiple Mipi-CSI-2 inputs and outputs and can merge data from several Mipi cameras.

The latest 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.

Basler and **Variscite** both offer solutions based on the NXP i.MX 8 applications processor series, as well as various evaluation kits. For its development kits destined for multimedia use, Variscite employs Basler embedded cameras so that companies can quickly get started and test vision-based applications.

Coinciding with the announcement of NXP's latest applications processor, the i.MX 8M Plus, Basler released a reference camera module that matches the system-on-chip (SoC). The company also recently launched an industrial-grade embedded vision processing board with vision optimised interfaces based on a Variscite system-on-module (SoM). Various camera types can be connected to the SoM - it is suitable for prototyping and series production.

Also working with NXP boards, **Thine Solutions** recently introduced its second Theia-Cam family kit - the THSCM101, a 13-megapixel phase-detection auto-focus (PDAF) linux camera reference design kit. The kit interfaces to NXP's i.MX 8M family and is based on Thine's THP7312-P image signal processor and Sony's IMX258 13MP CMOS PDAF image sensor. It includes →



Vision Components

Vision Components' Flexible Printed Circuit cable

BitFlow Featured product

BitFlow's latest in CoaXPress: The Claxon-CXP

CXP-12 is the latest CXP standard, now transmitting video at 12.5 Gb/s. While the speed of data through the frame grabber has doubled, the overall architecture has remained the same as the previous generation Cyton.

This allows users to easily migrate to the newer cameras without major software changes. The Claxon-CXP4 is a quad CXP-12 PCIe Gen 3 frame grabber. It supports multi-link CXP-12 cameras of up to four links. The Claxon CXP4-V (shown here) is designed for small form factor PCs with little to no airflow.

More information www.bitflow.com/products/coaxpress/claxon-cxp4-v/

→ a camera board, a mini-SAS cable to connect the camera to the NXP i.MX 8M's CSI port and all the required software to stream images. The kit is plug-and-play, including firmware optimised for most of V4L2 camera functions.

The German firm **Phytec** also concentrates on NXP solutions for its embedded vision offerings. It has 26 years' experience building solutions.

Other new embedded cameras include the Nicla Vision 2-megapixel camera from **Arduino**. It measures 22.86 x 22.86mm, has a powerful dual processor and is compatible with Portenta and MKR components. It integrates with OpenMV, supports MicroPython and features wifi and Bluetooth low-energy connectivity.

E-con Systems' latest launch is the See3Cam_CU135M, a 13-megapixel monochrome USB 3.1 gen 1 camera. It is based on the 1/3.2-inch AR1335 monochrome CMOS image sensor from Onsemi. This camera comes with an auto-exposure feature; an absence of colour filter arrays results in high quantum efficiency in both visible and near infrared regions, compared to cameras with RGB colour filters.

On the software side, **Irida Labs** recently launched PerCV.ai, a software and services platform that supports the full vision-AI product lifecycle. PerCV.ai integrates machine learning models for people, vehicles, or any type of object detection together with vision system design, data management and deployment tools for on-device intelligence. The platform is suitable for companies looking for a vision application-as-a-service using COTS HW components, as well as those aiming to develop new vision sensor products.

Available from **MVTec Software** is a plugin for Intel's OpenVino toolkit. This will enable users of MVTec software products to benefit from AI accelerator hardware that is compatible with OpenVino. The toolkit from MVTec is based on the Halcon AI accelerator interface - supported AI accelerator hardware can be used for the inference part of deep learning applications.

The **AMD Xilinx** Kria system-on-module portfolio, was launched last year. First to market was the Kria K26, specifically targeting vision AI applications in smart cities and factories. The Kria K26 SoM has 1.4 tera-ops of AI compute and is built on top of the Zynq UltraScale+ MPSoC architecture, featuring a quad-core Arm Cortex A53 processor, more than 250,000 logic cells and a H.264/265 video codec. The SoM also features 4GB of DDR4 memory and 245 IOs for connecting to virtually any sensor or interface.

Following the above launch, **Pinnacle Imaging Systems** announced it would offer its Denali 3.0 HDR ISP with a new HDR sensor module for the Kria K26 SoM and KV260 vision AI starter kit. Pinnacle Imaging also offer an IAS HDR sensor module paired with and tuned for the KV260 vision AI starter kit. This sensor module is based on the On Semiconductor AR0239 CMOS imager, capable of capturing up to 120dB/20EV of dynamic range at 1080p/30 full HD resolution.

Like Pinnacle, **Hema Electronic** integrated AMD Xilinx Kria SoMs into its embedded vision platform, adding modules specifically designed for use in areas such as machine vision and smart cities.

Vendors of embedded computing kits include **Gidel** with their FantoVision 20, a small and robust embedded computer tailored for high-throughput image acquisition and processing. It allows image processing, compression and recording of video streams with up to 20Gb/s in real time. Its architecture combines an Nvidia Jetson Xavier NX embedded computer with an Intel Arria 10 FPGA for frame grabbing with real-time AI and image processing.

The **Cincoze** Gold series is a range of GPU computers designed to meet the needs of large-scale image processing, machine vision and machine learning applications in AIoT. The series includes the GP-3000 and GM-1000, providing a range of sizes, performance, I/O and functionality.

Advantech offers a series of solutions for embedded computing powered by Nvidia GPUs. Built on the Nvidia Ampere architecture, the latest Sky-MXM-A2000 is an industrial-grade GPU-accelerated solution designed to deliver the latest RTX technology. It features real-time ray tracing, accelerated AI, advanced graphics and high-performance computing capabilities.

Finally, **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. The company also recently extended its i.MX 8 ecosystem with a new starter set for AI accelerated embedded vision applications. The new set contains an entire ecosystem for developers to start designing applications. At its heart is the Smarc 2.1 computer-on-module Conga-SMX8-Plus.

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.**

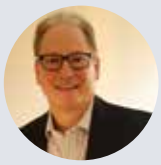
Webinar
Tuesday, 5 April 2022 @ 3:00pm

IMAGING & MACHINE VISION EUROPE

Deep learning

Join us as we discuss how deep learning is best applied to industrial inspection, including how to make the best use of image data, as well as combining different techniques to get good results.

Speakers



David Dechow

David Dechow, vice president of outreach and vision technology at LandingAI, will speak about ways to work with data to get the best out of deep learning in industrial inspection.

Daniel Soukup

Daniel Soukup, a deep learning specialist at the Austrian Institute of Technology's high-performance vision systems group, will give his take on how to get good results using deep learning. AIT's approach is to use a combination of more traditional image processing techniques together with deep learning.

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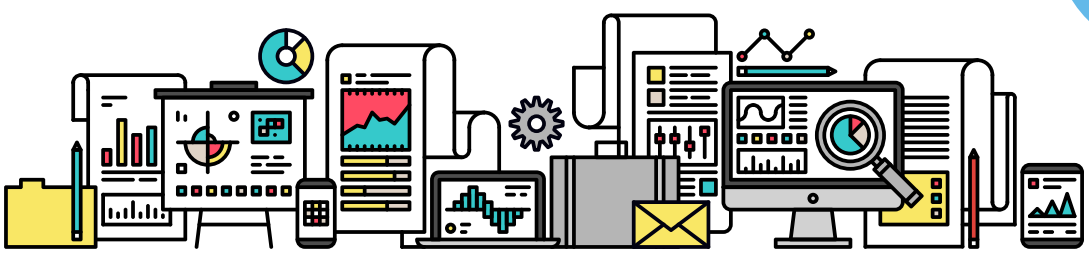

Multi-Core Acquisition Optimizer for fast GigE Vision cameras

MATRIX VISION

The Multi-Core Acquisition Optimizer is a software-based innovation for using 10GigE cameras at maximum frame rate without any concerns and running time-consuming algorithms for processing the images at the same time

Event-based vision compared with machine vision

IMAGO TECHNOLOGIES

From high-speed applications to tracking, vibration analysis and counting applications: event-based vision opens up new possibilities in numerous machine vision fields

Photometric stereo technique - 3D machine vision's next frontier

SMART VISION LIGHTS

Photometric stereo uses 3D surface orientation and its effect on reflected light to produce a contrast image accentuating local 3D surface variations, making complex inspections cheaper and more effective

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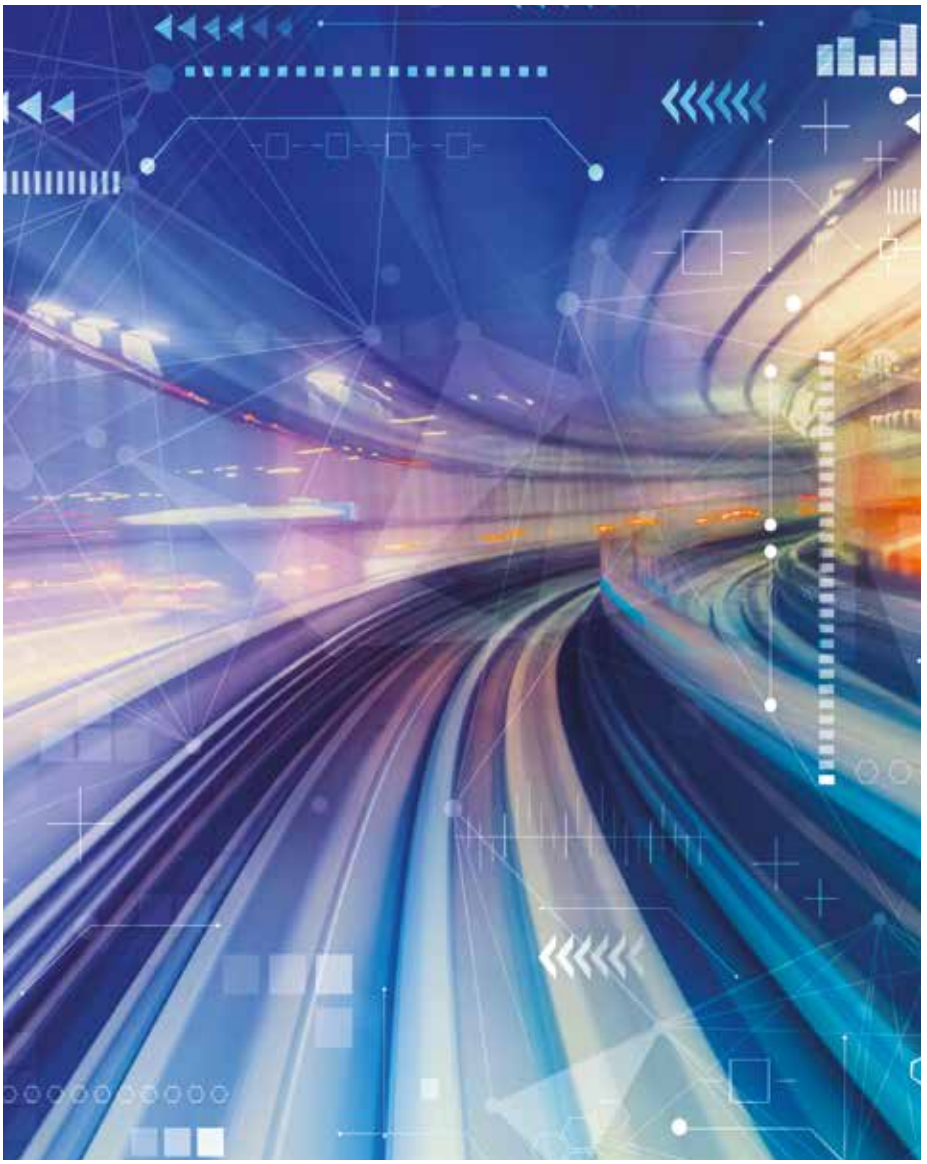
IMAGING & MACHINE VISION EUROPE

Need for speed

Keely Portway on how vision application designers can use embedded technology to reduce complexity and time-to-market



TierneyMJ/Shutterstock.com

Advances in embedded computing have been transforming how imaging devices are deployed, thanks to lower associated development and deployment costs than more traditional machine vision. This has led to more use cases, with applications in industries such as aerospace, automotive, augmented reality (AR), pharmaceutical, consumer electronics, defence, security and even retail.

The technology behind embedded computing has been around for some time. The first 'smart cameras' emerged from research institutions in the 1980s. When they reached the commercial market, most embedded products were custom solutions ideally suited for high volume manufacturing.

Alexis Teissié, product marketing manager at Lucid Vision Labs, explained: 'For many years, the option was to buy new, more powerful x86 CPU processing, PC-based systems. The way to go if you needed faster processing and higher bandwidth was upgrading the PC architecture, which was very flexible.'

The benefit here, explained Teissié, was that this could be adapted to a variety of configurations, both simple and high-end. 'Instead of having a central processing system, there was a shift towards moving the processing closer to the acquisition side, closer to the edge,' he said. 'There was also the evolution of the graphic processing unit (GPU) that was well suited for a lot of vision processing tasks. One of the big motivations for moving to GPU and edge analytics was being able to run those paradigm shifts compared to traditional machine vision. Being able to run artificial intelligence (AI) on-camera is another motivation, because an optimised AI network doesn't need the high-end processing hardware.'

Smaller and easier

The evolution of embedded tech has also driven a need for systems to be smaller and easier to integrate. 'Systems started to become less enclosed,' said Teissié, 'so designers would not have to deal with cabling, for example – and the camera and processing would be nearby.'

However, as with all developing technologies, embedded tech does not always come without its challenges. With progress towards miniaturisation and edge processing, application designers found that they needed to work through several time-consuming steps to reach a finished product. Advances in modules that can connect directly to embedded boards have helped to alleviate some of these problems for designers, allowing more freedom to create an embedded vision system without having to design everything from a standing start. But the next challenge for vision application designers was architecture limitations, as Teissié explained. 'For example,' he said, 'it can be difficult to deal with multiple cameras, because there is no standardised connection. So they would have to design carrier boards or interface boards. Then there is the industrialisation part, which is how to produce at scale with something that is robust and reliable.'

This move from concept to system production is a particular challenge.

Teissié continued: 'It's very easy to get an off-the-shelf embedded development kit and use it to get something working. The question is around reliability. Can it be produced for many years? How sustainable is the lifecycle? Some of the chips have a long lifecycle, whereas the boards and the development kits are refreshed every year-and-a-half to two years. In the industrial space, long-term availability is key. So the designers have to do it themselves, managing obsolescence and updating their systems. They have to make sure that these pass all testing and certification, are reliable and can withstand harsh environments. They have to maintain all of this over the lifetime of the product and ultimately, that is a big investment. The alternative is that they select a platform from a manufacturer that can commit to supporting their business for the long-term.'

Simplification solutions

In the latter case, vision application designers are looking to manufacturers for solutions that simplify these stages. For Lucid, this has involved a collaboration with AMD Xilinx, leveraging the Zynq UltraScale+ multiprocessor system-on-a-chip (MPSoC) to provide a solution for customers facing these challenges.

Zynq devices are designed to provide 64-bit Arm processor scalability, combining real-time control with soft and hard engines. They are built on a common real-time processor and programmable logic equipped platform. Lucid has integrated the Zynq chipset into its latest development, the Triton Edge camera. Teissié revealed: 'We have a strong partnership with AMD Xilinx and are leveraging the development framework, as it can adapt to various customers – from the application specialist to the embedded software engineer, all the way to the hardware developer dealing with the field-programmable gate array (FPGA). The Triton Edge is an expandable platform that designers can get running very quickly using the off-the-shelf tool we have built in with the Zynq interface.'

The camera is designed to help vision application designers, avoiding hardware validation required to qualify a product for challenging environments – with IP67 protection, it is certified against physical shocks and vibration, offers EMC industrial immunity and operates at temperatures between -20°C to +55°C ambient. Lucid and AMD Xilinx also manage the miniaturisation process before the camera reaches the designer – the Triton Edge features a compact size at 29 x 44 x 45mm. High-speed video direct memory access (AXI VDMA) is allowed for between the on-camera image signal processor, user-programmable FPGA and on-board RAM, while the Arm cores use their own direct memory access (DMA) engine, freeing up the processors from managing data transfers. The video direct memory access (VDMA) and DMA also help reduce system bottlenecks, frame buffer overhead and memory access latency, so that designers can focus on the efficient running of the vision processing.

'The embedded FPGA is really the uniqueness of this camera, that part of the FPGA is open for the customer,' said Teissié. 'The FPGA is optimised for low-level or parallel processing tasks. It could be accelerating an AI engine, or a more standard computer vision type of processing running on the FPGA of the camera.'

In the future, Teissié predicts that major advancements and new use cases will come from designers customising this tech for their own requirements. 'You really can customise these systems,' he said 'It's at a low level as well, so we have no intention of becoming a solution provider ourselves – however, we are working with a variety of partners that can offer this type of solution and we are eager to see how people use it. We are already seeing many communities and open-source resources with lots of information sharing – but these advancements are not really the hardware side – more analytics, AI or deep learning processing. We are looking forward to seeing what comes next.'

Products

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Cameras

Basler stereo camera family

Basler has added an industrial-grade stereo camera series to its product portfolio. The cameras are available with two different baselines – 65mm and 160mm – and monochrome and colour versions.

All cameras are equipped with a pre-installed, modular software package suitable for typical robotics applications, such as object recognition or bin picking. The software contains six modules adapted for different robotics tasks. The aim is to make the cameras plug-and-play.

Basler worked on the stereo cameras with Munich-based Roboception, a specialist in 3D vision hardware and software. The aim of the cooperation with Roboception was to make intelligent stereo solutions that are user friendly, so that a wide range of customers are able to implement vision-guided robots.

www.baslerweb.com

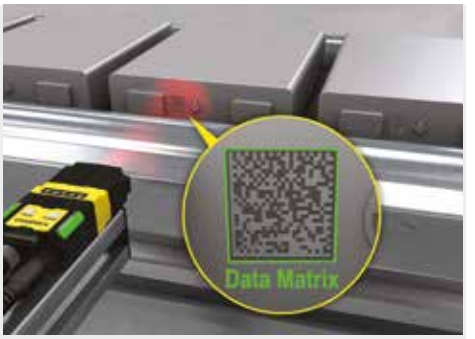
NXT Ocean vision sensor

New features have been added to the IDS NXT Ocean camera. These include multi-region-of-interest for AI-based object detection, and the possibility to use different neural networks for different ROIs in one image via Vision App. In addition, there are binning, line scan mode, and performance and configuration improvements.

There's also the option to use IDS NXT Lighthouse training software in AWS or, now, via Microsoft Azure Cloud. Users can start training their own neural network in NXT Lighthouse without prior knowledge of deep learning or camera programming. This involves uploading sample images, labelling them and then running automatic training. The network is optimised for use with IDS NXT industrial cameras. Users can trial NXT Lighthouse free for one month.

www.ids-nxt.com

DataMan 280 barcode reader



Cognex has introduced the DataMan 280 series of fixed-mount barcode readers, engineered for 1D, 2D and direct part mark (DPM) code applications in manufacturing and logistics.

The DataMan 280 features a 1,440 x 1,080-pixel sensor combined with a dynamic image formation system to improve code handling and coverage. The device is fitted with connectivity options for today's Industry 4.0 manufacturing needs.

DataMan 280 offers web browser connectivity, device management, performance monitoring and fast image offload. It allows users to configure multiple devices at once and begin trending important system performance metrics quickly.

The device uses modular hardware, including interchangeable lights and lenses, along with the latest software algorithms. DataMan 280 can be configured straight or at a right angle for tight spaces, and is compatible with most DataMan 260 accessories for easy upgrade. For applications with a large field of view and multi-side scanning at high speeds, multiple readers can be deployed together.

Application examples include decoding difficult DPM codes on challenging surfaces of automotive parts, reading and tracking small DPM codes on medical devices, or reading barcodes on high-speed packaging lines. Other typical tasks include reading multiple codes simultaneously, presentation scanning and label-based 1D and 2D code reading on pallets behind reflective foil.

www.cognex.com

Dualis 2D vision sensors

New from Ifm Electronic are Dualis 2D vision sensors. These sensors are capable of checking patterns, shapes, areas, dimensions, contours and target contrast, either as individual parameters or in combination.

Typical applications include: detection of missing components in assemblies; identification of malformed threads, missing holes or incorrectly applied adhesive; sensing incorrect product orientation or positioning; and counting the number of items present in a target area. The Ifm Vision Assistant application software, supplied as standard with the sensors, incorporates wizards that provide detailed guidance for many of these applications, and also offers an advanced mode with additional functionality.

Dualis sensors feature integrated illumination and are available in both infrared and RGB-W versions. With the RGB-W versions items can be distinguished by colour, while the built-in polarising filter also makes it possible to detect highly reflective objects easily. To minimise the effect of extraneous light, the sensors incorporate a daylight filter and, in strongly fluctuating light conditions, they can be configured to take up to five images with different exposure times and automatically select the best for analysis.

The devices can be supplied with standard, wide-angle or telephoto lenses, with all versions available with either Ethernet/IP or Profinet TCP/IP interfaces.

www.ifm.com

Software

Merlic 5.1

MVTec Software will launch version 5.1 of its Merlic machine vision software on 7 April. Merlic is designed so that complete machine vision applications can be developed and operated without having to write any code.

Merlic 5.1 includes a new tool for optical character recognition, based on Halcon's Deep OCR technology. Compared to other algorithms, this holistic deep learning-based approach can localise characters much more robustly, regardless of their orientation, font type and polarity. It also requires significantly less parameter tuning. Recognition performance is further increased by automatically grouping characters. This means the software can identify entire words and thus reduces the chance of misinterpretation of similar-looking characters. The tool is included in the entry-level package, Merlic 5.1 S.

Merlic 5.1 also includes artificial intelligence acceleration interface (AI^2) plug-ins for the Nvidia TensorRT SDK and the Intel distribution of OpenVino toolkit. Merlic tools using deep learning functionality can thus achieve significantly faster inference times when paired with compatible hardware like Nvidia GPUs or Intel processors. By adding support for AI^2, Merlic will also benefit from any future plug-ins that integrate new accelerator hardware.

Finally, selecting and setting the correct camera parameters within the image source manager (ISM) is simplified in Merlic 5.1.

Merlic 5 also forms a part of the new Up Squared Pro AI vision development kit, a vision bundle designed for users to get started with machine vision and deep learning. The bundle combines Aaeon's Up Squared Pro system, an AI acceleration module based on the Intel Movidius Myriad X VPU, with a Basler Pulse USB 3.0 area scan camera. **www.merlic.com**

BFPython API

BitFlow has introduced BFPython, an application programming interface for engineers with Python expertise to acquire images from BitFlow's broad range of frame grabbers.

The Python bindings wrap BitFlow SDK's configuration, acquisition, buffer management and camera control APIs. The download also includes several Python examples that illustrate how bindings can be used. In machine vision, where prototyping is critical to understanding how a proposed imaging solution is progressing, BitFlow BFPython accelerates the building process and reduces final development costs for those experienced with Python code. BFPython includes several sub-modules that provide interfaces to access features such as Coaxpress camera control (via GenICam) and Camera Link camera control (via the CL serial API), among others.

Supporting the full line of BitFlow frame grabbers, the BitFlow SDK enables developers to bring high-speed image acquisition into machine vision applications. **www.bitflow.com**

CxSupportPackages for 3D sensors

Automation Technology has updated its CxSupportPackage to give customers a kit of software programs for the firm's 3D sensors. The CxSupportPackage has a variety of tools customers can use to acquire 3D images, configure the 3D camera and provide 3D data in the form of range maps or point clouds, among other things.

These tools include CxExplorer, CxDiscover, CxShow3D and CxSDK – the latter, which contains all the libraries for communication with the 3D camera, has been significantly expanded. The wrappers have been revised in version 2022.2, and compatibility of MultiPart support for Automation Technology's new C6 camera series has been enhanced.

In addition, CxSupportPackage includes an optimised CxExplorer tool, which is used to configure 3D sensors. Another new feature is standard file upload and download of data containers, which contain all

measurement data and sensor configuration. This can be used, for example, to save sensor configurations on the PC, or customer-specific configuration and calibration information on the 3D sensor.

Automation Technology has also integrated a new software function, MultiPeak, into its Cx4090HS sensor. MultiPeak is designed to give noise-free 3D laser triangulation data, even for highly reflective materials such as metal, plastic or glass.
www.automationtechnology.de

Lenses

Double-sided and near-infrared aspheres

Edmund Optics has added Techspec double-sided aspheric lenses and Techspec near-infrared aspheres to its selection of aspheres.

Aspheres are optical lens elements with at least one non-flat, non-spherical surface. There are a number of benefits associated with using an asphere over a spherical lens element, such as the elimination of spherical aberration, superior focusing ability for smaller spot sizes and reduced blur, and better light collection. Aspheres are commonly used as a lighter and smaller alternative to using a series of spherical components to accomplish the same result in a lens assembly.

The Techspec double-sided, aspheric lenses feature high numerical apertures, diameter options from 10mm to 500mm, and are excellent options ideal for light collection or for 1:1 imaging applications. The double-convex or bi-convex design is used to reduce the number of optical elements in the optical system and consolidate the system space and weight for superior performance.

Techspec near-infrared aspheric lenses are optimised to eliminate spherical aberration in the near-infrared spectrum. These lenses are manufactured from S-LAH64 or N-BK7 substrates and polished through a computer numerical controlled machining process to achieve high-precision performance. While the uncoated substrate option is designed for 780nm, other coatings options are available for 350-700nm, 600-1,050nm, and 900-1,700nm.

Edmund Optics offers a wide range of different aspheres and possesses extensive asphere design, manufacturing and metrology expertise.
www.edmundoptics.eu

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