IMAGING & MACHINE VISION EUROPE

For suppliers, integrators and OEMs using machine vision

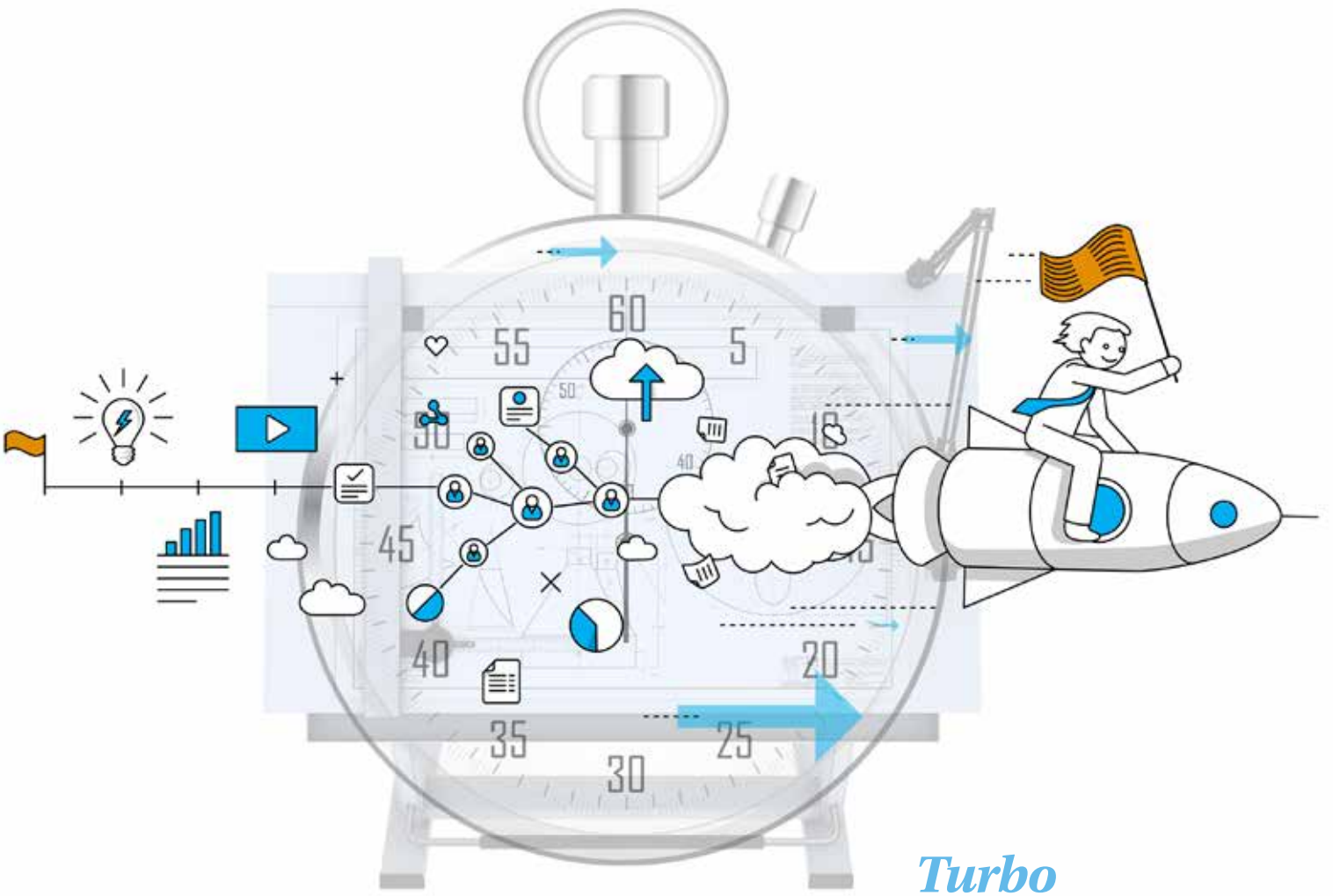
February/March 2021
Issue 103

Teledyne-Flir $8bn acquisition analysed

Understanding the Brexit trade deal

Greater robot automation if 3D can deliver

Inexpensive SWIR with Imec's quantum dot sensor



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Leader
Greg Blackman

New beginnings

The new year began with a bang – in the machine vision world at least – with the news that Teledyne had bought Flir for $8bn, a deal that could see combined sales of $5bn. Teledyne now has imaging technologies that stretch from the visible into the thermal infrared, becoming one of the dominant forces in the machine vision market along with Cognex and Keyence. This issue has analysis and opinion on the deal (page 4) from Vision Ventures' Chris Yates and from Dimitrios Damianos and Eric Mounier at Yole Développement.

The start of the year also saw new trade rules come into force between the UK and Europe, which vision firms are having to adapt to. The trade deal signed on 24 December is certainly a relief for the manufacturing sector and many firms that do business between the UK and EU. On page 8, the UK Industrial Vision Association's Neil Sandhu and Allan Anderson set out what vision companies need to know about trading under the new regulations.

Elsewhere in this issue are articles on embedded processing and the development effort that goes into building embedded vision products (page 12), how 3D vision can help increase uptake of robot automation (page 26), and a look at Imec's new quantum dot SWIR sensor that promises to lower the price of SWIR imaging (page 28).

While this winter continues to be difficult for many countries grappling with the pandemic, the various vaccination programmes underway offer hope for more productive times ahead. Roll on summer!

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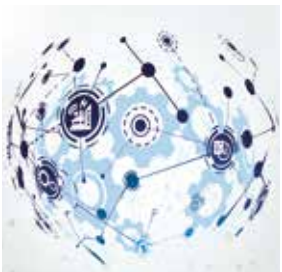

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Subscriptions:
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Imaging and Machine Vision Europe
is published by Europa Science Ltd,
4 Signet Court, Cambridge, CB5 8LA, UK
Tel: +44 (0)1223 221030
Fax: +44 (0)1223 213385
Web: www.europascience.com
ISSN: 1745-5758

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Will Teledyne deal trigger more acquisitions?

With Teledyne set to acquire Flir, we asked two industry analysts to give their take on the $8bn purchase

Dimitrios Damianos and Eric Mounier at Yole Développement examine the market landscape

When Teledyne acquired Flir earlier this year, many industry players were surprised. Buying Flir – the market leader in thermal imaging cameras – plugs Teledyne's infrared thermal detector gap at a time when Yole Développement predicts this market to grow from $4.5bn in 2019 to $7.5bn in 2025, according to the recent report *Thermal Imagers and Detectors*.

Flir also brings machine vision cameras to Teledyne's portfolio, making the US industrial conglomerate a massive player in machine vision. Now holding 16 per cent of the industrial camera segment, Teledyne becomes the joint-second largest market player, alongside Cognex, leaving Keyence, Japan first with a 19 per cent share.

But what does the future hold for Teledyne with Flir? On thermal imaging cameras, Covid-19 gave Flir a boost, with demand for devices to screen for elevated skin temperature increasing from $1.2bn to $3.16bn in the last year. Growth in this segment will slow as the world deals with coronavirus, but rising demand for applications such as driving monitoring and night vision will ensure the thermal imaging market remains buoyant.

However, a key threat looms. Thanks to Covid-19 and a demand for cheap surveillance systems, Chinese thermal imaging manufacturers, including GuideIR and Hikvision, made huge progress in 2020, chipping at Flir's market share. The jury is out on whether this is the start of a growing trend or a one-time success – US trade restrictions may thwart progress – but Teledyne will have to keep a close eye on competition from China.

Meanwhile, strong growth is anticipated in the industrial camera market, including machine vision. Yole forecasts the market to grow from $3.6bn in 2020 to $5.5bn in 2026, fuelled by factory automation, factory-automated data collection, medical applications, robotic mobility and more (*Machine Vision for Industry and Automation* 2021 report).

> 'Teledyne will have to keep a close eye on competition from China'

Although the market has multiple players, with its stronger presence Teledyne is primed to capture market share. Still, the →

Combined sales estimated at $5bn

The acquisition adds Flir's thermal and infrared imaging technologies to Teledyne's visible imaging capabilities. It will increase the digital imaging segment of Teledyne's business from 32 to 59 per cent, with Teledyne's expected combined sales reaching $5bn once the acquisition is complete.

Robert Mehrabian, executive chairman of Teledyne, said: 'At the core of both our companies is proprietary sensor technologies. Our business models are also similar: we each provide sensors, cameras and sensor systems to our customers. However, our technologies and products are uniquely complementary with minimal overlap, having imaging sensors based on different semiconductor technologies for different wavelengths.'

Under the terms of the agreement, Flir stockholders will receive $28 per share in cash and 0.0718 shares of Teledyne common stock for each Flir share, which implies a total purchase price of $56 per Flir share based on Teledyne's five-day volume weighted average price on 31 December.

As part of the transaction, Teledyne has arranged a $4.5bn 364-day credit commitment to fund the transaction and refinance certain existing debt. Teledyne expects to fund the transaction with permanent financing prior to closing.

Net leverage at closing is expected to be approximately four times adjusted pro forma EBITDA, with leverage less than three times by the end next year.

Teledyne recorded Q4 sales of $809.3m. The company's digital imaging segment's Q4 net sales were $262m, a decrease of 2.3 per cent over the same period in 2019.

In Q3 of last year, Flir recorded $466.4m of revenue, compared to $471.2m for the prior year.

The transaction, which has been approved by the boards of both companies, is expected to close in the middle of the year, subject to the receipt of required regulatory approvals.

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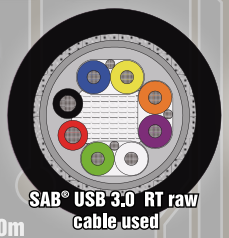

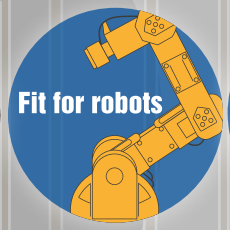

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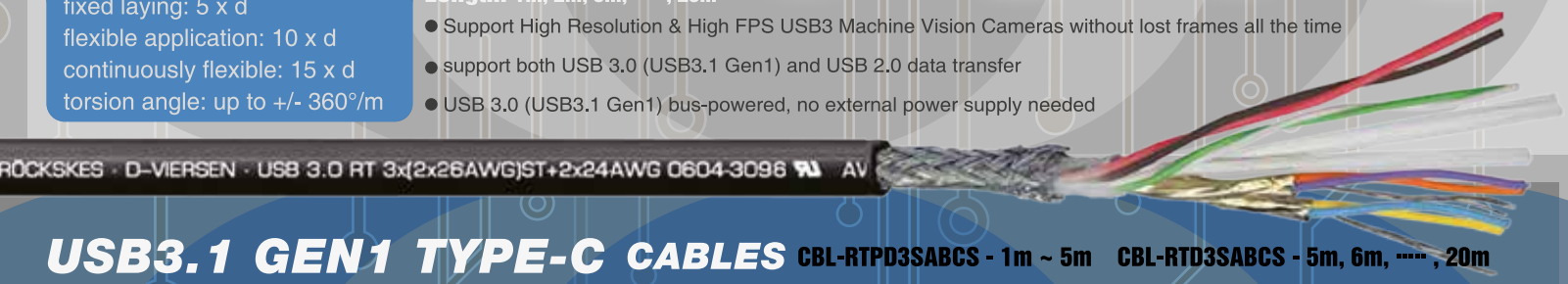

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Angle Micro-B

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CBL-RT(P)D3SABMBS - xmUA

Left
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Acquisitions elsewhere

LMI Technologies has bought FringeAI to form a new AI solutions group. FringeAI is an AI and IIoT/5G inspection company based in Boston, Massachusetts. Its technology incorporates neural networks, edge devices and cloud services. Mark Radford, CEO of LMI, said: 'With FringeAI, LMI can combine a highly-effective AI software solution to deliver the benefits of AI deep learning to the factory that includes sensor hardware and cloud-based support for the most challenging 2D and 3D inspection tasks.'

Z-Laser is now owned by Boston-based private equity firm Union Park Capital. The manufacturer of laser sources and laser projectors will serve as the core and initial asset in Union Park's newly created holding company, Exaktera.

The owner of Isra Vision, Sweden's Atlas Copco Group, has acquired the American firm Perceptron to expand its machine vision offerings. Perceptron makes automated 3D measuring solutions and co-ordinate measurement systems. The products complement Isra Vision's 3D vision systems and, together, they offer a portfolio of solutions for automating key applications along the automotive production line.

Konica Minolta has bought Finnish hyperspectral imaging firm Specim to expand in areas such as recycling and food sorting.

Applied Vision, of Akron, Ohio, is now owned by the Antares Vision Group.

→ question on everyone's lips for thermal imaging and machine vision camera markets is: how will the remaining industry players react? In each case, rapid technology development may ensue as businesses rush to gain a competitive advantage.

At the same time, more acquisitions could follow. Thermal imaging firms may reposition themselves across their market, while machine vision players such as Keyence and Cognex could consolidate power. And given Teledyne's record of aggressive growth by acquisition, perhaps we will see more buyouts from the industrial giant, making it even more of a formidable force.

Dr Dimitrios Damianos is a custom project business developer, and technology and market analyst at Yole Développement, while **Dr Eric Mounier** is the firm's director of market research

Dr Chris Yates, director of Vision Ventures, says the deal emphasises the relevance of vision as an attractive investment

The first few days of 2021 saw the announcement of the largest ever corporate transaction with a strong vision focus, in the takeover of Flir Systems by Teledyne Technologies, expected to complete in mid-2021 subject to regulatory approvals. The $8bn deal is the largest in Teledyne's history and will create a group with combined earnings in excess of $5bn (based on 2019 figures) and a very wide coverage of vision technology.

Both have an established history of growth through acquisitions. Teledyne has acquired well over 50 companies during its history, with several recent transactions focused on vision technologies, notably through the acquisition of the e2v group in 2017, followed by the Lumenera, Princeton Instruments and Photometrics deal which formed the scientific imaging business of Roper Technologies. Teledyne's imaging technology business represents around a third of group revenue, and is likely to be the largest overall segment when this transaction closes.

Similarly, Flir has acquired more than 30 companies since the firm's initial public offering in 1993, including Point Grey Research in 2016 and multiple companies in the infrared detection and imaging space, reinforcing its well-known capability in thermal imaging. More recently Flir has broadened its focus and made a series of acquisitions and investments in robotic and drone technology firms, including iRobot spin-out Endeavour Robotics in 2019, and several drone technology suppliers such as Prox Dynamics and DroneBase.

For the vision industry this new acquisition represents further consolidation, continuing the trend of the last years as the wider industry matures, as well as the provision of a very broad portfolio of imaging technologies from one supplier. Both Teledyne and Flir have strong capabilities in the development of image sensors, and the combined company will be able to offer imaging products across probably the widest spectrum in the market, targeted at multiple verticals, as well as products and solutions created on top of the foundation sensing modalities.

Clear synergies between the companies can be seen in addition to the focus on imaging technology, particularly in the areas of unmanned or autonomous vehicles, exposure to the defence, aerospace and marine markets, plus industrial instrumentation and sensing.

The relatively small overlap between the two firm's product portfolios and proprietary technologies highlights the strategic nature of the acquisition and long-term Teledyne perspective. At the same time the large transaction size and increased Teledyne footprint will increase the awareness of vision technology, and should emphasise the relevance of vision as a source of innovation and attractive investments for the future.

> 'The combined company will be able to offer imaging products across probably the widest spectrum in the market'

Vision Ventures specialises in corporate transactions in automated imaging, machine vision and computer vision

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Vision sees through Brexit red tape

The UK Industrial Vision Association's **Neil Sandhu** and **Allan Anderson** assess some of the implications of the trade deal between the EU and the UK

When UK Prime Minister Boris Johnson announced on 24 December that a trade deal had been agreed between the UK and the European Union following Brexit, he said: 'The devil is in the detail.'

Well, the UK vision industry is certainly finding that to be the case, as it picks its way through the changes that the deal is bringing. However, while there are many operational complexities in adjusting to the new requirements, it is also very important to recognise the opportunities that the deal will bring.

UKIVA members include suppliers of machine vision components and systems, machine builders and systems integrators, and original equipment manufacturers (OEMs) which make use of vision in their products. Some members operate solely in the UK, while others have an international business base, so the association acts as a useful barometer for the impact of the deal in the industry.

The taxing question of tariffs

One of the major headlines around the deal was that there would be no tariffs or duties on goods traded between the UK and the EU, but that is only true to a limited extent. Zero tariffs apply to products manufactured in the UK being exported into Europe for use in Europe, or to products manufactured in Europe being imported into the UK for use in the UK, but with both subject to the 'rules of origin.'

Rules of origin are a standard part of free trade agreements to prevent a country without a trade deal finding a cheap back door route to one market through another, such as accessing the EU market through the UK or vice versa. The rules of origin essentially require that only a certain percentage of the value of any product can originate from outside the respective territory for a product to qualify for zero tariffs, and there needs to be documentary evidence to prove this.

The exact percentage varies from one product to another, and is determined by the harmonised system (HS) code – developed and maintained by the World Customs Organization – assigned to the product. This code also determines the amount of duty (if any) that must be paid. HS classification of a product is based on its function, form or composition. This can be a difficult and challenging process.

The impact on the vision sector

Clearly, the additional import and export paperwork required as a consequence of the deal increases costs for vision companies, and things such as the allocation of HS codes are still being sorted out for products in the vision industry, which adds to the problems. Errors in the paperwork, such as the application of the wrong code, could even lead to a hold-up in supply of a particular consignment. In addition, certain components may also require export licences, based on their end use.

While the logistics of this are challenging at the moment, many vision companies already have well-established systems to deal with the paperwork needed to import and export products to non-EU countries, and in due course the process for EU transactions will also become routine, although this may take several months. Nevertheless, there will inevitably be some residual additional administrative costs, and companies will have to decide whether to increase prices or take a reduction in profits.

Exchange rate changes may mitigate this to some extent – at the time of writing, the value of the pound against the euro has increased by around 1.3 per cent since the announcement of the deal, making imported goods cheaper. However, exchange rates can be volatile for many other reasons, so relying on beneficial exchange rates may not be the best business practice.

The small UK manufacturing base for vision components means that around 90 per cent are imported, so the biggest impact of the new deal is likely to be felt by component suppliers. Of course, not all these components come from Europe; they are also sourced from many different regions including US, Canada, Japan and other countries in the Far East. A further complication for this sector, however, comes from the fact that products imported tariff-free from the EU will be subject to tariffs if it is subsequently re-exported to the EU.

> 'Early disruptions should be outweighed by the increased opportunities for machine vision'

Many UK vision companies serve markets in the Republic of Ireland, so for these transactions, tariffs would be added. Any goods from Great Britain destined for Northern Ireland, however, will not be subject to tariffs as long as they are not deemed to be at risk of leaving the UK customs territory. EU tariffs will be applied, though, to goods that are deemed 'at risk' of entering the EU's single market. Suppliers that have significant sales in Ireland and mainland Europe, may need to consider establishing local offices and warehouses in these territories for direct supply, rather

Chris Bain/Shutterstock.com

than routing through warehouses in the UK and paying the onward tariffs, which again creates increased costs.

For UK machine builders and systems integrators, however, the situation is quite different. Although all of the paperwork and associated costs related to the importing of components is just the same, because the vision components generally constitute a comparatively small proportion of the total project cost, there will be only a marginal impact on overall costs. In addition, since the production of the system will have a significant element of UK design, development and manufacture, their contribution to the total price is likely to be sufficient to satisfy the rules of origin for zero tariffs.

Certification

The beginning of the year saw the introduction of the UK Conformity Assessment (UKCA) and UKNI marks in the UK. UKNI marking will supplement, but not replace, CE marking for products in the Northern Ireland market; while, in Great Britain, the UKCA mark is required for all new products that would previously have required the CE mark.

CE marking continues to be recognised in the UK for existing products until the end of 2021. Although a large proportion of vision components sold in the UK are imported, their manufacturers will presumably decide whether or not to UKCA mark their products based on individual volume sales. This could lead to a reduction in the choice of vision components available in the UK.

UK machine builders and systems integrators will, of course, need to implement UKCA certification for UK sales, while maintaining CE certification for sales into the EU. The same will apply for OEMs who make use of vision in their products.

Looking at the wider picture

A major benefit of the deal is that much of UK manufacturing, including the automotive industry, can continue without major trade barriers. For example, Nissan has not only said that its Sunderland plant is secure for the long-term as a result of the deal, but has also decided to localise the manufacture of the 62kWh battery in Sunderland, so that all products qualify for tariff-free export to the EU. Currently, the batteries in its Leaf electric cars are imported from Japan.

A lot of industries were looking to move to higher levels of automation incorporating vision systems and robotics at the beginning of 2020 before the pandemic took hold. While many projects have been delayed, these will be reinstated as the vaccination programme helps economies reopen. The vision industry offers an extensive range of established and versatile technology that can be readily adapted to meet emerging requirements.

Another important factor from Brexit is the end of free movement, which means that there will be a shortage of the low-cost labour used extensively in many sectors, especially food, beverage and agriculture. That, combined with the fact that many industries that have people working in close proximity – such as meat and poultry processing and packing plants – have been hugely impacted by rapid spread of the virus, is likely to lead to increased investment in automation.

Help from UKIVA

The biggest immediate challenge for the vision industry resulting from the trade deal is understanding and implementing the new rules and regulations. UKIVA is part of the Processing and Packaging Manufacturing Association (PPMA) group, and UKIVA members have benefited from the wide range of support offered by PPMA on these issues.

The PPMA sits on the council of Export Partners UK to help fly the flag for British exporters, and is actively engaged with the UK government's department for business, energy and industrial strategy (BEIS) and Make UK (the manufacturers' organisation), to represent the interests of members who move goods in and out of the UK.

The PPMA members' information library is a valuable tool for sourcing relevant business information to help members make informed decisions. It provides access to hundreds of documents and associated government and industry links to provide advice on importing and exporting, conformity assessment and access to business support templates. Also, the PPMA has issued six e-business updates to help bring some clarity post-Brexit and post-Brexit transition period.

The new normal

This phrase is generally used in the context of the pandemic but is equally applicable to the post-Brexit era. The layers of complexity arising from the deal will inevitably bring some real pain points for the vision industry in the short term, but it won't be long before these processes become the new normal for doing business with the EU. These early disruptions should be outweighed by the increased opportunities for machine vision through significant need for automation.

Neil Sandhu, from Sick UK, is the incoming UKIVA chairman, while **Allan Anderson**, from ClearView Imaging, is the outgoing chairman

Association news

Neil Sandhu appointed UKIVA chairman

UKIVA
UK Industrial Vision Association

By David Harrison, chief operating officer, PPMA group

Neil Sandhu, product manager for imaging, measurement, ranging and systems at Sick UK, has formally been appointed chairman of UKIVA during the vision association's on-line AGM on 29 January.

Sandhu takes over from Allan Anderson, managing director at ClearView Imaging, who has completed a two-year cycle as chairman. Anderson was elected to take over the role of vice chairman.

Sandhu paid tribute to Anderson's contribution, saying: 'Allan has done a superb job in taking the association forward. In particular, he has been hugely instrumental in establishing UKIVA's Machine Vision Conference and Exhibition as a major event in the machine vision calendar. I am also delighted Allan will continue to serve the association and that we will be working together again during my period in office.'

Sandhu is a well-established member of the UKIVA committee and brings a wealth of experience to his new role.

He said: 'The UK vision industry faces many challenges, both as we emerge from the constraints of the coronavirus pandemic and as we adapt to the new trading arrangements with the EU. However, with these challenges come many opportunities.

'Even in the most demanding economic conditions, the need for greater automation in manufacturing sectors and reductions in workforce availability have led to a surge of interest in machine vision. The extensive range of established and versatile vision technology already in use in different industries can be readily adapted to meet these emerging requirements.'

The other members of the UKIVA committee were also re-elected at the meeting. They comprise representatives from: Acrovision, Alrad Imaging, Bytronic Automation, FT System, IDS, JentonDimaco, Mettler-Toledo Safeline, Multipix Imaging, Scorpion Vision and Stemmer Imaging.

The prime objective of UKIVA is to raise awareness and promote the use of machine vision and image processing technology throughout UK industry. It provides a voice for the UK vision industry through several channels, including events such as the Machine Vision Conference and Exhibition, webinars, opinion pieces, regular contributions to trade and technical publications and social media platforms.

As a part of the Processing and Packaging Machinery Association (PPMA) group, UKIVA has an opportunity to influence government policies through PPMA's affiliate partner membership with Make UK – The Manufacturers' Organisation. There are also plans for greater collaboration with other international vision trade bodies to encourage a more global representation for the industry. These and other initiatives offer considerable benefits for UKIVA members.

News from EMVA

emva
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By Thomas Lübkemeier

The economic uncertainty caused by the pandemic remains at the start of the year, and inevitably has an impact on short- and medium-term business in the machine vision sector. Many companies are suffering from the pandemic, but at the same time new opportunities and growth areas are emerging.

One clear technical trend in the vision industry is the establishment of artificial intelligence. The basic physical and technical barriers have now been overcome. Five of the most common applications addressed by the industry are classification, segmentation, OCR, anomaly detection, and counting and tracking. AI provides solutions for all five.

Embedded vision standard

There is no standard to support special hardware interfaces in embedded vision systems. Existing user interfaces do not provide sufficient support to address problems in the machine vision environment. The diversity in camera hardware interface, camera API and possible extensions, leads to the problem that one driver must be programmed for each MIPI/SLVS/SLVS-EC/etc camera module connected to a system on chip (SoC). Much of this effort could be avoided by joint work on a generic user interface to the SoC camera interface.

G3, the global alliance of international image processing associations, has mandated the EMVA's EmVision standardisation initiative to develop an industry-compatible camera API standard for embedded vision systems. For manufacturers, as well as for system integrators, a consistent EmVision standard for embedded vision can help enormously to save development resources and increase acceptance of embedded vision. With broad support from the industry, the EmVision working group has identified GenTL, from the GenICam family of standards, as the appropriate interface to integrate cameras in embedded systems. Interested companies are invited to join the EmVision working group, which only recently established a standardisation exploratory group with a consortium of leading companies from embedded technologies.

New members

Five companies have joined the EMVA in recent months. We are happy to welcome Saccade Vision, from Israel, developing a 3D machine vision solution for industrial dimensional inspection and vision-guided robotics. A warm welcome also goes to Kowa Optimed, a lens producer that has been operating since the 1940s. Two other members joined at the end of 2020: AT Automation Technology, a leader in the field of imaging sensors; and Faro, a provider of 3D measurement technology. Early in the new year we welcomed Basler, the international manufacturer of imaging components.

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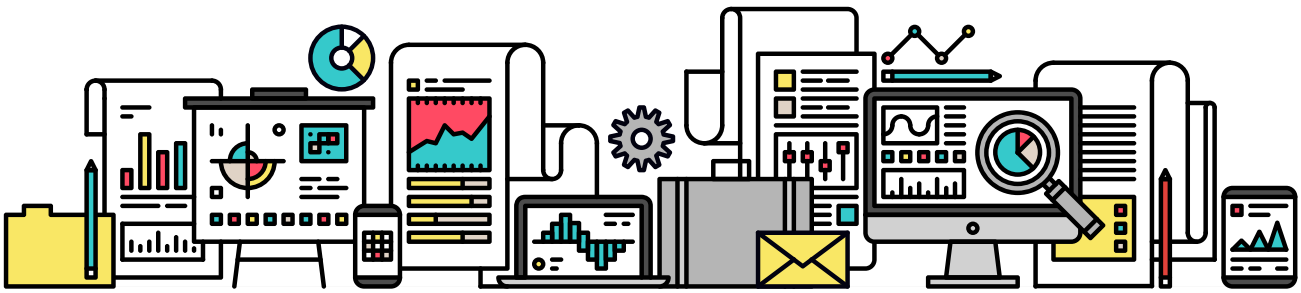

Deep Learning: Its Proper Role and Use in Machine Vision

MATROX IMAGING

Deep learning is a key enabler of Industry 4.0 in the manufacturing sector where machine vision is an important contributor. This white paper from Matrox® Imaging details how and where machine vision benefits from deep learning technology, and how to get the best out of deep learning for machine vision.

Machine vision – a driver of digital agriculture

MVTEC SOFTWARE

This white paper explores how machine vision automates and optimises processes in agriculture. From industrial-scale agricultural enterprises to small farms, everyone is relying more on digital technologies in line with smart farming.

Measuring 17,360 solder balls per second

CHROMASENS

Chromasens' Dr Maximilian Klammer and Daniel Dürhammer describe a 3D imaging system to inspect ball grid arrays

Deploying hybrid AI to reduce inspection costs

PLEORA TECHNOLOGIES

The white paper describes how one of Pleora's customers has benefited from the firm's AI Gateway product, which simplifies the deployment of machine learning to improve quality inspection. Working with existing hardware and software, the embedded platform integrates plug-in AI skills, a user-friendly approach to algorithm training, and powerful processing to support more advanced machine learning and computer vision algorithms.

Getting started with a deep learning factory automation project

COGNEX

Deep learning image analysis is opening factory automation opportunities across a wide range of industries. However, plant managers rightly hesitate to risk their existing qualified processes in favour of a new technology's potential rewards. Here are five areas to consider before deploying a first pilot project to avoid costly missteps and lost time.

Free space optical communication and adaptive optics with C-Red 3

FIRST LIGHT IMAGING

This white paper describes the benefit of performing free space optical communication in the SWIR wavelength range, and how the C-Red 3 SWIR camera is well suited for acting as the detector in an adaptive optics loop for wavefront sensing

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Board-level beauty

Greg Blackman examines the effort that goes into developing embedded vision systems

Announcements last year of Nvidia's plan to acquire Arm and AMD to buy Xilinx will inevitably impact embedded vision developers. In an opinion piece reacting to the news, Jonathan Hou, president of Pleora Technologies, said that vision developers will benefit from a unified programming interface from each vendor, but that developers will have to make a choice – more so than before – to develop on a specific platform.

What the next generation of computer chips from the combined forces of Nvidia and Arm, and AMD and Xilinx will look like remains to be seen. But those building embedded vision products today have a reasonably broad choice of embedded boards, as well as MIPI camera modules, according to Jan-Erik Schmitt, VP of sales at Vision Components. He said that how easy or difficult it is to develop an embedded vision system depends on the knowledge of the engineer, but that compared to 25 years ago – which is how long Vision Components has been making embedded vision components and systems – it is now a lot easier. Most systems are based on Linux, which a lot of computer vision programmers are familiar with and for which there is a good choice of CPUs, mainly Arm-based.

Schmitt sees interest in embedded vision in the medical field, for medical analytical devices such as DNA sequencing and blood analysis. Here, it's usually a switch from PC systems using USB cameras to embedded processing boards, to get rid of the PC. There are also a lot of new tech applications, Schmitt noted, often based on AI – devices for smart cities and smart appliances, for example. AI is also finding uses in medical devices.

Vision Components

Vision Components MIPI modules can be connected to various embedded processors, including Nvidia Jetson boards

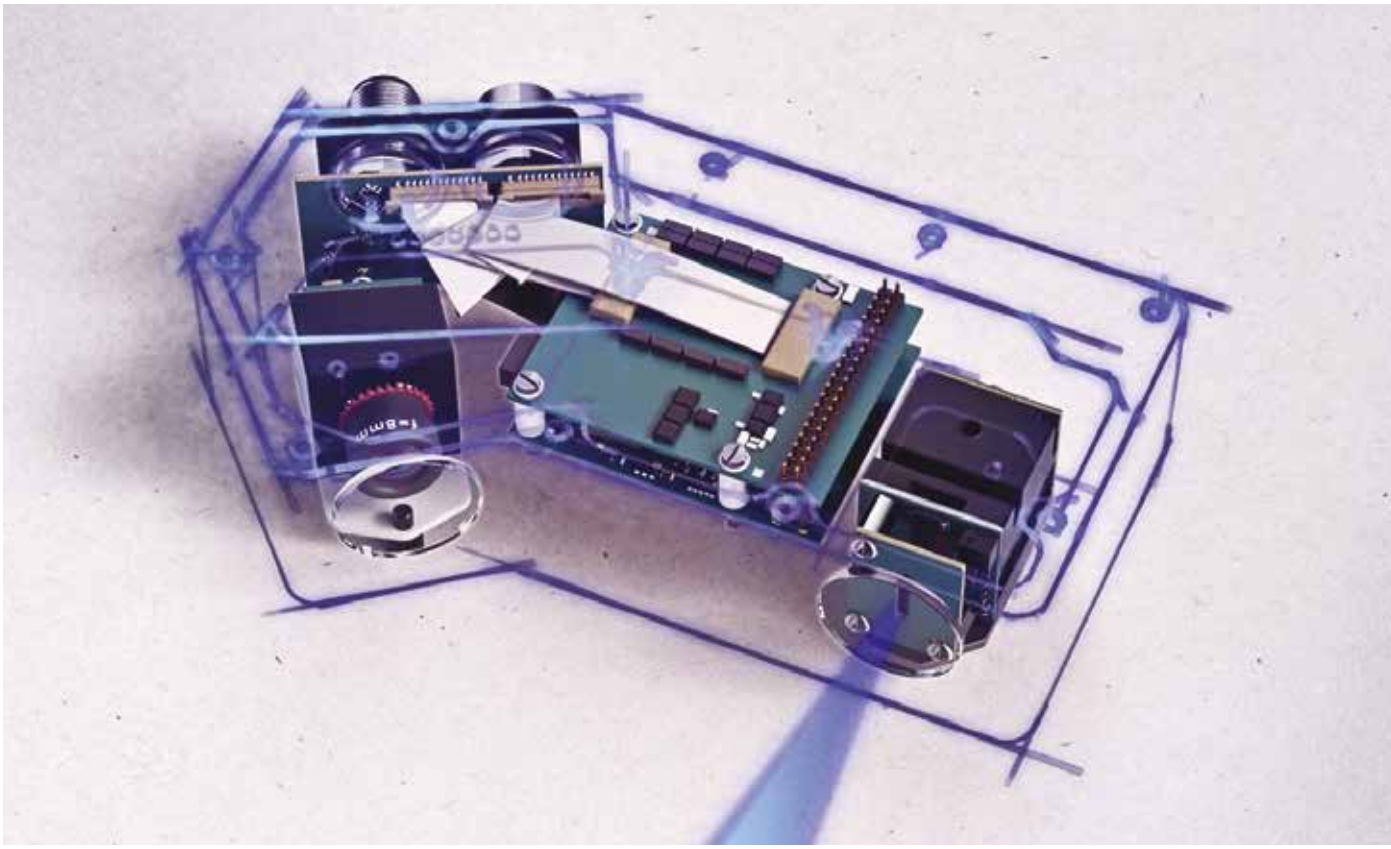
The rise of MIPI CSI-2

To build an embedded vision system involves connecting a camera to a processing board, for which the MIPI CSI-2 interface is becoming more important, Schmitt said. MIPI CSI-2 has its origins in the consumer sector, where it is used in mobile phones, tablets and cameras internal to PCs or laptops. It is a low power solution, which is important for edge devices and embedded platforms, where power consumption has to be kept low. It has started showing up in industrial or semi-industrial applications, as companies like Qualcomm or Nvidia expand into sectors outside consumer, bringing the MIPI interface with them on their boards. Areas like automotive with autonomous driving, and IoT, are thought to be the next big markets for computer chips.

The data rate of MIPI CSI-2 is around 1.5Gb/s per lane, and depending on the system and sensors there can typically be up to four lanes, giving around 6Gb/s bandwidth. The cable length from the image sensor to the processing platform is limited to about 200mm for robust data transmission, which is fine for most embedded applications.

'The MIPI interface is a good one, but the percentage of standardisation is quite low,' Schmitt said. 'This has many advantages, but in terms of speed of development it can be a disadvantage.'

One thing that Schmitt says embedded vision developers need to be aware of is that



Vision Components

A compact embedded vision system using Vision Components modules

there isn't a common MIPI camera control interface for processing units, so processors aren't easily interchangeable. In this regard, every combination of MIPI camera and processor needs a specific driver. 'As long as the driver is offered together with the MIPI camera module, then development is quite easy – it's a standard Linux OS and a Linux driver to access the camera,' Schmitt said. 'Where issues can occur is in making sure the driver is available, or having a MIPI camera manufacturer that offers a driver together with the hardware.'

Engineers – at least those outside the industrial vision space – tend to start by choosing the processor board and then picking the image sensor. Vision Components offers purely MIPI camera modules together with the standard drivers in source code for custom adaptation options, to give the engineer full flexibility of processor choice.

There are other interfaces that are often used, such as LVDS, but MIPI is now being included in a lot of newer embedded boards. Meanwhile, on the image sensor side, Sony has developed its SLVS-EC high-speed interface – standing for Scalable Low-Voltage Signalling with Embedded Clock – which has potential for embedded vision system design, although specific drivers are still needed. In the industrial vision world EmVision, a standardisation initiative led by the European Machine Vision Association, aims to develop a camera API standard for embedded vision systems.

Choosing a platform

According to Schmitt, there are four platforms that are getting attention at the moment: Nvidia; Raspberry Pi for rapid prototyping; a growing interest in NXP; and FPGA-based solutions.

FPGA is the most complex of these four, Schmitt said, but there are companies very familiar with FPGA programming, and a MIPI camera module attached to an FPGA can give a product with a long lifespan.

Schmitt added that each of the other three platforms are fairly similar to develop on, as long as the drivers are available. 'The Raspberry Pi is still a closed system in some ways, because if you are not using the official Raspberry camera, you have no access to the internal ISP. It's easy, but it's limited,' he said. 'Nvidia Jetson is a bit more complex, but you have many more options – you have access to the GPU and ISP functions.

'I wouldn't say any of the three other platforms stand out as being easier to use, because for each there are advantages and disadvantages.'

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

'As long as the driver is offered together with the MIPI camera module, then development is quite easy'

building embedded vision solutions, and, like Vision Components, ensures drivers are provided for cameras in its board support package (BSP). This package also has support for various vision middleware, including OpenCV, MVTec's Halcon library, and Tensorflow Lite. Cameras with MIPI interface are available, and the company now offers the NXP i.MX 8 M Plus processor containing a neural processing unit to accelerate AI applications.

Along with design, customisation and rapid prototyping services, Phytec also supplies development kits to give customers easy access to embedded imaging and to let them start developing immediately. Susan Remmert, responsible for strategic partnerships at Phytec, noted that all components in the kit are industrial-grade, so customers can make a prototype very close to what might be the final product.

Various industrial vision suppliers are now offering embedded vision development kits, including Basler, The Imaging Source, →

→ and Allied Vision. All three have kits based on the Nvidia Jetson Nano developer kit. Allied Vision and MVTec have teamed up on their starter kit to offer Allied Vision's 1.2 megapixel CSI-2 camera, Alvium 1500 C-120, along with Halcon software. The Imaging Source also provides a kit based on Raspberry Pi, and has recently introduced MIPI CSI-2 and FPD-Link-III board cameras, as well as FPD-Link-III cameras with IP67-rated housing. The board camera range includes monochrome and colour versions with sensors from Sony and On Semiconductor, and resolutions from 0.3 to 8.3 megapixels.

Remmert said the kind of questions Phytec has asked, relating to embedded imaging, concerns aspects such as lens specification – Phytec offers M12 or C/CS-mount lens holders on its camera modules, or can create a custom camera with integrated lens – how rugged the components are, and questions about

'If you are fast, you can do everything from scratch in one year'

maintenance and the lifetime of the components. Part of developing an embedded vision product is to validate the image acquisition chain: the optics, the lighting, the image sensor. The algorithm also has to be validated, and then there's the choice of hardware for the end product and validation of that software and hardware combination.

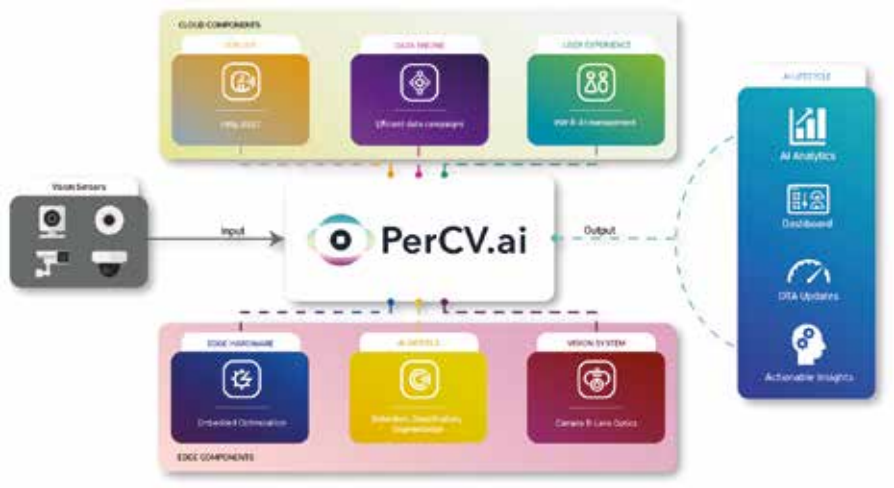
'Image processing development takes time,' Schmitt said. 'Creating a prototype can be reasonably fast, but the validation of the final solution takes time. And then companies have to bring this into mass production.'

Building an image processing system involves a lot of image acquisition and a lot of testing, Schmitt explained. The device has to be tested in the real world, which can throw up problems and means the developer has to alter the algorithm or the image acquisition chain. This takes time, and adapting the system can happen several times.

'If you are fast, you can do everything from scratch in one year,' Schmitt said. 'If you are making a commercial product, it's between one and four years.'

Sometimes the software development is already done and the customer is transferring from a PC to an embedded platform. Once the software is ready, then the work involves porting and optimisation of the final mass production system.

Schmitt added that, as long as the engineer is working with a Linux-embedded solution mainly based on Arm processors, it is easy to assess the performance on a standard platform, such as a Raspberry Pi, and then tell how fast or slow it will be on a different platform.



Irida Labs

Irida Labs' PerCV.ai workflow: an AI software and services platform that supports the full vision-AI product lifecycle

Throwing AI into the mix

The performance of the system also depends on whether the engineer is using AI or rule-based image processing algorithms. AI is highly dependent on hardware acceleration, and there are differences between using accelerators from Intel, Google, GPUs or FPGAs, according to Schmitt. Also, the type of neural network the developer is using will make a huge difference. Engineers will often already have made this choice, Schmitt said; it's taken at the beginning of the project because someone has expertise in Tensorflow, for example, or knows all the tools in the Nvidia toolchain.

Developing with the OpenCV AI kit

To celebrate OpenCV's 20th anniversary, the open source computer vision library is running a Kickstarter campaign for its OpenCV AI kit (OAK).

At the time of writing, the campaign, which launched last summer, has raised more than $1.3m.

OAK is an MIT-licensed open source software and Myriad X-based hardware solution for computer vision.

Those pledging $99 will receive an OAK 12 megapixel rolling shutter camera module, capable of 60fps, or $149 for the OAK-D stereovision synchronised global shutter camera.

The cameras can be programmed using Python, OpenCV and the DepthAI package. They are supplied with neural networks covering: Covid-19 mask or no-mask detection; age recognition; emotion recognition; face detection; detection of facial features, such as the corners of the eyes, mouth and chin; general object detection (20-class); pedestrian detection; and vehicle detection. Those wanting to train models based on public datasets can use OpenVino to deploy them on OAK.

There are two ways to generate spatial AI results from OAK-D: monocular neural inference fused with stereo depth, where the neural network is run on a single camera and fused with disparity depth results; and stereo neural inference, where the neural network is run in parallel on OAK-D's left and right cameras to produce 3D position data directly with the neural network.

OpenCV is running a second spatial AI competition, inviting users to submit solutions for solving real-world problems using the OAK-D module. A similar competition last summer featured winning projects ranging from systems for aiding the visually impaired, a device for monitoring fish and a mechanical weeding robot for organic farming.

Artificial intelligence adds another layer of complexity to an embedded vision project. The hardware platforms are now available, which is helping companies to start working on vision AI projects, noted Dimitris Kastaniotis, product manager at Irida Labs. However, for real-world vision-AI solutions a lot of effort beyond connecting libraries and hardware platforms is needed to create and support a successful vision-AI application, he said.

Kastaniotis said there are several pain points that need to be addressed during the development of an AI vision solution, such as defining the problem in the first place, the availability of data, the hardware optimisation, and the AI lifecycle management.

Irida Labs has developed an end-to-end AI software and services platform, PerCV.ai, to shorten development time for building embedded vision AI systems. It is designed to help customers define a problem, and deploy and manage vision devices.

The first step, according to Kastaniotis, when starting an AI computer vision project is determining what the customer needs – getting a detailed specification from the customer. This can be the first area that can introduce delays, as there can be varying expectations from the customer of what can and cannot be achieved.

'You have to create a common understanding with the customer, and do that quickly,' Kastaniotis said. 'The definition of the problem can not only affect the performance, but also the specifications of the vision system and the hardware platform selection. In addition, when working with AI you have to describe the problem in terms of data, as this is what neural networks understand.'

Once the problem has been defined, the next step is a pilot project with customer samples in order to gauge whether the vision solution is solving the problem according to the expectations of the customer.

Then comes the data campaign, which can be time consuming and expensive, in Kastaniotis's experience.

Cameras need to be installed to collect the data, and the data annotated. PerCV.ai aims to keep data campaigns to a minimum by collecting the right data, as well as minimising annotation effort.

Vision at Embedded World

The Embedded World exhibition has gone digital, with a variety of embedded vision technology, along with conference talks, presented virtually at the show from 1 to 5 March.

The embedded vision conference track will run on 4 and 5 March, and will include case studies covering agricultural livestock monitoring, wildfire surveillance, and a system for detecting anomalies during welding. There will be two sessions on system integration, with talks from the Indian Institute of Technology in Mumbai, Allied Vision, Arm, Neil Trevett at The Khronos Group, Xilinx, and Core Avionics and Industrial. Intel will speak about its OpenVino platform, Basler about optimising neural networks, and Toradex about tuning performance.

VDMA Machine Vision will organise a panel discussion on embedded vision, asking what are the factors for success when developing embedded vision systems, and what are the barriers to entry.

'By solving the three main bottlenecks in embedded AI vision development, we saw a significant improvement in the time-to-market'

The next stage is to move from the first pilot installation to deployment, while also maintaining customer feedback. 'When you start to scale up the system with more sensors and more feedback loops, then you definitely need a platform that will help roll out updates, get feedback, and also detect drift in the distribution of the data,' Kastaniotis said. The PerCV.ai platform can help with these aspects to scale and maintain the vision system over its lifetime.

'By solving the three main bottlenecks in embedded AI vision development – defining the problem, the data campaign, and updating the system during deployment – we saw a significant improvement in the time-to-market of an embedded vision solution,' Kastaniotis added.

'With our platform, we are able to go from six months or one year for a standard embedded vision project, to four to eight weeks for developing and implementing a first system.'

Ultimately, according to Schmitt, the toolsets vision engineers have available now are far better than 10 or 15 years ago. There are also ways to speed up prototyping, by evaluating the image acquisition chain in parallel with the choice of CPU, for instance. 'Choices you make in software may automatically influence the choice of hardware and vice versa,' Schmitt said. But that 'grabbing images and validating the image acquisition equipment – image sensor, lens, and lighting – can be determined completely independently from the processing platform, using any standard cameras.'

In addition, upgrading with a Linux OS-on-Arm system is relatively easy, such as moving to a quad core Arm solution, or a dual core Arm with higher clock rate, which 'wouldn't impact your development time,' Schmitt said, adding 'you don't have to start everything from scratch.'

Phytec

PhyBoard-Pollux embedded imaging kit with i.MX8M Plus module and VM-016 MIPI CSI-2 camera module

Suwin/Shutterstock.com

Smarter cities in sight

Keely Portway finds out how imaging is helping keep cyclists and pedestrians safe

Highway authorities have long used vision to keep track of road users, the most recognisable being automatic number plate recognition in traffic enforcement, toll booths, parking and speed detection.

The cameras used in these types of scenarios are able to produce clear images of moving objects in widely varying light conditions. As the technology has developed, so too has the breadth of uses for vision technology in traffic and transport – no longer can the association remain with just speed cameras.

Despite being much maligned, it is hard to argue against the speed camera's role in helping improve road safety. Now, there are other vision-driven safety applications making their way into the traffic sector.

Fusion Processing, which develops sensing systems for autonomous vehicles and driver assistance, has had a cyclist detection system for trucks and buses on the market for a few years. Last year the first Transport for London buses were equipped with the latest version of the system. It uses radar and cameras, with the software programmed to identify cyclists next to the vehicle and notify the driver. 'We have a number of bus companies using it, and Transport for London has been very interested in cyclists' protection,' said Jim Fleming, marketing director at Fusion Processing.

One could argue that Fusion Processing's CycleEye system arrived ahead of its time,

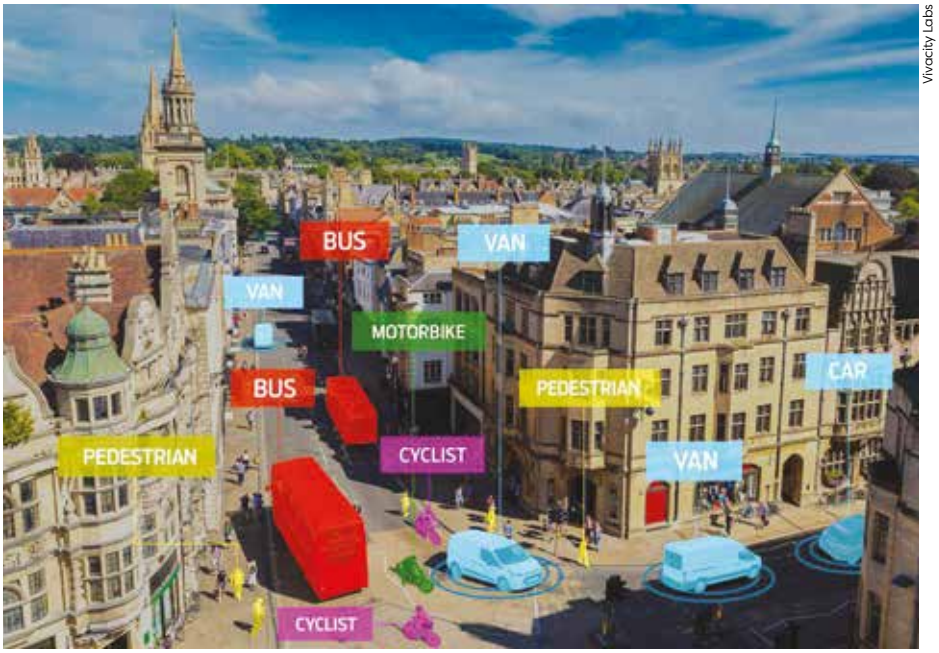
particularly in light of the decision taken by the European Union to revise its general safety regulations for motor vehicles. Next year new safety technologies will be mandatory in European vehicles to reduce the number of fatalities and injuries on roads. Such features include systems that reduce dangerous blind spots on trucks and buses, and technology that warns the driver if it detects they are drowsy or distracted.

Commissioner Elzbieta Bieńkowska, responsible for internal market, industry, entrepreneurship and SMEs for the EU, noted that many advanced safety features already exist in high-end vehicles, and that the new regulations will raise the safety level for vehicles across the board. For trucks and buses in particular, there will be specific requirements to improve what drivers can see directly and remove blind spots, as well as systems at the front and side of the vehicle to warn of vulnerable road users, especially when making turns.

Fusion Processing has a mirror replacement version of CycleEye, designed to replace wing mirrors with a camera system to give driver assistance – it is this version that has been installed on some Transport for London buses. The CycleEye camera mirror system (CMS) combines HD cameras covering the field of view of class II and class IV mirrors – the main exterior mirrors of vehicles and wide angle mirrors respectively – and an optional class V, close proximity mirror FOV to provide a live feed from the cameras to displays mounted to the inside of the windscreen. The system uses a →

'We have a number of bus companies using it, and Transport for London has been very interested in cyclists' protection'

'The pandemic has brought about changes to road and pavement use... Data insights provide the ability to analyse it'



Vivacity Labs

A smart city pilot study in London is helping support crowd management when lockdown restrictions are eased

→ single camera and radar unit on each side of the bus, plus two internal displays for the driver; Fusion Processing's AI algorithms identify cyclists. Each unit can be fitted at the external mirror location of most buses using the same or similar mounting bolt pattern.

The system achieves the low latency required by EU regulation #46, to provide the video stream in real-time, and superimposes images onto the display screens, warning if cyclists and pedestrians get too close to the vehicle.

The CycleEye CMS replaces the wing mirrors, which in itself has a lot of benefits including eliminating mirror head strikes that can occur when pedestrians are too close to buses and trucks. 'The head strikes are a real issue for the industry,' Fleming said.

'There are more and more standards out there, so safety engineering has become even more important. It's not just about understanding sensors,' he added.

Designing a system such as this must also take longevity into consideration, particularly when it is used in the kind of conditions faced on London's roads. It has to be able to withstand all weather conditions, along with aspects such as being put through a bus wash every day, Fleming explained.

In the future, Fleming foresees vision technology finding its way more often into the areas of driver assistance and autonomous driving. He said that providing technology for autonomous vehicles is a huge area for Fusion Processing, as is helping drivers identify vulnerable road users. 'Look out for autonomous buses in the future,' he said.

In a similar vein, London-based Vivacity Labs is providing its AI and Internet of Things technology to help London's Sutton and Kingston Councils improve active travel insight and, ultimately, the safety of pedestrians in high footfall areas. But rather than accidents, this project aims to keep people safe if they need to travel during lockdown.

The work falls under the InnOvaTe project, an initiative funded by the Strategic Investment Pot as part of the London Councils Business Rates Retention scheme.

Fusion Processing

CycleEye CMS replaces wing mirrors on buses, combining HD cameras and radar to give the driver a view of what's around the vehicle

'With each frame of video deleted immediately after processing, only anonymous data is extracted'

The funding will allow the boroughs involved to deliver a multi-purpose Internet of Things platform, connecting various sensors across borough boundaries. This is being used to gain new data insights to support and drive economic growth and create a safer environment across the sub-region.

The pilot study recognises the cultural shift created by the pandemic, resulting in a dramatic drop in traffic levels, so residents feel safer on the roads when they are taking their daily exercise or making essential trips. But, as the world begins to return to some sort of normality, the study can anonymously support crowd management, monitoring the impact of road and pavement changes and reducing the infection risk for residents with better management of high footfall areas.

Mark Nicholson, CEO at Vivacity Labs, explained: 'The pandemic has seen a significant shift in travel trends, and it has brought about changes to road and pavement space in order to accommodate for active travel and help people to keep their distance.'

The project uses a sensor mounted on a lamppost. The sensor contains a local

LMI Technologies

American highway officials are using a rig comprised of five LMI Gocator 2375 sensors mounted on a vehicle to measure the condition of pavements

edge processor to take video from the in-built 1080p board-level camera, and runs machine learning algorithms to extract the location and classification of each road user. With each frame of video under normal operation deleted immediately after processing, only anonymous data is extracted, stored and transmitted. The sensors have mobile connectivity, so the data can be sent to the cloud, enabling remote access at any time to view operation status, enable remote debugging and maintenance, and action remote updates as functionality is improved.

Nicholson said: 'Data insights provide the ability both to analyse where to implement changes and evaluate the effectiveness of these schemes. The next stages of regeneration are crucial, and we're delighted to be working with Sutton and Kingston Councils to help improve their active travel insight, and assess and improve the safety of high footfall areas.'

If the pilot is successful, the scheme could be expanded across the boroughs and into the adjacent boroughs of Merton, Croydon and Richmond.

Pavement management

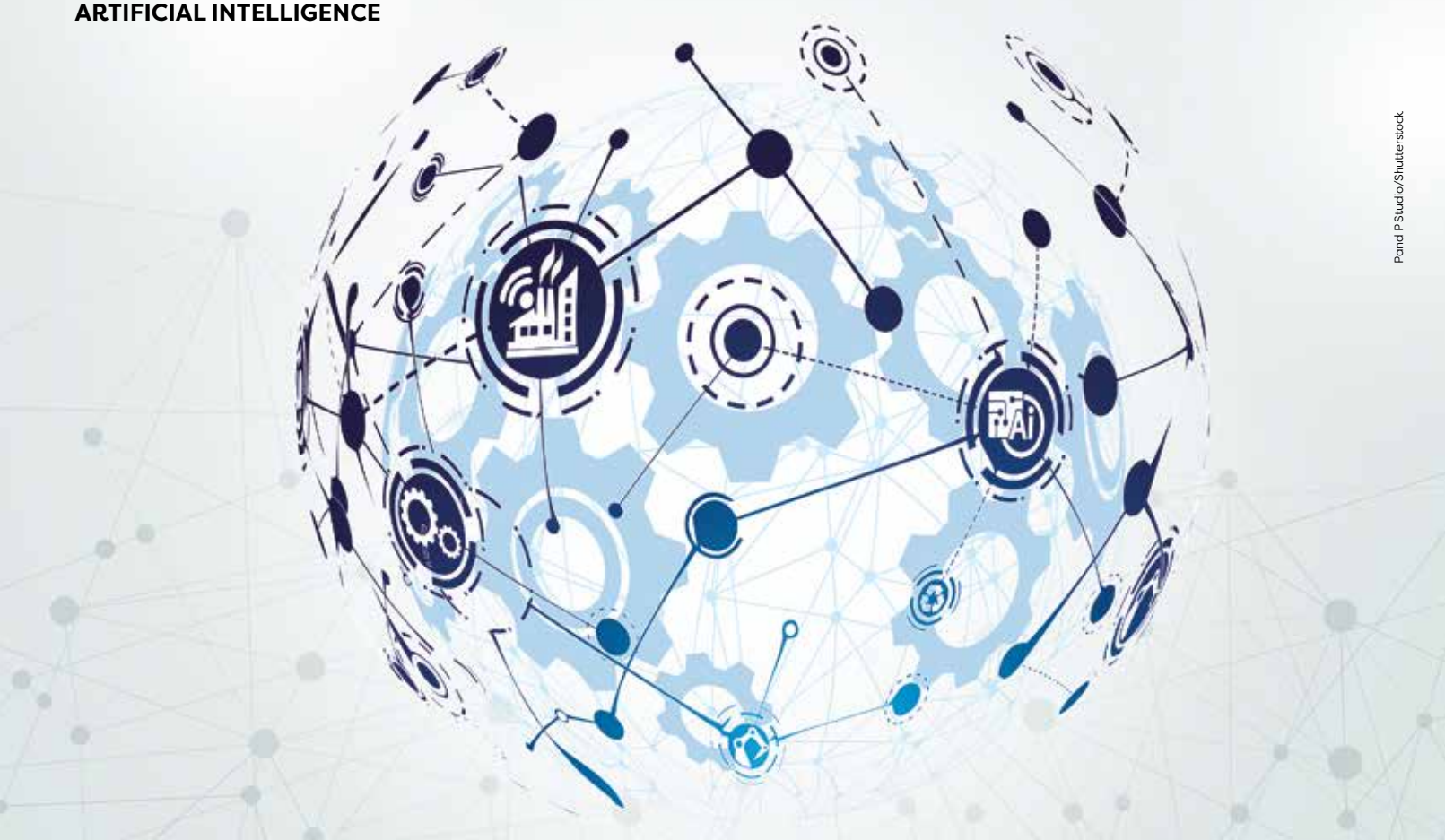
Vision is also being used in the US to help keep pedestrians safe in a pavement management exercise that has been implemented by the American Association of State Highway and Transportation Officials (Aashto). The association introduced some provisional new specifications for measuring the condition of pavements, detecting whether and to what extent they are damaged.

The association's new specifications define measurement of ruts, cross slopes, deformations and lane-edge drop-off. However, it struggled to find a complete profiling system that complied with these specifications. Surface Systems and Instruments (SSI), together with LMI Technologies, built a 3D-profiling system able to meet these needs. The 3D sensor had to provide high-speed data acquisition with a large coverage area, large clearance distance, high measurement accuracy in an outdoor environment, and a robust industrial package with a small footprint.

SSI had previously partnered with LMI Technologies, using sensors from its Gocator range. It selected the Gocator 2375 sensors for the solution, which generates 3D data using laser line profiling.

Several profiling systems have been mounted on pick-up trucks and are currently in use with Aashto. To cover the specified transverse profile width of 4 or 4.25m, five Gocator 2375 sensors were mounted on each vehicle, three pointing straight down, and the outer two angled outward to minimise vehicle width, while maintaining a large scan width.

SSI also equipped the vehicles with GPS, an inertial measuring unit for vehicle pitch and roll compensation, a camera for area imaging, two Gocator 2342 3D sensors in the vehicle frame for ride and roughness measurement, and a high-end, ruggedised notebook computer. SSI integrated all sensors with data synchronisation, and developed a software package for analysis, display and reporting in compliance with the Aashto specifications.



Pond P Studio/Shutterstock

Added value: identify where AI makes a real difference

Experts from AIT, MVTec, Irida Labs and Xilinx discussed AI and machine vision during one of our latest webinars. **Greg Blackman** reports

Surface inspection and optimising processes beyond the production line, such as helping staff with tasks, were two areas the panel saw potential for the use of neural networks in manufacturing. But deep learning algorithms for machine vision should not be considered the Holy Grail, the panel warned.

At the Austrian Institute of Technology (AIT), researchers are working on combining classical machine vision approaches and neural networks to overcome some of the problems encountered with deep learning. Petra Thanner, senior research engineer at AIT, described work into reducing the dependency on the image source – the difference in noise levels from different cameras, for instance – by pre-processing images before applying them to a neural network. She said her team had managed to train a network with pre-processed images – even with images of different optical resolutions – and applied it to an industrial problem with good results.

The group at AIT is also investigating methods such as one-class learning, a technique to spot anomalies in data consisting of images of only good parts – large datasets of defects are hard to come by in industrial inspection. It is also working on improving the quality of image data using generative adversarial networks (GANs) for data augmentation, a technique that can also help with small datasets.

One specific application example Thanner mentioned was using deep learning to detect cracks and machining marks on metallic surfaces. Olaf Munkelt, managing director of MVTec Software, also noted that deep learning can add a lot to the area of surface inspection, which has traditionally been difficult to solve using rule-based approaches.

He also pointed to optical character recognition (OCR) as an area where deep learning can improve existing technology – MVTec's Halcon software now has in-built deep learning in its OCR tool. The firm has millions of samples of industrial printed characters on which to train its neural network. 'There you can really add three percentage points [to improve the recognition rate], which makes the customer happy,' Munkelt said.

This illustrates the point that Munkelt and the other panellists made, which is that deep learning has to add value first and foremost. Quenton Hall, AI system architect at chip maker Xilinx, said he's seen a shift over the last three years in the understanding of what deep learning can accomplish. But that neural networks are best applied to areas where they can increase performance

or yield, or areas where it is challenging to build a classical algorithm for a task.

MVTec is offering training courses on deep learning to give a better understanding of where it can and can't be applied. Munkelt said there is an onus on suppliers to explain what neural networks can achieve and how much effort is required to develop a system. Hall also made the point that, in the machine vision market, a lot of the OEMs that are developing cameras are not necessarily the same companies that will be training and deploying the model. He said: 'It's a big question for a lot of machine vision camera suppliers: how do they enable their customer to integrate their own custom deep learning model onto these hardware platforms?'

The development effort can be considerable when working with neural networks. Vassilis Tsagaris, CEO of Irida Labs, noted it is easy to design an initial solution with 80 per cent success, but it's difficult to move to a fully scalable solution. 'You need an infrastructure not only for training and deploying, but also for taking care of the lifecycle of the product,' he said. 'You need to put the user in the loop [for real-world deployment]; you need to define the objectives, understand how you are going to work with data – more data doesn't necessarily mean a better model… understand what type of detection is important, and have a holistic approach that will deploy and feed the model throughout the product lifecycle.' He added: 'A first prototype is easy, but going into production requires more effort.'

Thanner estimated that around 70 to 80 per cent of all the work in building a system based on neural networks revolves around data – its collection, preparation, and making sure it is without bias. 'You need to know where the data is from, you need to annotate the data, you have to generate a ground truth to train the network,' she said. 'It takes lots of effort to collect and maintain a good and valid dataset.'

> '70 to 80 per cent of work building a system based on neural networks revolves around data'

Thanner added that the dataset has to be balanced and cover all scenarios with no holes, with examples of good samples in all possible situations and also all possible defects. If there are two Gaussian distributions in the dataset, and in the real world only one of these datasets is represented, then the neural network won't be able to make proper decisions for the second distribution. A neural network is only able to learn on the data, not on something it hasn't seen before.

Tsagaris agreed that data handling is 'important for faster time to market and successful implementations.' He said there are different ways to make the best use of data – like augmentation methods – but it still comes down to field data as 'what's going to drive the success in machine vision.'

Irida Labs provides AI on embedded platforms, and Tsagaris believes that in the future there will be a convergence between computer vision, AI and embedded vision. Munkelt added that in the coming years the ecosystem will be understood better, and there will be more knowledge around when to perform tasks in the cloud or on the edge, and where deep learning adds value.

The webinar can be viewed at: www.imveurope.com/webcasts

Share your experience of developing a vision system using deep learning. Please get in touch for opportunities to write for us: greg.blackman@europascience.com.

Unlocking flexible production

Matthew Dale finds out how vision is enabling smaller batch sizes to be processed on packaging lines

Packaging lines are working with smaller batch sizes, a trend that vision is both aiding and having to respond to. At the same time, new vision technology such as hyperspectral imaging is finding its way onto packing lines, with UK-based automation specialist Brillopak, which has begun integrating the technology into robotic packing and palletising systems.

Hyperspectral cameras can vary from those covering distinct bands and giving extended colour information, to those recording spectral data across a wide range of the electromagnetic spectrum. The technique is able to detect minor blemishes and defects on food, for example, such as bruises on apples or burnt areas on cooked items.

Brillopak intends to use hyperspectral imaging between packing and case loading operations, where human workers have previously inspected food packs, rejecting any that don't meet quality standards. Workforce fatigue and human error has meant that on fast packing lines, even visible defects, such as bruising and blemishes, can be missed. 'Today's hyperspectral vision systems are programmed to have a level of impartiality that human eyes just don't have,' said Brillopak director David Jahn. 'With many end-of-line packing stations now automated and processing in excess of 100 packs of produce a minute, incorporating vision is becoming increasingly commonplace.'

Brillopak says that more automated quality inspection will be used in packhouses that have previously relied heavily on EU migrant workers, but are now experiencing staffing pressures because of Brexit and the pandemic. Such pressures have been building, as the availability of labour has declined steadily since the 2016 Brexit vote, but now, with the pandemic, staff can no longer work in close contact with each other. Both factors have conspired to challenge packers, who often do not have the space to accommodate social distancing while maintaining production levels. For Brillopak, automating such quality inspection presents an obvious solution.

To help minimise the risk of an out-of-spec product heading out of the factory doors and onto retailers' shelves, Brillopak has begun to integrate hyperspectral imaging as an option on its Unipaker robotic crate packing systems. This, and other vision technology, will improve the accuracy of how products are picked and presented to the packing robot at speed.

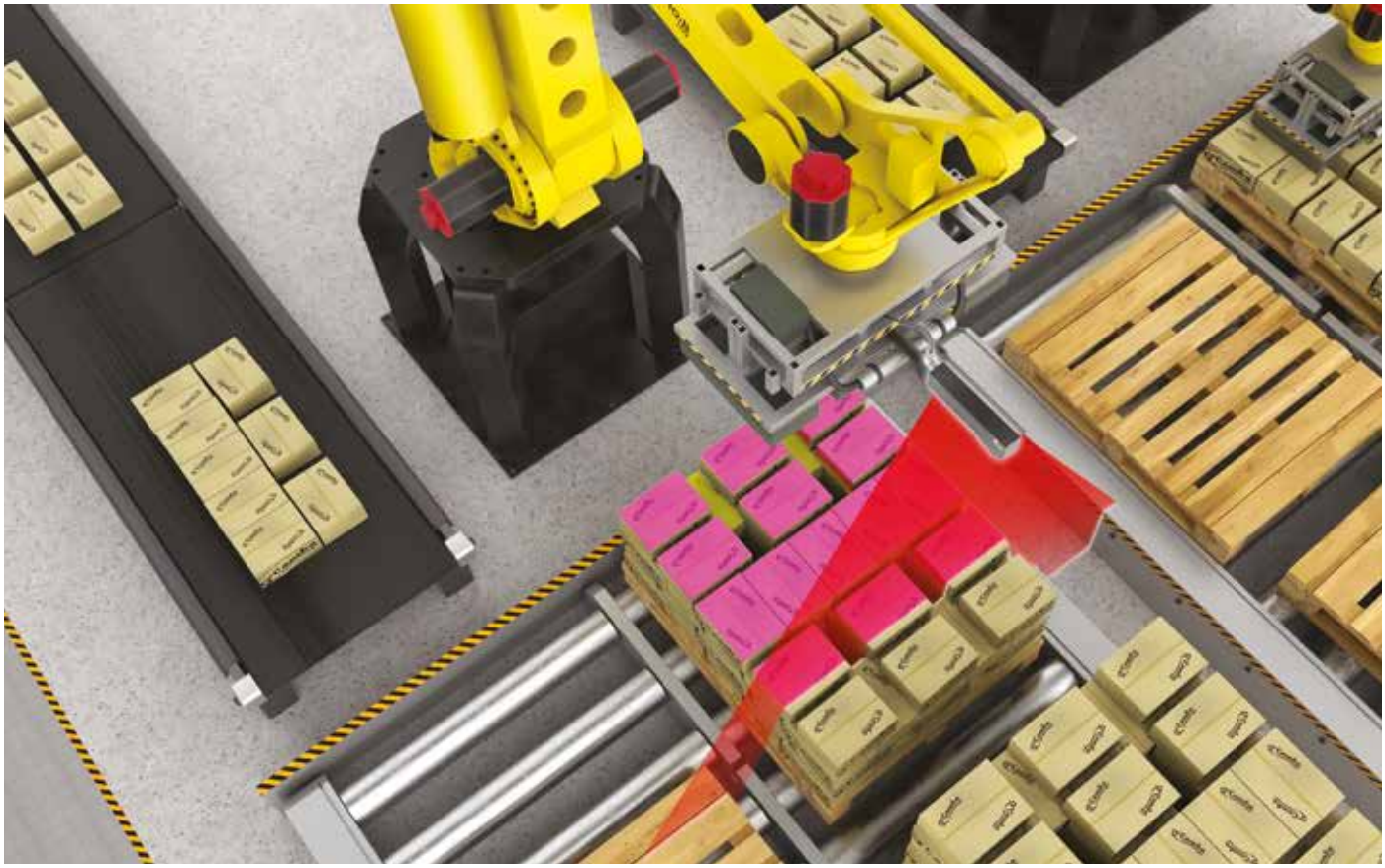
'Using cameras we can find the centre and orientation of products,' said Jahn. 'This information is conveyed to the robot, which accurately responds, adjusting its speed and position to pick up the pack, regardless of location on the conveyor. The result is fewer line stoppages to address bottlenecks and better presentation in the retail crates.'

Brillopak incorporates vision for appraising labels, packaging condition, print inspection, position detection with 2D and 3D imaging, and barcode and data code reading. Although still a relatively small adopter of hyperspectral technology, Brillopak expects food processing and agriculture to benefit significantly from advances in the imaging technique.

'With food safety, quality assurance and food waste so high on the agenda, we anticipate that hyperspectral imaging

Brillopak

Hyperspectral imaging can be used to check for blemishes on food packaging lines



LMI Technologies

3D sensing can be used in warehouses for inspecting packages and for palletisation

will soon become the go-to vision system on food processing lines in the future,' confirmed Jahn.

Raise a bottle

Danish firm Novio Packaging has turned to machine vision to achieve a flexible quality inspection system that can cope with changes in the types of bottles it produces.

Using a vision solution supplied by Omron, Novio Packaging is now able to cope with rapid changeovers and can meet customer demands for a wider portfolio, involving smaller but more variable batches. This also helps to avoid any delays in the development of new products.

Novio initially explored systems that proved to be ineffective, as they were insufficiently accurate and users couldn't make adjustments or programme the software themselves. It was looking for a solution that could successfully eliminate defects down to one bottle out of 100,000.

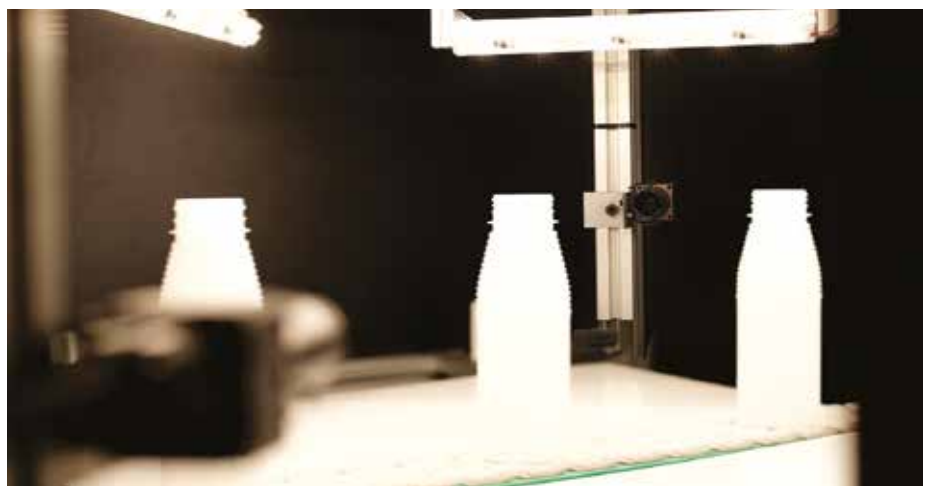
The solution from Omron combines the firm's FH vision system, as well as its FQ2 cameras. The system incorporates lights and cameras set at different angles from all sides so that they can detect any defects, such as scratches or dust, that would affect the quality of a bottle. Any bottle identified as having defects is automatically discarded.

The Omron vision system is very precise, scalable, and adaptable, and can easily cope with changes in production. It also has a single software program that Novio employees can configure with ease.

Peter Lykke, Novio Packaging's technical manager, said: 'After I've carried out the basic programming and set up the cameras, our technical staff can easily adjust the program for new types of bottles themselves.' This saves Novio time and money, with no need to call in a specialist or a systems integrator to handle any changes.

Ease of programming is something that →

'Many end-of-line packing stations are automated with processing in excess of 100 packs a minute'



Omron

Cameras inspecting bottles for defects from multiple angles

‘The traditional production line is transforming into a production matrix’

→ vision provider Sick is aiming for with its AppSpace software platform, which the company is supplying for automating new, increasingly flexible packaging lines. The company has worked with a European food packager that supplies supermarkets, which is capable of carrying out single-figure production runs, enabling it to deliver tailored orders. In a world of sustainability this means less waste. If products can simply be made to order, companies no longer have to worry about making large batches of products just to cover potential – rather than guaranteed – orders.

‘This is having an impact on how we, as vision firms, are developing our technology,’ remarked Neil Sandu, the new chairman of UKIVA and Sick’s UK product manager for imaging, measurement and ranging. ‘We are having to design our systems to be equally as flexible as modern production technologies, to better meet challenges posed by production and packaging.’

Sandu explained that, rather than having long production lines for single types of product, autonomous mobile robots can now transport different types of product around a factory for processing at different workstations. ‘This enables single production systems to process multiple types of product, rather than one system being required on each different production line,’ he said. ‘The traditional production line is transforming into a production matrix, with its different workstations dotted around the factory floor.’

Sandhu said that Sick is moving to more general solutions that can be tailored to a wider range of tasks, and be configured easily without specialist knowledge in machine vision. Rather than having to design a camera for new tasks, the company will instead develop a software app to add to its AppSpace platform. The apps can then be downloaded directly onto a smart camera and configured from a web browser.

‘In doing this, our cameras can be flexible enough to move with the times in production and packaging,’ said Sandhu.

He said that a camera with a label-checking app, for inspecting best-before dates or label position, could be redeployed with a robot guidance app that lets it be used in a different part of the factory for pick-and-place tasks.

Sick

Smart cameras such as Sick’s Inspector P camera can carry out different tasks simply by uploading new software apps

Sick has had to employ software developers and create branches of its business to deal directly with software, according to Sandhu. He noted that multiple vision firms are going down the app development route, although he said this does not mean traditionally hardware-oriented vision firms, such as Sick, are now looking to take on dedicated machine vision software firms such as MVTec, or software giants such as Microsoft. Sandhu said that Sick is partnering with such firms to enhance its capabilities.

Multi-purpose 3D

In warehouse automation LMI Technologies says the logistics sector has undergone a shift from assessing shipping fees strictly by weight, to also charging by dimensional weight. It means LMI’s 3D profilers are now being used to measure box dimensions, as well as to scan open boxes to determine fill volume based on 3D height map data.

The firm’s wide field of view Gocator 2490 3D laser profiler, released last year, can be used for both tasks. The Gocator 2490 has a 1m² scan area, and operates at a rate of 800Hz and 2.5mm resolution in all three dimensions.

Data from the sensor can be used to sort packages into appropriate locations depending on their size. The same sensor could also be used to determine the fill volume of open boxes, so that individual boxes can be packed efficiently. A third use is for robot palletisation and depalletisation, where the sensor is mounted on a robot arm and gives precise positional co-ordinates to tell the robot which boxes to handle on the pallet. Here, the Gocator 2490 sensor’s wide field of view is able to cover the entire pallet and its contents in a single scan. Robot calibration algorithms are built into the sensor to increase its ease of integration.

In addition to dimensional gauging, packages also need to be inspected for surface defects. Receiving and sorting centres usually conduct this type of quality inspection, checking for surface defects such as dents, tears, punctures and folds. The 3D sensors can be used here too, to scan the exposed sides of boxes travelling on a conveyor, providing real-time defect detection to flag damaged packages. Pass/fail control decisions are stamped with time and position information for every box, with each decision tag representing an outcome to be communicated to downstream sorting equipment.

As if that wasn’t enough to demonstrate the flexibility of modern 3D smart sensors, the same systems can also be used for scanning barcodes to ensure traceability in logistics. Built-in software running in LMI’s Gocator sensors enables engineers to scan and read data encoded in 1D barcodes or OCR data from a 3D scan, without the need for 2D vision cameras or specialised barcode readers. The flexibility of vision devices is making them much more attractive as a tool to help automate packaging lines and warehouses alike.

IMAGING
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Food glorious food

This webcast will cover three case studies of vision technology used in food production. These include two instances of hyperspectral inspection, one for determining the quality of fish as they pass down a conveyor fresh from the boat, while the other considers how hyperspectral imaging can be used to inspect strawberries for bruising. A third case study looks at a machine for removing apple cores using 3D vision to guide the knife.

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Speakers

Silje Ottestad,
Senior research scientist, HySpex by Neo

Hyperspectral imaging in the fish industry
Hyperspectral imaging is emerging as an important tool in the fish industry. Several applications that have been explored by researchers for years are finally finding their way to the production line. In this presentation we will give an overview of the challenges in the fish industry where hyperspectral imaging has been investigated as a solution. The focus will be on detection of blood content and parasite detection. We will also go through the technical requirements for the different applications when it comes to spectral and spatial resolution, depth of measurement, and measurement speed.

Peter Matus,
3D vision consultant, Photoneo

Apple coring system using 3D vision
The solution was developed to automate the removal of apple cores and thus increase productivity and reduce the rejection rate in production. The system is based on 3D vision by Photoneo - the PhoXi 3D scanner - that is able to recognise and localise the position and orientation of apple cores, and guide the cutting machine to remove them. The scanner provides high resolution and accuracy of 3D reconstruction, and also a large scanning range that means eight apples can be processed at a time, with a cycle time of less than one second.

Christoph Miksits,
Application engineer, Perception Park

Inspecting strawberries for bruising with hyperspectral imaging
Mechanical handling can bruise fruit during harvest, transport, and storage. The bruises lower the quality and cause significant economic losses because such produce easily ferments, rots, or gets mildew and infects other produce during storage. By using hyperspectral imaging and Perception Park software it is possible to make the invisible visible with a non-destructive technique for quality control. Perception Park software is designed to analyse data from any hyperspectral camera and prepare it for machine vision applications. Perception Park software and a Specim FX17 hyperspectral camera were used to detect and colour-code bruises on strawberries.

Coping with Covid six months in: What next for the vision industry?

Following on from our panel discussion back in April, Imaging and Machine Vision Europe has invited back our experts to review how the machine vision industry has been coping with the impact of Covid-19. We'll discuss the latest market statistics from the UK, Germany and the USA, talk about the events landscape and how companies are doing business in the absence of face-to-face contact, and look at the ongoing challenges and opportunities ahead of us in the next 12 months.

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smart vision lights
Where Innovation and Lighting Begin

Speakers

Allan Anderson,
Chairman UK Industrial Vision Association (UKIVA)

Jeff Burnstein,
President, AIA – Advancing Vision + Imaging

Anne Wendel,
Director, VDMA Machine Vision Group

Chris Yates,
President, European Machine Vision Association (EMVA)

Moderator

Warren Clark,
Publisher, Europa Science

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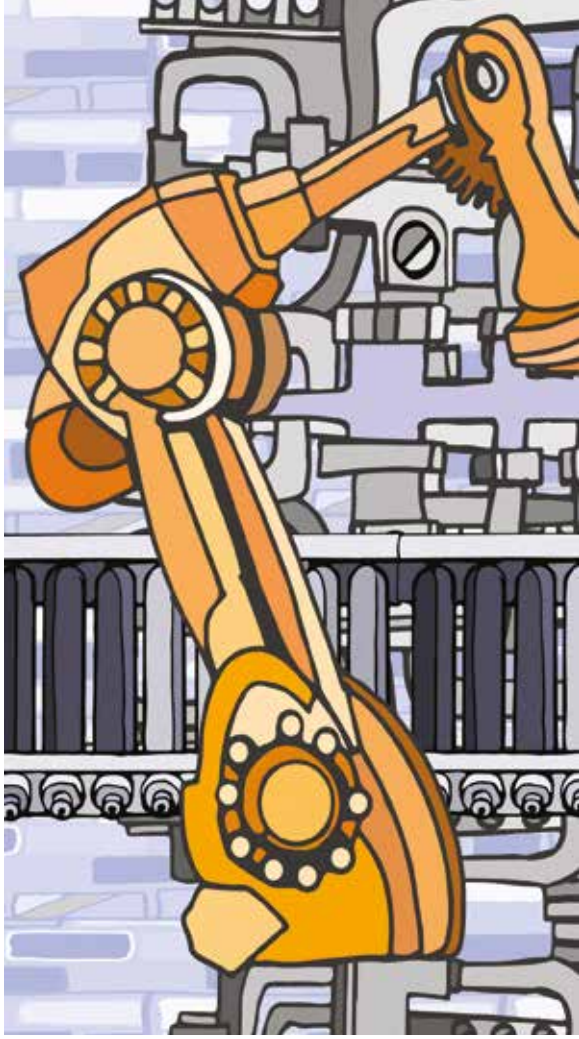
*Registration required

Delivering 3D vision's potential

We gathered a panel of experts to discuss uptake of 3D vision in robot automation. **Greg Blackman** reports from our webinar



'Our largest competitor of vision, in general, is no vision.' That's Pickit CEO Peter Soetens' response when asked how often 3D vision is used for robot guidance and automation.

Pickit makes 3D vision solutions for robotics, and Soetens listed three areas where 3D vision is opening up applications: bin picking (impossible to solve without 3D vision, he said); depalletising, where items are unloaded from a pallet with a robot; and 3D part localisation, using vision to find a large part in space for the robot to pick it up and perform tasks.

But, as Soetens said, vision is not used as often as it might be because it is often considered complex, costly and beyond the expertise of engineers working on automation solutions, especially if they have limited resources or budget. Oliver Selby, robotics business development manager at Fanuc UK, estimated that 15 to 30 per cent of the robots his firm sells include a 2D or 3D vision system. Fanuc has its own range of integrated vision systems, but also offers solutions from third-party suppliers.

Some automation machines don't need vision to be effective, but Kamel Saidi, leader of the Sensing and Perception Systems Group at the National Institute of Standards and Technology (NIST), believes 3D vision can open up many more applications, especially for small- and medium-sized enterprises. He said the benefit of 3D vision for SMEs, and manufacturing in general, is that it reduces the need for mechanical conveyance systems, jigs and fixtures that would otherwise be required to automate a process. Building a solution with a lot of mechanical fixtures has its own complexities, and if the manufacturer is producing low volumes of parts – and many different parts from month to month – it can't invest a lot in infrastructure to automate this.

Saidi said: '3D vision is an enabler for robot automation. When a robot starts to understand its surroundings in 3D – not just 2D – we believe that it opens up many possibilities to interact more intelligently with the physical world.' The robot doesn't need as many mechanical fixtures to operate.

Working with 3D vision requires its own levels of expertise, however. Reducing the barrier to entry for 3D vision is something Saidi and his team at NIST are working on by developing standards for industrial 3D vision systems.

'We feel that standards are the building blocks of many successful applications of technology, because they help people understand how well the technologies work,' he said.

He added that NIST has 'talked to a lot of manufacturers or integrators who want to use 3D machine vision, and who haven't had their expectations met,' because the terminology behind 3D cameras isn't defined well enough. Saidi said that terms such as resolution or depth error have to be defined, and the methods for measuring them must also be developed and become standard across industry.

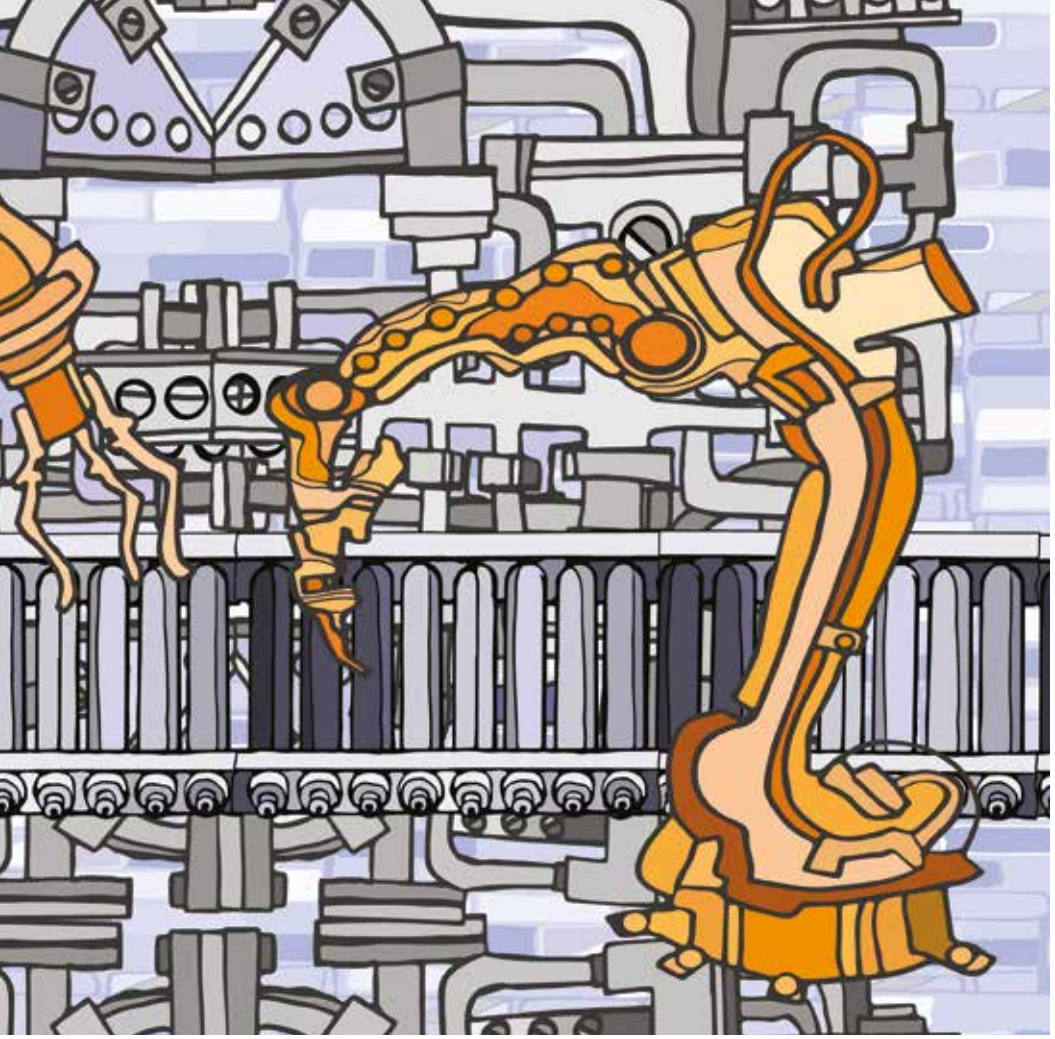
A 3D camera might not perform as well as advertised because the parts the robot is asked to handle keep changing, or the environment – the lighting – changes, for instance.

'We feel that standards will help bring a common language, a way to talk about all of these things, so that people understand each other better,' Saidi said. 'That's a starting point for helping technology become more prevalent.'

Selby agreed, saying that smaller manufacturers looking for robotics and automation tend to try and find a one-solution-fits-all approach, because it gives them the best return on investment. 'As soon as you look at feeding components to an automation cell, the cost in fixturing components to get them accurate enough to pick and place becomes prohibitive,' he said. '3D vision allows us to essentially not have to fixture those components, and it becomes flexible.'

Selby, at Fanuc UK, has been working on pick-and-place of battery components for battery packing cells in automotive; also in applications for food, pharmaceutical and assembly of electronic components. In typical food applications or assembly applications, he said that Fanuc aims to pick 60 per minute, which might equate to around 10 to 15fps, depending on the application, along with factors such as the size of field of view.

Mark Robson, senior research engineer at the Manufacturing Technology Centre in the UK, noted integration of robots and vision is still a key challenge for improving uptake of automation. He believes there are opportunities for vision companies to form closer relationships with robotics and other automation integrators. The centre is compiling a list of integrators in the UK – it is up to 600 firms so far that sell or maintain industrial automation systems. 'There's a



abyrvalg00/Shutterstock.com

> ‘The performance needs to be well understood, so when the customer asks... they know what to expect’

huge pool of people with automation knowledge who don’t necessarily have that vision knowledge where there’s opportunities for partnerships,’ he said.

The Manufacturing Technology Centre, which takes ideas from academia and translates them into practical applications for industry, has worked on depalletising applications and, most recently, has been looking at deep learning-based methods for speeding up pick-and-place.

‘The challenge that we see with quite a lot of pick-and-place applications isn’t really around the vision; the vision is good enough and fast enough. Even the robots are fast enough,’ Robson said. One challenge, he feels, is robot path planning. ‘If your task isn’t structured enough and there are several options for how the robot has to move, then figuring out the best motion plan for more complicated tasks is a challenge that we’re looking at.’

The centre is investigating deep learning for robot assembly, where the robot has to find an object and pick it up accurately enough to assemble it. Robson also believes there are quite a lot of applications using 3D vision and robotics, in combination with deep learning, around agriculture and handling food.

Make it easy to use

The key to increasing adoption of 3D vision for robotics, according to Saidi, is to make the technology as simple to use as possible.

‘Unless SMEs understand what to expect from a technology, it’s going to be hard to get them to use it,’ he said. ‘Because even people with experience in machine vision have had lots of issues in terms of expectations – they think a technology is going to do something for them and it ends up not working the way they expected. It gets shelved or not used, and it’s very frustrating for them. SMEs going through that, that will completely put them off.

‘First, it needs to be very simple to use,’ he continued. ‘More importantly, the performance, how well these things work, needs to be well understood, so that when they [the customer] ask for something they know what to ask for, and when they get it they know what to expect.’

In order to help the users and integrators of these systems, NIST is working on best practices for 3D vision solutions for particular applications. Saidi and his team are speaking to industry experts and consolidating the information into something that everyone can use – users, integrators, and manufacturers. He said he welcomes participation from the industry.

Selby said that any reputable company developing automation solutions should be able to offer trials and demonstrations of equipment to a reasonably high level, so that the expectation is met by the customer prior to sale, or through a period of test and proof of concept.

Soetens said that a lot of people are yet to buy their first 3D vision system. ‘What we see is that a lot of users are making the same mistakes regarding designing the gripper or setting up their cell,’ he said. This led Pickit to the conclusion that the firm has to help customers think about the gripper and the robot alongside the vision – as more of a complete solution.

‘We see companies partnering – gripper companies, vision companies, robot companies. Everyone is looking for this magical mix of the perfect combination for a given application,’ he said.

‘The industry would prefer to have a reliable and tested set of components that work well together, instead of having all the freedom of choice but the freedom to make a mistake,’ Soetens continued. He believes that over the next two years there will be much more integration between the gripper, the software, the camera and the robot.

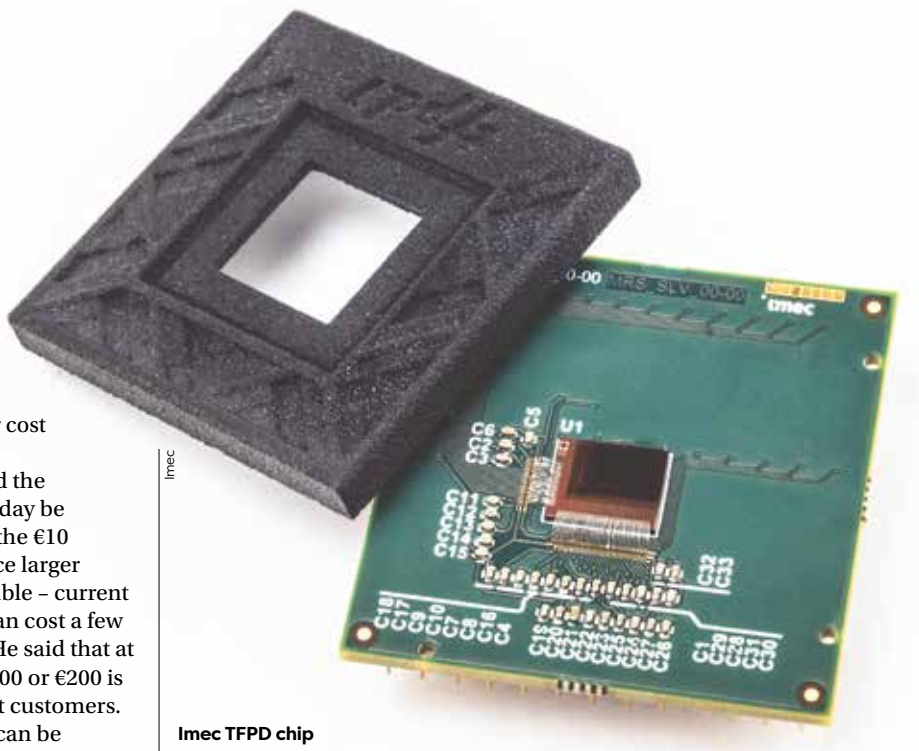
Selby added that education at an early stage – at university and schools – is important to further the use of robotics. Fanuc globally has education products for robotics that include vision. ‘It’s important to us that engineers of the future are able to take those robotic products and implement vision systems on them,’ he said.

The webinar can be viewed at: www.imveurope.com/webcasts

Share your experience developing and deploying 3D vision and robot systems. Please get in touch for opportunities to write for us: **greg.blackman@europascience.com**

SWIR cost cut: Imec achieves 1.82µm pixels

Greg Blackman speaks to Imec's Paweł Malinowski about the institute's new quantum dot SWIR sensor



Imec

Imec TFPD chip

Late last year Imec presented a shortwave infrared quantum dot image sensor with a pixel pitch of 1.82µm at the IEEE International Electron Devices Meeting (IEDM).

The work is the latest in several advances in SWIR image sensor technology, which have been gathering pace where, previously, progress in III-V detectors had ground to a halt. A year earlier at the previous IEDM, Sony announced SWIR sensors with a 5µm pixel pitch, achieved by connecting the InGaAs photodiode to the readout circuit via copper-to-copper bonding. This meant that, finally, the limitation of double-digit pixel size found in traditional hybrid bonded InGaAs sensors was broken, offering a path to higher resolution SWIR sensors.

The Imec sensor is based on thin-film quantum dots, which are integrated monolithically on top of the readout circuit. This means it doesn't have the limitations of flip-chip bonding or interconnects, so the pixel can be very small – 1.82µm is the smallest pixel Imec has made with this particular technology node of 130nm in a three-transistor (3T) structure.

'We want to have small pixels, which is good for image quality but also for squeezing more pixels in the same footprint,' explained Paweł Malinowski, program manager for pixel innovations at Imec. 'This translates to lower cost per pixel.'

Malinowski said the sensor could one day be manufactured in the €10 to €100 range, once larger volumes are possible – current InGaAs sensors can cost a few thousand euros. He said that at this early stage €100 or €200 is adequate for most customers.

Quantum dots can be engineered to have absorption at 2µm and above. The absorption peak can be tuned to certain wavelengths by the way the thin-film layers are constructed. In the IEDM paper, Imec focuses on sensing at 1,450nm, a useful detection wavelength for some applications, especially if water content is a desired metric.

A quirk of designing image sensors with quantum dots, Malinowski noted, is that the quantum dot absorber layers, at 300 or 400nm thick, are significantly thinner than the wavelength of light they are used to detect, 1,450nm. 'From a physics point of view, it's quite amazing,' he said.

Imec has reached around 50 per cent external quantum efficiency (EQE) on test structures, while on ROIC samples EQE is currently 10 to 20 per cent. InGaAs reaches up to 80 to 90 per cent EQE, so quantum dot sensors won't compete where high quantum efficiency is needed, but for a lot of applications, 50 per cent EQE is acceptable, Malinowski said.

Complete package and new applications

The announcement is the result of several things coming together: the optimisation of the photodiode for the infrared range; designing a circuit that can read out the signals from such a thin-film photodiode – typically these materials have higher noise or higher dark current, so the photodiode has to cope with that; and all the necessary integration, the interconnects, and how the sensor is encapsulated and packaged.

Imec is now working on transferring the process to its 200mm fab and making the devices on full wafers. Once that is available, throughputs will be higher and the device can be optimised for uniformity and reliability.

Malinowski said that the first applications might be for areas in industrial vision requiring higher resolution in SWIR, for instance inspecting solar cells or silicon chips. Higher resolution means the field of view can be increased.

Smart agriculture is another area that he highlighted. He said that agricultural robots don't use SWIR sensors at the moment because they can cost more than the robot itself, so a less expensive SWIR imager might open the door to more widespread use of SWIR in agriculture.

The example given in the

IEDM paper is inspecting structures through silicon using lens-free imaging, a type of microscopy where the image is reconstructed computationally. Here, there is an advantage of having a large field of view and sub-wavelength pixels in the shortwave infrared. 'The new sensor is an enabler, because right now lens-free imaging for SWIR is quite difficult,' Malinowski explained.

A bit further off, the SWIR sensors could potentially be used onboard cars – although automotive has strict requirements in terms of reliability – and also in consumer devices. The cost would need to drop even further, but one potential application is in VR glasses for eye tracking at 1,500nm.

To reduce the price point further, the sensor would have to be manufactured on 300mm wafers, which would allow pixels to be scaled down even more and additional functionality added.

Imec is also considering making a multispectral sensor, to incorporate different absorbers for different pixels or pixel regions.

Malinowski said that the priority at the moment, however, is using just one type of absorber for a straight SWIR sensor.

Optimising on 200mm wafers

Peak absorption in the 1,450nm sensor detailed in the IEDM paper has a full width at half maximum of around 100nm. The detector has a sensitivity profile of 60 to 70 per cent sensitivity in the visible spectrum, which drops to 10 per cent between the visible and the peak in SWIR, with the peak optimised to a maximum of around 50 per cent EQE.

'It's a pretty broadband detector,' Malinowski said. 'If you want to use it with a light source of a certain wavelength this is where you want to optimise the peak. If you want to capture as much light as possible, all the wavelengths between the visible and the peak are usable.'

At the moment Imec is working at room temperature, but there are tests to see the effects of operating at higher or lower temperatures.

'There's quite a lot of movement disrupting the SWIR market'

'We keep on optimising the stack and working with material suppliers to explore new materials,' Malinowski said. 'Going lead-free is a big topic.' At the moment, Imec's baseline technology is lead sulphide quantum dots, but some companies have a strict lead-free policy. Indium arsenide is another potential material, he said.

'This is not a technology that will substitute or take away market from traditional SWIR imagers,' Malinowski added. 'This is filling the gap between the silicon image sensors and the InGaAs or III-V for applications that can't afford SWIR, or that need higher resolution than that available in flip-chip sensors.

'I see this technology as a new thing, rather than a competitor. InGaAs will always be preferable for high-end SWIR imaging, where you need the highest efficiency.'

Progress is being made in this area from other companies too, notably SWIR Vision Systems in the US, with its Acuros quantum dot SWIR sensors and cameras, and Finnish firm Emberion, which is working on integrating graphene and other nanomaterials onto CMOS integrated circuits for broadband detectors. In addition, Spanish research institute ICFO last year spun out Qurv Technologies to develop quantum dot image sensors operating from the visible to the shortwave infrared.

'There's quite a lot of movement disrupting the SWIR market, which has for decades been made up of traditional players,' Malinowski said. 'We are at an interesting point in time, and we hear from integrators and application companies that they want to have SWIR. I'm optimistic for the future.'

Commercial products

Gpixel has announced the first sensor in a new family of CMOS line scan imagers supporting true charge-domain time delay integration (TDI). GLT5009BSI is a backside illuminated, TDI image sensor with 5µm pixels and 9,072 pixel horizontal resolution. The sensor has two photosensitive bands, 256 stages and 32 stages respectively, enabling a high dynamic range imaging mode.

The sensor's 5µm pixel provides a full well capacity of 16ke$^-$ and noise of 8e$^-$ which delivers 66dB dynamic range. The GLT sensor family employs scientific CMOS BSI technology to achieve excellent sensitivity from the ultraviolet to the near infrared.

Read out of the image data is achieved through 86 pairs of sub-LVDS channels at a combined maximum data rate of 72.58Gb/s. This output architecture supports line rates up to 600kHz using 10-bit single band mode, and 300kHz using 12-bit single band mode.

The length of the photosensitive area is 45.36mm and the sensor is assembled in a 269-pin µPGA package. The sensor integrates several features to ease camera integration, including an internal sequencer, channel multiplexing, and selectable scan direction.

The GLT family's combination of high speed and sensitivity from the UV to the NIR, is ideal for applications such as flat panel display inspection, printed circuit board inspection, wafer inspection, digital pathology and fluorescence imaging.

Other recent image sensors from Gpixel include: GMax2518, a global shutter, 18 megapixel sensor with correlated double sampling and an optical format of 1 inch; GSprint4521, a 21 megapixel APS-sized sensor designed with 4.5µm charge domain global shutter pixels; and the 103 megapixel GMax32103 medium-sized sensor with a 3.2µm global shutter pixel.

Elsewhere, foundry Tower Semiconductor and Opix, a supplier of time-of-flight sensors, have developed a ToF technology platform for 3D imaging and face recognition. The technology is implemented in a high-end image sensor product that is being integrated into a 3D camera module in partnership with a provider of imaging systems for mobile applications. The product will serve a variety of markets such as mobile, AR/VR, retail, robotics, automation and industrial inspection.

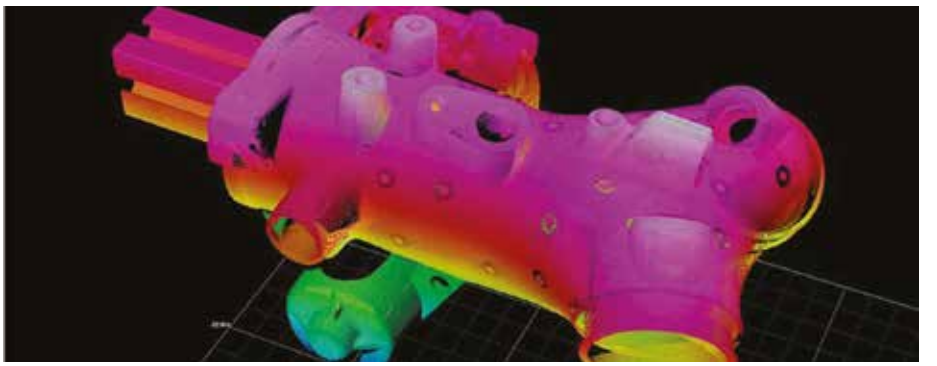
Products

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

Software

Sapera LT 8.60 SDK

Teledyne Imaging has released the latest version of the Sapera LT software development kit. Sapera LT 8.60 offers a USB3 device manager to select supported USB3 cameras and protocols. The SDK also includes enhancements to the Sapera Network package with improved CPU use when decoding 5GigE packets. This provides better performance for Genie Nano-5G (5GigE) cameras, especially in multi-camera mode. In addition, this release introduces Sapera Z-Expert with a graphical configuration environment for setting up and configuring of the Z-Trak family of 3D profile sensors.
www.teledyneimaging.com



Gocator 6.1

LMI Technologies has launched Gocator 6.1 software, which includes 6DoF alignment and 3D mesh data generation for shape measurement on 360º surface scans. Users can now transform multiple 3D point clouds into meshed surface data for use in high-precision shape measurement and inspection. Mesh data consists of interconnected data points that form a continuous, 360º surface representing the object's complete geometry. It makes use of 6DoF alignment for wide and ring-type multi-sensor layouts. Users can then apply any of Gocator's built-in surface tools to perform measurements on the meshed surface, such as measuring features on the sides of objects.

The Surface Pattern Matching tool allows users to implement contour-based part matching to locate parts and features from 2D or 3D data regardless of scale, orientation, partial occlusion, distortion, contrast or height reversal, and overlapping patterns. Surface Pattern Matching allows the user to find one or more patterns simultaneously in a single scan cycle, which is especially useful when scanning complex parts or surface features that have multiple patterns of interest.

Also, using the GoHMI SDK, programmers can now develop their own Gocator-to-factory human machine interface using Visual Studio. Other new tools include translucent spot detection for scanning semi-transparent materials, and a tool for measuring cylindrical objects or features.
https://dev.lmi3d.com

Common Vision Blox 2020

The CVB 2020 release from Stemmer Imaging offers MultiStream support for cameras streaming multiple datasets, such as prism-based cameras with colour and infrared datasets. MultiPart acquisition supports cameras that deliver complex data, such as 3D cameras where separate and different formatted data needs to be transmitted, for example 3D point cloud, RGB surface and information about data integrity at the same time.

For the expanding use of GPU processing, especially in deep learning, the FlowSet Pool feature enables direct transfer into user-defined memory locations such as GPU memory, improving efficiency. Support for Teledyne Dalsa's TurboDrive v2.0 enables compressed image acquisition from compatible devices, which provides acquisition rates of up to three times the interface bandwidth.

CVB 2020 CameraSuite is included with all GigE Vision and USB3 Vision cameras supplied by Stemmer Imaging without additional cost.
www.commonvisionblox.com

Computing

GM-1000 embedded platform

Cincoze, a manufacturer of embedded systems, has expanded its GM-1000 machine vision platform with two Quadro MXM GPU modules. The MXM-RTX3000 and MXM-T1000 provide additional GPU capacity for rapid adoption of machine vision in smart factories, from environmental perception applications such as positioning, measurement, identification and sorting, to vision-guided automation functions.

The GM-1000 is positioned as a high-performance machine vision system featuring high computing performance, high-speed I/O, and industrial-grade reliability. The platform's carrier board can be matched with a selection of Cincoze MXM GPU modules, including the MXM-RTX3000, MXM-T1000, MXM-P2000 and MXM-E9174, providing a match for different computing requirements.

The new Quadro MXM GPU modules – the MXM-RTX3000 and MXM-T1000 – use the latest Nvidia Quadro Turing GPU architecture. The MXM-RTX3000 has 1,920 Cuda cores, 5.3Tflops peak FP32 computing power, parallel integer execution, AI computing Tensor core, and RT core for ray tracing. The MXM-T1000 has 896 Cuda cores, 2.6Tflops peak FP32 computing power and 50W power consumption.

Both models support GDDR6 memory. The MXM-RTX3000 has a single card capacity of up to 6GB and 336GB/s memory bandwidth; the MXM-T1000 has 4GB capacity.
www.cincoze.com

Cameras

Go-X series

JAI has launched the Go-X series, industrial cameras from €289 and a six-year warranty, the longest offered by any camera manufacturer.

The series encompasses a total of 24 different models with a range of resolutions including 2.3, 3.2, 5, 8.9, and 12.4 megapixels. Interface options include GigE Vision or USB3 Vision, supporting power-over-interface or the use of separate power supplies connected via I/O connector. Sony Pregius CMOS global shutter sensors are used, including monochrome and Bayer colour versions at each resolution.

JAI has put extra emphasis on the reliability aspects of the Go-X series. The cameras feature high shock and vibration ratings of 80G and 10G, respectively, and are designed to dissipate heat to avoid breakdowns in industrial environments.

Cameras in the series have a footprint of 29 x 29 x 51.5mm and weigh 62g. They undergo a rigorous dust prevention and screening process prior to shipment.

All Go-X series models provide a rich set of standard features, including region-of-interest, image flipping and mirroring, 2 x 2 decimation, 8/10/12-bit output, blemish compensation and shading correction. Plus, advanced features such as two different sequencer modes and an automatic level control function for use in dynamic lighting conditions.

JAI has also added four models to its 45-megapixel Spark series, and a new three-CMOS area scan camera to its Fusion series. The Spark cameras use On Semiconductor's XGS 45000 CMOS global shutter sensor and CXP-12 interface with maximum data transfer of 50Gb/s, while the Fusion camera simultaneously captures a monochrome image and images from two separate near-infrared bands.

www.jai.com

EoSens Creation

The EoSens Creation series of FPGA programmable-ready smart cameras is new from Mikrotron. Designed for multi-camera industrial automation systems, the Creation series enables engineers to embed their own IP into a Mikrotron 2-megapixel 10GigE GenICam-compliant camera. The cameras are able to externally stream 10-bit pixel resolution images at 535fps, or internally stream 8-bit images at 2,240fps.

EoSens Creation cameras offer sensitivity of 20V/Lux at 550nm. In addition, the camera's SFP+ connection works with both copper and fibre interfaces, making it possible to install long cable runs using low-cost Ethernet cabling, switches and network interfaces.

Offering an open, scalable framework, the cameras feature a Xilinx Kintex Ultrascale FPGA plus an additional on-board 2GB DDRD of memory for edge functions such as defect pixel correction, gamma correction, dynamic range correction and noise reduction. By reducing the linear data flow to the host PC's CPU, this design accelerates image pre-processing.

FPGA processing can be customised with Xilinx Vivado Design Suite software. An open platform concept provides a clear separation between the basic camera functions and the application IP to assure a straightforward development environment.

www.mikrotron.de

Global shutter UV camera

Photonfocus has introduced a global shutter CMOS UV camera. The new model – MV4-D1280U-H01-GT – has a quantum efficiency of 40 per cent from 170 to 820nm, meaning it covers the UV, visible and near infrared spectra.

Photonfocus, however, says it is designed primarily for UV imaging applications such as laser profilometry, monitoring pantographs – the apparatus mounted on electric trains to collect power – semiconductor wafer inspection, in recycling, and UV laser or LED triangulation technology for transparent materials.

The camera has a frame rate of 140fps at full resolution of 1,280 x 1,024 pixels. It has a 10GigE Vision interface for high-speed data transfer with cable lengths of up to 300m, and is supplied with a C-mount lens connection.

UV cameras are available, although Photonfocus says this model is the first global shutter UV camera, meaning there will be no distortion when imaging moving objects.

www.photonfocus.com

Scarlet 3D depth camera

Nerian Vision Technologies has released the Scarlet 3D depth camera, designed primarily for agricultural, bin picking, pick and place, autonomous driving and autonomous vehicle applications. The camera reaches speeds of up to 120fps and 70 million 3D points per second; it has a resolution of 5 megapixels. Furthermore, Scarlet can process twice as large a disparity range (512 pixels) as its predecessor SceneScan Pro, resulting in double the depth resolution.

The image data is processed in real time on an FPGA. The result is a sub-pixel accurate disparity map – an inverse depth image – transmitted via 1 or 10 Gigabit Ethernet to a computer or embedded system. Post-processing the data includes detection of erroneous disparities and noise reduction. Nerian's open source, cross-platform API converts this disparity map to a dense 3D point cloud.

The camera is based on Sony's Pregius IMX250 image sensor. In addition, a fast inertial sensor has been integrated into Scarlet, which captures motion data at up to 400Hz. Inertial data is particularly valuable for applications in mobile robotics, such as simultaneous localisation and mapping.

Scarlet is IP67 rated and is available in two versions: a 10cm baseline distance – the distance between image sensors – for measurements at close range (as close as 14cm), and a 25cm baseline distance for depth measurements at greater distances. Lenses are available from 5 to 25mm focal length.

https://nerian.com

FXO camera series

SVS-Vistek has based its FXO camera series on Pregius S sensors and a10GigE interface. The Sony sensors, with 2.74µm pixels, deliver excellent image quality with a dynamic range of 70dB.

To operate at the maximum sensor frame rate, SVS-Vistek has implemented a thermal design with dust-free, external cooling. The multi-channel strobe controller integrated in the camera and the precise I/O module with the sequencer are addressed via GenTL. The 10GigE interface does not require a frame grabber and is therefore very economical. For times when even more power is required, SVS-Vistek also offers the FXO models with the Coaxpress-12 interface.

The new series includes models with resolutions from 16.1 to 24.5 megapixels, and frame rates from 30.1 to 45fps. The cameras measure 50 x 50mm.

www.svs-vistek.com

Cameras

In-Sight 3D-L4000

New from Cognex is the In-Sight 3D-L4000 smart camera, featuring 3D laser displacement technology.

The 3D-L4000 combines speckle-free blue laser optics and a broad range of 3D vision tools. The In-Sight spreadsheet interface allows users to set up and run 3D applications without the need for programming or external processing.

It simplifies application development and streamlines factory integration with a full I/O and communications function set.

The camera can also combine 2D and 3D vision tools within the same application, leading to faster deployments. The smart camera is supplied in three factory-calibrated fields of view.

www.cognex.com

Alpha full-frame cameras gain SDK support

Sony's Alpha range of full-frame mirrorless cameras has been upgraded with a new software development kit. The upgraded SDK, version 1.03, gives control over white balance, resolution, image compression, zoom, focus and video triggering.

Full frame mirrorless cameras have a better lens lineup than their industrial counterparts. They also use a 35mm sensor, which doubles the sensor area versus APS-C cameras, and increases the area by seven times versus an industrial camera with a 1-inch sensor. This allows resolutions to be increased without reducing pixel size and sensitivity.

The solution is targeted at sectors such as intelligent transport systems, security, e-commerce and drones used for mapping or content creation.

The SDK also gains multi-camera functionality, enabling multiple shots of a subject to be captured from different angles. In e-commerce this multi-camera operation allows products to be captured from multiple angles and packshots to be created.

The range of cameras that support the SDK has also increased, including the addition of lighter and more rugged models.

www.sony.eu/businesssolutions

Pixelink PL-X957

Pixelink has released the second model in its 10 Gigabit Ethernet series. The Pixelink PL-X957 model uses the 7 megapixel Sony Pregius IMX420 1.1-inch CMOS image sensor.

A key feature of the Sony IMX420 is a dual ADC mode, where each pixel can be read out with two different gains. Dual ADC images are combined into a single hybrid HDR image directly on camera, thus removing the need for host processing. Real-time on-camera HDR is an easy way for the user to gain 6-10dB of additional dynamic range on the image without requiring additional software algorithms.

The PL-X957, available in colour or monochrome, is ideal for high dynamic range imaging. Additional specifications include a pixel pitch of 4.5µm, up to 112fps, and dynamic range of 70dB.

With a 10GBase-T interface, these cameras offer high bandwidth and are ideal for multi-camera synchronisation, automated inspection and VR/AR applications. Additional camera features include optional power-over-Ethernet and IEEE1588 clock synchronisation.

www.pixelink.com

Pregius S cameras

Ximea has introduced camera models based on Sony CMOS Pregius S sensors, starting with 24.5MP IMX540, 20.3MP IMX541 and 16.1MP IMX542. The global shutter sensors have 2.74µm pixels and dynamic range of 71dB. Ximea has integrated them into a camera form factor of 26 x 26 x 33mm that weighs 38g. Power requirements are 3W, which allows the cameras to be bus-powered directly through the cable. The sensors use both USB3 and PCIe interfaces to offer simplicity and multi-camera system synchronisation.

Ximea plans to start with the HDR feature from the sensors, and then support other features – such as an ultra-short interval between two shutters, exposure time monitoring and an improved on-sensor thermometer – through firmware updates.

In collaboration with Imec, Ximea has also updated its XiSpec hyperspectral cameras. The XiSpec2 series has an optimised camera housing and bandpass filters to improve the spectral performance. New models include snapshot versions covering visible into the near infrared with 10, 15 and 24 channels, and a line-scan version with 150 channels imaging across 470 to 900nm.

www.ximea.com

Illumination

Cobra MultiSpec LED line light

ProPhotonix has added a hyperspectral LED line light to its Cobra MultiSpec platform. With a spectral range from 400 to 1,000nm and excellent spatial and spectral uniformity, this light source is an ideal solution for hyperspectral line scan cameras.

The spectrum is well-matched to the Specim FX10 camera, for example, or machine vision cameras using the Sony IMX174 sensor. For applications covering an extended spectrum, the Cobra MultiSpec can be provided in configurations of up to 12 wavelengths from 365 to 1,700nm. LEDs offer significant advantages over traditional halogen light sources including compactness, longer lifetimes and greater control of the emission spectrum. System designers will also benefit from reduced form factors, without the need for additional heat extraction equipment.

The new user-friendly GUI provides precise control of the light, so that system designers can fine tune the performance of the system. Discrete control of each wavelength allows users to configure the optimum wavelength balancing and relative intensities to refine the output spectrum specific to the application needs. The platform operates in both continuous and strobe mode, the latter for high-speed image acquisition.

www.prophotonix.com

Cameras

Contact image sensor for pipe QC

Tichawa Vision now offers the BoroCIS for internal inspection and optical quality control of the interior of tubes, pipes and bores. The industrial contact image sensor (CIS) scanner gives a distortion-free 360º internal view of tubes, round or angular pipes, and profiles made of laminate, plastic, metal and glass with diameters from 10 to 80mm. With an immersion depth of up to 250mm, the BoroCIS detects defective seams, paint defects, chips or bubbles. In tubes, it ensures imaging down to the tube bottom, optionally even including the tube bottom. Up to ten tubes per second may be inspected directly in the production line.

The scanner creates images with a resolution of 50 to 600dpi corresponding to a pixel size of 0.04 to 0.5mm. The use of long focal length optics ensures clean images even under harsh production conditions. Users can choose from monochrome and colour imaging. A transport speed up to 60m/min is possible, and an interchangeable lens enables different tube widths to be inspected in a production line. The BoroCIS is optionally available with additional UV light for high-contrast detection of dust and clear differentiation between plastic and metal.
www.tichawa.de

Boost CXP cameras

Basler has expanded its Boost camera series with Coaxpress 2.0 interface by six models with sensors from On Semiconductor's XGS global shutter family.

The cameras offer resolutions of 20, 32 and 45 megapixels, with up to 45fps. Thanks to their CXP 2.0 interface, Boost cameras are suited for tasks such as photovoltaic or display inspection, or in the printing and packaging industry, where image transmission distances of up to 40m at high data rates and resolutions are required.

The models are available as a bundle with the Basler CXP-12 interface card 1C. In addition, Basler offers components such as high-resolution F-mount lenses and Coaxpress cables.
https://baslerweb.com/boost

Lenses

M117FM-RG vision lens

The seven models in the new M117FM-RG lens series from Tamron fit 1/1.7-inch and 1/1.8-inch imagers. They are the perfect match for C-mount cameras with Sony's IMX178 sensor, for example. Focal lengths vary from 6 to 50mm.

The lens series is suited for uses needing high contrast but with limited space. The lenses resolve 2.4µm pixel-pitch at up to 6 megapixels, even in the corner of the image. The lens body has a diameter of 29mm. A distortion of less than -1.5 per cent in the wide angle is achieved.

The series' rugged mechanical design gives good anti-vibration and shock performance. The mechanism suppresses the impact of vibration and shock of up to 10G of magnitude, and limits the optical deflection within 10µm.
www.tamron.vision

Techspec LT fixed focal length lenses

Edmund Optics has introduced the Techspec LT series of fixed focal length lenses. It includes integrated liquid lenses that provide a dynamic and fast electronic autofocus optimised for 1.1-inch sensors. The f/2.8 optical design achieves up to 12-megapixel resolution. These C-mount lenses feature front filter threading and are ideal for high-speed machine vision, where focusing at multiple distances is a necessity, such as quality inspection and package sorting.
www.edmundoptics.eu

MachVis 5.2 lens configurator

The latest version of the Qioptiq lens selection software, MachVis 5.2 lens configurator, is available from Excelitas Technologies. Designed to simplify the tasks of vision system designers and engineers, MachVis 5.2 features an intuitive user interface for fast, comprehensive information on product data, new lens series and accessories – including access to 3D files – and improved lens selection algorithms. It includes information about all of the Excelitas Linos machine vision lenses, Optem Fusion micro-imaging, and Qioptiq Mag.x microscopy systems.

The MachVis 5.2 software identifies suitable lenses and generates useful supporting documentation based on user-provided parameters. It is an ideal tool for a variety of machine vision tasks, semiconductor, electronics and flat panel display manufacturing inspection, quality assurance and logistics applications. The software also acts as a product database and offers access to all drawings and product data, including mechanical accessories such as focusing units and extension tubes, and schematic illustrations of complete system setups.
www.excelitas.com/product/machvis-lens-configurator

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Gardasoft Vision Ltd
JARGY CO., LTD.
LUCID Vision Labs GmbH
MATRIX VISION GmbH
Midwest Optical Systems
Opto Engineering®
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Cameras
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AT – Automation Technology GmbH
Basler AG
Edmund Optics
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LMI Technologies Inc.
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Sensor to Image GmbH
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Euresys SA
The Imaging Source Europe GmbH

Illumination
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CCS Europe N.V.
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Macnica ATD Europe
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Opto Engineering®
Smart Vision Lights

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LMI Technologies Inc.

Lenses
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Edmund Optics
Kowa
LUCID Vision Labs GmbH
Macnica ATD Europe
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Live panel webinar:
Robotics and 3D vision

Robot automation has huge benefits for manufacturing, which has been emphasised to some extent during the pandemic. The vision technology used to guide industrial robots can achieve excellent results, but is machine vision reaching its full potential? We've gathered a panel of experts to ask how vision can help advance robot automation and improve uptake of robotics in manufacturing.

Kamel Saidi
Leader of the Sensing and Perception Systems Group, National Institute of Standards and Technology

Peter Soetens,
CEO, Pickit

Oliver Selby,
Robotics business development manager, Fanuc

Mark Robson
Senior Research Engineer at The Manufacturing Technology Centre

Greg Blackman
Editor, Imaging & Machine Vision Europe, Europa Science

Live panel webinar:
AI in machine vision

Neural networks hold the potential to revolutionise factory automation. But when should you use them, and how do you get the best out of them for building machine vision systems? We've gathered a panel of experts to discuss the latest advances in neural network-based approaches to vision applications, and to give advice on what engineers should focus on to develop a successful AI vision project.

Petra Thanner
Senior research engineer, Austrian Institute of Technology

Olaf Munkelt,
Managing director, MVTec Software

Vassilis Tsagaris,
CEO, Irida Labs

Quenton Hall
AI system architect, Xilinx

Warren Clark
Publisher, Europa Science

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