# Making vision even more accessible

**There has been an encouraging surge in orders in the UK vision market as the economy has opened up. However, Neil Sandhu, UKIVA Chairman, is keen to reinforce the message that vision solutions can be much easier to implement than many people would think.**

An example of this has been the emergence of 'out of the box' vision solutions. These are pre-configured for different applications and different industries, significantly simplifying installation and setup. They are covered in more detail in the dedicated centre-page feature in this winter issue of Vision in Action.

Sandhu is also excited by the return of UKIVA's Machine Vision Conference and Exhibition (MVC) (www.machinevisionconference. co.uk) on 28 April, 2022 at the Marshall Arena, Milton Keynes.

This will be the first major live machine vision event to take place in the UK since the start of the pandemic and supports UKIVA's commitment to informing and educating UK industry as a whole as to the many benefits offered by machine vision. More details on MVC 2022 can be found on Page 3.

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**World's leading trade fair for machine vision**
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# Top Performance in 2D and 3D



**Height and Angle Measurement**

A 2D/3D Profile Sensor with IP69K protection detects the entire width of the ice cream production line and measures the height and angle of the cardboard lids.



**Visual Quality Checks**

In the food industry, quality checks such as counting, presence or pattern match can be operated via weQube Smart Camera and the intelligent image processing software uniVision.
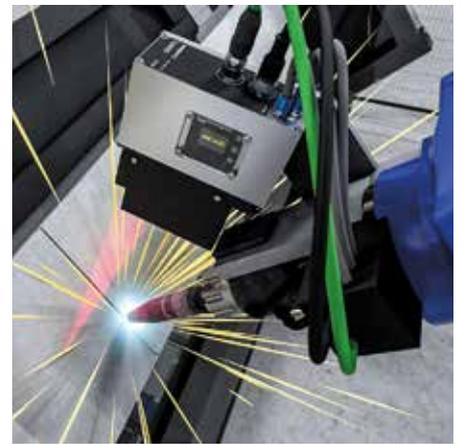


**Welding Seam Guidance**

With micrometer precision, the 2D/3D Profile Sensors weCat3D enable the tracking of weld seams in robot cells. Edges, angles or steps are detected automatically.



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# APPLICATION ARTICLES

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Content accuracy is the responsibility of individual UKIVA Members.

## ALRAD IMAGING      www.alrad.com

### Angular spectral measurements extend the range of applications displays testing

The viewing angle of a display is an angular range over which there is no excessive degradation of image quality. Each display technology can have different performance characteristics with viewing angle. Viewing angle luminance and colour data are therefore important measures of the performance of displays used in a wide range of sectors including Automotive, Avionics, General displays, Military and Mobile phone applications. These include LED, OLED, uLED and Micro Displays. ELDIM has developed the CubeX-150 multi-angle spectroradiometer with a new approach for producing angular measurement data with high speed and accuracy. This enables it to be used for a range of applications including standards and compliance testing, mass production QA and general display technology R&D and characterisation. The CubeX-150 is available in the UK from Alrad Imaging and is based on completely new technology patented by ELDIM.

*CubeX-150 multi-angle spectroradiometer*

This CubeX-150 operates in the visible wavelength range with a resolution of 2 nm. The use of the spectroradiometer can be thought of as moving a spectrometer around the Device Under Test (DUT) and taking a measurement every 2.5° in a viewing cone of +/-60°, with over 130 points measured in 0.5 s with a 0.002 colour accuracy. Multi-spectral angular emission mapping data, including flicker information, is provided at all of the above angles. The system has a 12.5mm working distance which is coupled with embedded proximity sensors making it safe to add this equipment to any type of mass production line. The measurement takt time of the equipment is less than 2 seconds, and all of the acquired data can be transferred across from the system by ethernet cable or WIFI.

## BYTRONIC VISION AUTOMATION      www.bytronic.com

### Implementing an industrial vision solution in 48 hours

Vision solutions are now an essential part of the Industry 4.0 toolkit in modern production facilities for the automation of processes, quality assurance and tolerance checks. The right vision system, properly integrated, can significantly improve the reliability of inspections and prevent downtime and waste. Sometimes, however a vision solution needs to be implemented very quickly.

A manufacturer of a well-known FMCG brand was facing inspection issues ahead of a large product launch. It was starting a production run for a new aerosol product but soon faced problems with manufacturing tolerances during the assembly of caps produced at another site. This was creating issues when placing caps onto the aerosol cans, causing the valve to jam and lift the button on the cap, which didn't meet aesthetic standards. As the lids were opaque, it was hard to see which caps were faulty without manually taking every lid off. Under the pressure of a launch deadline, workers at the site were taking lids off to check if they were sitting correctly on the valve which was causing a lot of the aerosols to accidentally vent contents. Stopping manufacturing on the day of the launch was not possible but 80% of the stock was quickly becoming waste.

*Aerosol valve assemblies*

# ASSOCIATION NEWS

## MACHINE VISION CONFERENCE AND EXHIBITION 2022

UKIVA's Machine Vision Conference and Exhibition (MVC) returns to the Marshall Arena, Milton Keynes, UK on 28 April, 2022. This live event will once again act as a focal point for the latest vision trends and technologies and their uses in real-life applications as well as offering the opportunity to see a wide range of the latest vision products.

## EXTENSIVE CONFERENCE PROGRAM

MVC has established an impressive reputation for its far-reaching educational Conference program. This extends over eight different technical themes and has content suitable for newcomers to vision technology right up to experienced practitioners. Retaining its

popular format, visitors can tailor their own program from the eight technical seminar theatres running in parallel. These cover Vision in Robotics, Understanding Vision Technology, Deep Learning & Embedded Vision, 3D Vision, Optics & Illumination, Camera technology, Systems & Applications and Vision Innovation.

## EXPLORE THE LATEST PRODUCTS

Even through the height of the pandemic vision suppliers have continued to bring new products to market. New image sensors with exciting new capabilities have been developed; new illumination sources have emerged, AI capabilities have improved, image processing toolkits have been enhanced, and much, much more. Now for the first time in two years a dedicated machine vision exhibition returns

to the UK alongside the Conference. The exhibition section at MVC 2022 will represent an excellent cross-section of the industrial vision industry. Many world renowned manufacturers, leading vision technology suppliers and distributors and vision systems integrators will be available to demonstrate product and discuss how their specialist expertise can help solve vision problems.

## ENGAGE WITH THE EXPERTS

With the conference theatres located around the exhibition stands, MVC 2022 will again provide an ideal informal environment where visitors and experienced and knowledgeable vision specialists can interact to discuss any aspect of machine vision. Since many of the presenters are also exhibitors, it is easy to meet up with them during Conference breaks to discuss any aspect of their seminars or any other machine vision topics.

**www.ukiva.org**

# APPLICATION ARTICLES

Bytronic Automation addressed the issue by quickly taking away a sample of the aerosol to analyse the tolerance issue on the cap. Investigations soon revealed that an infrared backlight could be used to see through the opaque cap to see if the button had been lifted or not, without having to risk expressing any contents. A vision solution using an infrared backlight was rapidly developed and by using products already in stock, it was built, installed and integrated in two days. This solution enabled products that needed attention to be quickly diverted from the main packaging conveyor line without manual intervention. This allowed the launch to go ahead as planned with wastage reduced to a fraction of previous levels. Key to being able to integrate an effective solution in such a short space of time was understanding the issue, the customer needs and the production environment of the facility. Meanwhile, the customer was able to begin reviewing the data and working on long-term improvements to the new system, all the while guided by the support team.



*The Agri-EPI Centre lettuce harvesting robot*

## IDS IMAGING DEVELOPMENT SYSTEMS        www.ids-imaging.com

## Robot solution for automating lettuce harvesting

Lettuce is a valuable crop in Europe and the USA, but sourcing sufficient seasonal labour makes it difficult to harvest this valuable field vegetable. Moreover, with wage inflation rising faster than producer prices, margins are very tight. In England, agricultural technology and machinery experts are working with IDS Imaging Development Systems to develop a robotic solution to automate lettuce harvesting. The team is working on a project funded by Innovate UK and includes experts from the Grimme agricultural machinery factory, the Agri-EPI Centre (Edinburgh UK), Harper Adams University (Newport UK), the Centre for Machine Vision at the University of the West of England (Bristol) and two of the UK's largest salad producers, G's Fresh and PDM Produce.

Within the project, existing leek harvesting machinery is adapted to lift the lettuce clear from the ground and grip it in between pinch belts. The lettuce's outer, or 'wrapper', leaves will be mechanically removed to expose the stem. Machine vision and artificial intelligence are then used to identify a precise cut point on the stem to neatly separate the head of lettuce. Since the cutting process of an iceberg lettuce is the most technically complicated step in the process to automate, the prototype harvesting robot being built incorporates a GigE Vision camera from the IDS uEye FA family. The GV-5280FA-C-HQ model featuring the compact 2/3" IMX264 global shutter CMOS sensor from Sony and equipped with an IP65/67 protection housing was chosen for this application. As this is an outdoor application, this is a particularly robust camera and therefore ideally suited to demanding environments. The 5 MP sensor was chosen mainly because of its versatility. Full resolution is not needed for AI processing, so sensitivity can be increased by binning. The larger sensor format also means that wide-angle optics are not needed. The prototype of the robotic mower will be used for field trials in England towards the end of the 2021 season.



*IVS system for automated inspection of packaged breads*

## INDUSTRIAL VISION SYSTEMS        www.industrialvision.co.uk

## Inspecting baked breads at speed

A prestigious baked foods producer required a solution to improve the output of their three baking lines by ensuring that the correct quantities of products are placed in the packaging and that bags are packaged correctly. Three tailored, fully automated inspection and rejection machines, based on IVS's standard IVS-LAMi-P packaging and label inspection machines, were designed to provide 100% inspection of every product. The adaptability and configurability of these machines enabled adjustment of the conveyor length of each one to fit within the existing space constraints. The vision system field of view was specified for the largest packaging of breads that the customer produced, thus allowing all sizes to be automatically inspected on the same machine.

One of the machines is mirrored from the base design, enabling an operator to tend to two lines simultaneously. Up to forty packs every minute pass the inspection camera to ensure baked products have been correctly packed six up, with no misses, empties or twisted product. Every pack must be cut, sealed, and perfectly presentable to be picked and packed into the shipping cartons. Real-time information, statistical data, and alarm conditions are all presented to the operator, to provide everything needed to run smoothly and efficiently, refine the production and make critical decisions on the performance of upstream processes.

Each system is fitted with its own automatic air nozzle rejection and verification system. The latest generation IVS® industrial inspection cameras capture multiple, staggered shots of passing packs to form one workable image of the highest possible resolution when combined within the IVS inspection software. In this way, inspection of any product length is possible. The integrated wide area, high-intensity industrial light provides repeatable inspection conditions independent of changes in ambient light. Fast detection algorithms instantly feedback the results to the multi-stage air reject station.

The machines are designed to operate independently if necessary, or they can be networked back to a single controller. Their standard interfacing relays for simple stop-start and feedback can be used to interface with the upstream and downstream machines, as well as back to the line controller. All data is transferred to the factory information system SQL database, which provides the production team with real-time statistics, quality yields, and line performance.

## 3D robot guidance in teacup production

An Italian luxury porcelain manufacturer wanted to develop a vision-guided robot pick-and-place system that could locate raw white teacups on their production line. However, they found that a 2D vision system was not up to the task of distinguishing the different sizes, shapes, and positioning of the teacups on the line. The manufacturer sought the expertise of AuTech and Fortek, two Italian companies renowned for providing automation solutions. These solutions providers knew that the 3D vision capabilities Matrox® Imaging afforded were ideal for the requirements of a vision-guided robot pick-and-place system.

The vision system needed to perform a 3D scan of the raw white teacups and analyse the 3D scans to establish the vessels' size, shape, and position. The results needed to be communicated to the collaborative robot so it can reach and position teacups as they move along the production line. Finally no operator interaction must be required to manipulate the robot arm or operate the vision system.

The system design comprises a Matrox AltiZ 3D profile sensor connected to a Matrox 4Sight EV6 vision controller running Matrox Design Assistant® X vision software. Mounted on the end of the robot arm, the sensor performs a 3D scan of each teacup. The vision software uses the 3D depth-map data to situate the teacups' coordinates relative to the carrier tray. It establishes the handle position and degree of rotation of each cup so the robot can perform its pick-and-place operations. Thanks to the flexible flowchart development within Matrox Design Assistant X, the solutions providers were able to create a single project that addressed all possible product variations. A single-sourced vision system now allows the porcelain manufacturer to manage their entire production line, contributing to a 15% reduction in overall production costs.



*Cobot-mounted 3D profile sensor for teacup pick & place*

## High speed area-scan cameras lead the way for wafer inspection

Optical semiconductor inspection presents complex challenges, including the diminutive size of the target and proximity of individual dies on the wafer. The quality of wafer inspection results is critical and requires vision systems with exceptionally high speed and resolution. In the past, line scan devices have been credited as best suited to this type of application, but Dr. Kyle Gilroy, Applications Engineer at Vision Research, reports how an area-scan CoaXPress high-speed, machine vision camera can excel in this area. Data is directly streamed to a backend host machine with GPU and FPGA processing.
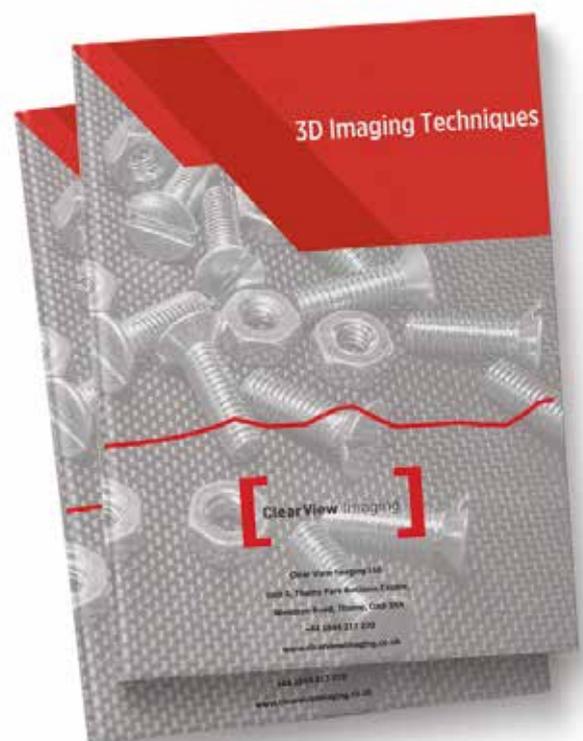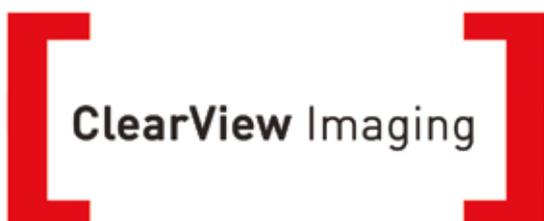
# OUT-OF-THE-BOX MACHINE VISION SOLUTIONS.
# THIS IS SICK

**Sensor Intelligence.**

Machine vision solutions make your manufacturing processes more efficient and competitive. But do they always meet your precise specifications? Now you can have customizable 2D and 3D vision sensors, tailored to your business. These are either ready-to-use solutions that can be easily configured without a vision or programming expert or they can be modified to solve your particular application – by SICK or its partners. We think that's intelligent. www.sick.com/sick-appspace

The test set up included a Phantom S640, 4MP machine vision camera (available in the UK from Multipix Imaging) mounted on a Nikon microscope equipped with a 5x magnification scanning wafer on an anti-gravity floating table. The sensor field of view was reduced to 1920 × 1100 pixels with an exposure time of 100 μs and 2500 fps speed. The anti-gravity table was set to scan the wafer at 300 mm per second. Both camera and microscope were mounted on an air bearing stage to isolate any movement in the Z-direction. This stage helps to avoid any inconsistency in depth of field of die that might skew the focal length of the lens. Camera and wafer synchronisation is critical. The S640 camera GPIO was used for trigger, sync, IRIG and other functions. In this setup the trigger signal aligns with the exposure time of the frame which enables alignment with the edge of a single die within a wafer.

In this system, the implementation of the Phantom S640 increased the manufacturing and packaging process significantly by increasing wafer-per-hour inspection from 1-2 wafers to 10-15. The sensitivity of the sensor, dynamic range and SNR of the camera are also extremely important for identification of foreign objects, damaged parts and any protrusions on the parts. The S640 camera scanned significantly faster than a line scan camera in this application, and in combination with the appropriate software, can process 30 wafers per hour. In addition, the CoaXPress interface allowed faster access to the data, making images available instantly on image processing units such as FPGAs of the frame grabber, and GPU & CPU of the host machine, further increasing system efficiency.
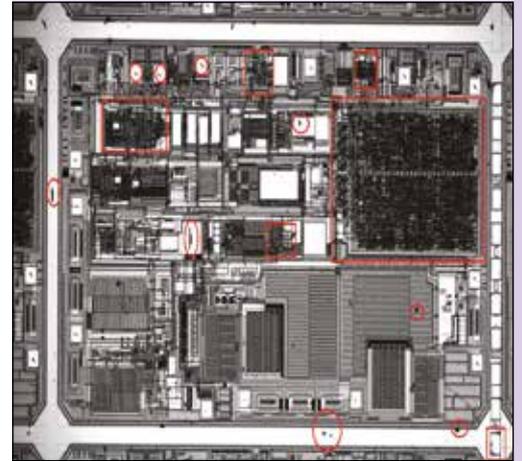


*Single die SWIR identification of foreign objects, damaged parts and protrusions*

## OMRON — www.industrial.omron.co.uk

## Traceability 4.0 through streamlined package labelling with cobots

A collaborative robot (cobot) solution developed by Bluengineering, part of Gruppo Romani SpA in Italy, carries out intelligent labelling on different product formats. This reduces downtime due to format changes by up to 70% compared with a traditional mechanical axis system, whilst guaranteeing the safety of nearby personnel. Bluengineering specialises in process control in the ceramic industry. To automate the labelling process of the packages at Gruppo Romani, they opted for the Omron TM5 cobot, which is versatile and adaptable and includes an integrated vision system.

The company needed to be able to apply labels on one of the four sides of outgoing packages, and to manage format changes quickly, without the need for any complex tooling operations. The Omron cobot was ideal, as it has a reach of 700 mm and can be taught how to handle packages of different sizes and shapes in just a few minutes. The operator can manually define the cobot's gripping, movement and deposit points. The cobot carries out most of the repetitive operations involved in labelling, leaving workers free to focus on activities that provide greater added value.

The Omron cobot's integrated vision system enables it to read the bar codes or QR codes on a label; to control the correct positioning of the package, and to track and verify the packages. All of the data is sent to and managed centrally by an Omron NX102 programmable logic controller (PLC), which is connected to the manufacturing execution system (MES). This provides integrated supervision of the entire production cycle in real time. From the terminal, the operator can see the status of production; the batches in transit; and the number, speed and method of labels to be printed and applied.



*Omron TM5 cobot*

## QUANTUM DESIGN — www.qd-uki.co.uk

## Detecting backside defects in silicon chips using SWIR

Silicon inspection can be a challenging problem for silicon and semiconductor manufacturers in terms of pattern alignment, pattern defect inspection and edge position bonding inspection.

During the manufacturing process, foreign particles and defects may appear on the top, bottom, inside or in between the wafers. As the thickness of wafers get smaller, the backside defects are becoming more important to detect. They include trapped air, air pockets, micro-cracks and other fine features caused by photonic emissions. It is important to find the location of these defects. Defects do not initially affect the chips functionality, but they do end up affecting the chips reliability.

While front side defects can be detected using visual inspection it is more difficult to detect backside defects. Silicon has an interesting property where it becomes translucent at wavelengths >1150nm, which makes two dimensional FPA InGaAs cameras ideal for detecting wafer defects. InGaAs cameras are capable of detecting light between 400nm and 1700nm in the visible and short wave infra-red (SWIR) range of the electromagnetic spectrum. With the use of filters, InGaAs cameras can limit the wavelength range they detect to only those where the wafers are translucent which makes them ideal to use for silicon wafer inspection, alignment and edge position bonding.

The OWL 640 II and OWL 1280 SWIR cameras from Raptor Photonics, available from Quantum Design, have already been incorporated into several inspection system setups for customers in the semiconductor industry. They combine a high sensitivity, large image area and high speed to allow for quicker inspections. In addition, they are rugged and compact with stabilised cooling, ensuring reliability. The low noise and high sensitivity of the cameras allow for quick detection of any defects in the wafer, improving quality and reliability.
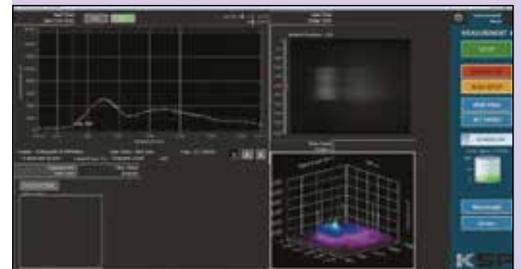


*The wavelengths of SWIR light passing through a wafer (Courtesy of Hanarotr Co., Ltd}*

# APPLICATION ARTICLES



*DS Smith palleting line*

## DS Smith pilots digital 3D dimensioning to transform logistic operations

DS Smith, a leading sustainable packaging manufacturer, designs, handles and ships custom packages to customer locations and warehouses from its Esmoriz site, near Porto, Portugal. A labour-intensive monitoring system needed to be automated to provide real-time data and determine the dimensions, volume and number of palleted packaging products at the end of the line. The data needed to be captured quickly and accurately without adding resources or interrupting production.

The solution used Sick's Visionary-T Mini 3D time-of-flight snapshot camera to provide high-quality 3D depth data and 2D intensity data. Solution integration and 3D vision camera processing was designed by Neadvance, a computer vision and artificial intelligence solutions provider. Mounted above the end of the production conveyor belt, just before the forklift pickup point, the compact, IP67-rated Sick Visionary-T Mini solution could be incorporated without major integration effort or changes to infrastructure. The solution uses an innovative 3D time-of-flight camera sensor from Microsoft to generate depth data that allows fast and accurate measurement of the spatial dimensions of pallets and their volumetric load. Three-dimensional images of a scene are created without any moving parts in the device or movement of the sensor itself. Since the distance data for each pixel of the complete sensor resolution is calculated very quickly at a high repetition rate, the occurrence of blurring effects and motion blur can be prevented successfully.

The solution at DS Smith combines on-site machine vision with cloud processing in one system. The 2D and 3D data from the Visionary-T Mini is pre-processed at the Edge, filtered and stored on Sick's digital IntegrationSpace service. The sensor system communicates with the digital service via Microsoft's Azure IoT Hub which encrypts the data connection. Sick's cloud software experts tailored and operate the digital service. DS Smith expects to achieve logistics efficiencies further to the pilot project. These will improve the accuracy and reliability of its stock data for finished goods and wooden pallets by minimising errors in goods movements in the warehouse through automatic pallet reading, using RFID tags and image processing. Advanced freight dimensioning will also enable DS Smith to transport more efficiently.



*Simac Masic iM series vision inspection system*

## Improving the quality of pharmaceutical packaging components

Rubber stoppers and plungers used in pharmaceutical vials and syringes must be free from defects and contamination. The iM series of modular, fully automated inspection machines manufactured by Simac Masic bv is capable of inspecting 700 components or more per minute, depending on the particular components. Utilising multi-camera high-speed vision systems, developed in conjunction with Stemmer Imaging, in combination with metal detection, they provide 100% inspection of these products and provide automatic rejection of out-of-specification product.

Potential particulate defects in the stoppers and plungers include loose and embedded particles, defects caused by trimming and moulding, hairs, fibres, grease and metal contamination from the moulding process. In addition, all of the surfaces on each and every stopper and plunger must be inspected for any loose contamination that may have moved there while the product is being transported.

The iM Series are designed for use in an ISO Class 5 clean room environment.  Stoppers are fed into the system and transferred to the first vision station. Two high resolution cameras inspect the top of the stopper and the steep internal sidewalls of the hollow plug for defects. This requires precise positioning and careful attention to the lighting and lenses used. The plungers have much smaller cavities, so a different camera with wide angle lensing is used. To accommodate the wide range of elastomer compounds available, colour cameras ensure the detection of light coloured defects on light product compounds. All failed components are blown into a reject bin. The rest move to the second vision station featuring a compact camera aisle with multiple cameras and then through a metal detector. Four cameras are arranged around the component to provide a full view of the entire side surfaces. One camera looks down to image the bottom surface of the top of the stopper.  Optional cameras may be added for dimensional measurements and inert surface coating inspection. Then following metal detection, any failed components are again automatically rejected. Data for every component inspected is saved and archived and include details such as time stamping to make possible a full inspection audit trail for every component, in accordance with CFR21 Part 11 requirements. Defect detection levels are >99% with inspection speeds limited by the mechanical feeder system rather than the imaging system.

# Giving sight to robots

**3D vision sensor for plug and play integration into gripper applications from Universal Robots**

The perfect combination of powerful hardware and easy-to-use software makes it possible to easily implement vision sensors in gripper applications from Universal Robots.
The core element of the ifm vision sensor is a 3D camera chip. It creates a 3D image using PMD technology and time of flight measurement.
The UR+ plugin ensures smooth and quick integration of the sensor. It detects any object, even moving ones, and transmits its exact position and dimensions to the robot control. Never before was gripper navigation so easy! ifm – close to you!

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# 'Out of the box' vision solutions

Machine vision is well-established and versatile, with a multitude of building blocks and a continuous stream of new developments and new technologies, making it a truly enabling technology for myriad applications across many industries. However it is this very versatility that has fuelled the view that creating a vision solution is some sort of 'black art' that can only be handled by vision specialists. 'Out of the box' vision solutions, designed to meet specific application requirements in various industries have been introduced to help address these issues. More users can now benefit from greater accessibility to ready-made, all-in-one solutions. These have been made possible by increased sharing of application knowledge in the system development stage meaning that there is no longer a need to 'reinvent the wheel' to arrive at the desired solution.

Out of the box solutions utilising 2D, 3D and AI imaging take a major step towards demystifying vision technology across a multitude of market sectors. Solutions are available for applications including label and packaging inspection; colour inspection and sorting; robot guidance including pick and place and bin picking of random parts; systems for mobile vehicles and many more. Being able to see a system that can carry out all of the required measurements by simply using the appropriate parameters for the application is a particularly powerful incentive for a potential end user. The rest of this centre page spread looks at some of the technologies involved in out of the box solutions and some of the applications and markets in which they are being used. And, special thanks to UKIVA members ClearView Imaging, IDS Imaging Development Systems, Industrial Vision Systems, Sick (UK) and Stemmer Imaging for the information used to compile this feature.

## App-based systems

The evolution of the smart camera provided industry with the first programmable vision sensor. With onboard image acquisition, processing and analysis capabilities, they can be set up to perform inspection tasks without the need for an image processing PC, and export the inspection result using industry standard communication protocols. The on-board software offers a versatile set of tools and capabilities which can be accessed through a standard web browser to create application routines that can be saved.
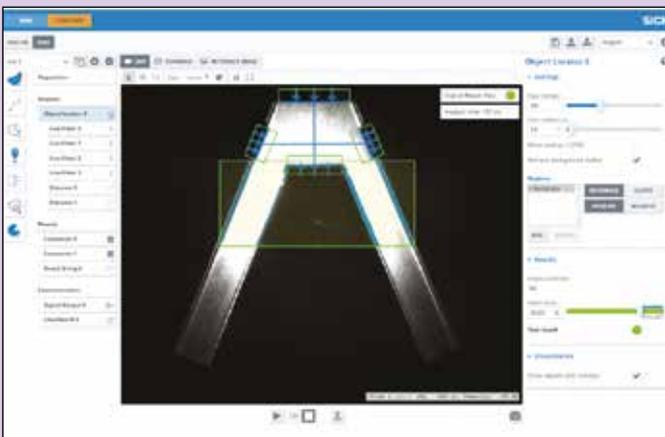


*Quality inspection app (Courtesy Sick UK)*

However, utilising a similar approach to that used for apps used on a mobile phone, it is now possible to take the development groundwork carried out for specific customer applications and turn it into more general, repeatable 'apps' which can be applied to the same application type for multiple customers. With the rapid advances in CMOS sensors combined with a broadening range of 2D, 3D and AI technologies, ready-made 'plug and play' systems for a specific need can be supplied in a box, ready to be powered up in a minimum number of steps. Guided through set-up with an intuitive graphic interface, users can set the parameters specific to that application with minimal effort and no specialist skills.

## Production line systems

For many production line applications additional hardware is required to facilitate handling of the product to be inspected. These types of out of the box solutions come in a variety of configurations, but in essence consist of a ready-to-use package of hardware and pre-written software to meet the specific application needs. In the manufacturing environment, in-line versions are available, as are stand alone systems which can be installed on the factory floor or in a QA laboratory. Typical hardware could include a conveyor (so they can be installed in a conveyor gap for in-line systems), reject mechanisms to allow separation of failed and good product, bins to collect good and failed product, or interfaces to the existing in-line reject mechanisms.



*Packaging inspection system (Courtesy Industrial Vision Systems)*

For pharmaceutical and medical component applications, hoppers and bowl feeds may be required. Special grips, fixtures or transport mechanisms may also be needed to correctly orient items for inspection. Stainless steel housings may be required for applications in hygienic environments. For applications requiring inspections from different sides, multiple cameras will be used. Whilst there are a lot of different possible configurations available, the important fact is that ready made systems can be supplied to meet a huge range of application needs.

# Sorting and colour inspection

Machine vision can measure size, shape, volume and colour, identify foreign bodies, surface defects and other damage, with excellent repeatability and at high speed. This has enabled the inspection, sorting, grading and classification of a huge range of components and products to be automated across a multitude of industries. Out of the box solutions range from smart camera systems including deep learning systems at the edge through to dedicated self-contained systems. Some of the simpler solutions involve using a smart camera equipped with an appropriate app to provide counting, sizing and colour validation capabilities. Dedicated high speed vision-based sorting systems can make a wide variety of measurements but can also offer capabilities that go much further than just ensuring no defective product reaches the customer. Analysing the measurement data generated allows production trends to be monitored in real time, while images of all failed parts can be retrieved at will. This enables operational and quality decisions to be based on real information.

## Sorting on the edge

In many ways, the deep learning approach is the ultimate out of the box solution for certain machine vision applications such as defect detection, object classification and optical character recognition. This is because instead of programming traditional machine vision processing tools in these applications, the deep learning approach uses a Convolutional Neural Network (CNN) to imitate the way the human brain works for recognition and decision making. It does this by extracting and modelling data from a large set of labelled training images in order to identify features such as objects or defects and then classify them into groups. Once the system has been trained, it can be used to classify new images the system has never seen before (the inference stage).
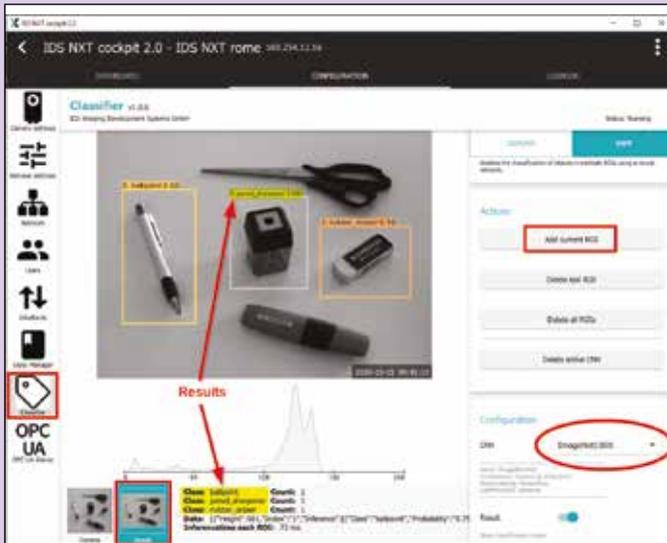


*Classifier app for use on an AI inference camera (Courtesy IDS Imaging Development Systems)*

The efficiency of this approach is optimised where the processing steps are located at the Edge, close to the source of the data. In some cases a CNN is deployed on a camera equipped with a specially designed parallel FPGA without the need for a host PC. Self-learning apps such as "Classifier" and "Object Detector" can be used on the camera in order to develop the specific solution from a suitable set of labelled training images, opening up universal application possibilities. The specialised knowledge needed for training neural networks and developing the application can be packed into the tools for many simple AI workflows but the creation and labelling of the most relevant training images still requires a degree of expertise.

# Label checking

Out of the box label inspection is well-established with a choice of methods. These range from hand-held code readers through to inspection systems added to packaging lines and to self-contained in-line inspection systems complete with reject mechanisms. The choice may be dependent on the complexity and/or the speed of inspection needed. Ensuring that a product and its packaging is correctly labelled is critical in the food, beverage, pharmaceutical, medical and other industries where consumer safety is of paramount importance. Mis-labelled products not only present a tangible threat to public safety but can also necessitate costly product recalls as well as the possibility of liability and/or significant damage to a manufacturer's brand and reputation. Product-specific data such as origin, quantity, ingredients, date, lot details, expiry dates, batch codes, allergen information, dosage etc can be printed on a label affixed to the product or packaging or directly onto the product or packaging.

## Setting the standard for print and code inspection

Typical requirements for out of the box label inspection systems are to ensure that both the machine-readable and human-readable information on each label is correct. Capabilities include:

- Checking the presence of labels
- Text reading and verification
- Barcode reading and verification
- 2D code reading and verification
- Checking print quality

There are a number of well-established machine vision tools available that can perform these tasks on the many standard types of 1D and 2D code that are used. Many manufacturers have incorporated these into easy to use systems complete with capabilities for reading damaged, distorted, blurred, or low contrast codes.



*On-line label verification system (Courtesy ClearView Imaging)*

Verification methods grade the quality of printing according to a variety of internationally recognised standards such as ISO 15415, ISO 15416, and GS1 standards. Code verification standards cover parameters such as symbol contrast, fixed pattern damage and distortion. Optical Character Verification inspects the print quality and confirm its legibility based on whether the text string is correct, as well as the quality, contrast and sharpness of the text.

## Extended packaging inspection

Some out of the box label inspections systems offer a range of additional label and packaging inspection capabilities. These include label placement and alignment checks and the ability to inspect multiple fields on a label, as well as checking that logos are present, in the right place and have the correct colours. Properties of the package itself may also be inspected, such as package size, and the presence of any damage or foreign bodies. Inspection of package seals can also be incorporated since leaking seals could invalidate 'best-before' dates or compromise the sterility of the contents.

# 3D Solutions

3D imaging has been one of the fastest growing machine vision techniques in recent years. This has been helped by the emergence of a range of 3D smart cameras with onboard FPGA processors for direct processing of 3D data without needing to transfer it to a PC. These factory pre-calibrated smart cameras can be supplied as out of the box solutions with application-designed measurement tools capable of making many of the common measurements required in real-world production environments. In some cases, 3D smart cameras can also form part of deep learning solutions although this is a more complex process. Stereo vision, laser line triangulation, structured light and Time of Flight are the main 3D imaging techniques in current use. 3D systems can be used for precise three-dimensional inspection and measurement of complex free-formed surfaces and open up a diverse range of depth perception application opportunities. (Robot guidance is a major out of the box 3D solution and is discussed in more detail in a separate section.) 3D imaging has applications in many different market sectors, including automotive, consumer electronics, pharmaceutical, packaging, food & beverage, transport & infrastructure, general manufacturing, wood, rubber & tyre and logistics. Choosing the optimum technique depends very much on the particular application.

## Multi-sensor networking

Choosing the appropriate field of view is an important consideration in 3D applications and each of the 3D techniques offer a choice of configurations to facilitate that. Some laser triangulation systems offer a particularly flexible approach whereby multiple cameras can be networked together and aligned to a common coordinate system with the results from individual sensors combined into a single high-density 3D point cloud. This can be valuable where a particularly wide field of view is required, or multiple different views of the object must be acquired simultaneously. In a recent development this capability has been extended to allow the linking of laser line profilers with different resolutions using a combined co-ordinate system. Since profilers that have wide fields of view typically have lower resolution, while high resolution profilers typically have much smaller fields of view, this opens up new possibilities. High-resolution inspection can now be performed only on the areas where it is needed, while simultaneous wide overall coverage from other sensors in the network can capture the entire object surface.



*Simultaneous wide field of view and high resolution 3D profile imaging of wood flooring panels (Courtesy Stemmer Imaging)*

This built-in networking capability allows more sophisticated and efficient out of the box solutions to be deployed using the fewest number of sensors.

# Robot guidance

The application of robots to automate factory processes can be greatly enhanced through the addition of machine vision to provide guidance for the robot. Vision can be used in combination with traditional 6-axis robots or the increasingly popular small to medium-sized collaborative robots (cobots). Historically, vision-robot interfaces have been complicated to set up, but out of the box plug and play vision solutions greatly simplify this process by connecting the camera directly to the robot controller or PLC with no control system in between.

## 2D guidance systems

2D systems are best suited for simpler applications involving pre-determined, highly repeatable parts and locations. In a typical application, a single camera can communicate with the robot via an app without the need for specialist machine vision expertise. It can be used to locate parts reliably and quickly and tell the robot how to pick it up and where to place it, very accurately.

## 3D guidance systems

2D-driven systems can only locate parts on a flat plane relative to the robot. Robot systems equipped with 3D vision, on the other hand, can identify parts randomly posed in three dimensions to ensure even products with complex profiles can be picked from variable heights and moved to a target destination without risk of damage. A number of plugins are available to enable direct interfacing of 3D cameras with robots for applications such as:

- Pick-and-place of incoming raw materials or subassemblies travelling on a transport system (e.g., conveyor, pallets), placing them randomly or directly onto a conveyor/pallet.
- Palletising and depalletising: placing goods on pallets at the end of manufacturing or removing boxes from pallets or conveyors.
- Bin picking: removing often randomly placed items from bins for further processing.
- Robot packaging: identifying spaces in a box or rack as part of the robot packing processes.

Choosing the most appropriate 3D imaging technique for the application is a critical requirement.

## Automated Mobile Robots (AMRs)



*Automated guided vehicle equipped with 3D time-of-flight camera (Courtesy Sick UK)*

Automated, or semi-automated vehicles are essentially Automated Mobile Robots (AMRs) and the same integration principles apply to mobile as static machines. Complete plug and play solutions are available to adapt existing vehicles, or to make the design and configuration of new designs much quicker, simpler and more cost-effective. For example, out of the box apps for time of flight cameras can cut out delays associated with lining up both automated and manual forklifts to load pallets in high-bay warehouses, as well as positioning automated guided vehicles to collect dollies. The app can be easily adjusted to a wide range of pallet and dolly types.

## Specialist Solutions

There are many specialist applications that require more complex vision installations yet have 'out of the box' solutions available because there is a significant market demand. By searching out these solutions, end users can save time and money compared to having a bespoke system designed and built. In addition, there is production line equipment available within a wide range of industries that already has machine vision built into it for quality control purposes. This may be a more attractive proposition than adding separate vision inspection systems when plant is being upgraded or new plant commissioned. Just a few of the types of systems available in different market sectors are highlighted below. This is by no means comprehensive but illustrates the sheer scope of specialist vision solutions already established which can be deployed for new users.

### Automotive

- Inspection of vehicle seat moulds to ensure they are loaded with the correct components prior to injection moulding
- Automation of inspection and measurement for bore expansion testing of sheet metal
- Monitoring the application of the adhesive beads in bonding processes
- Automated detection of beans, slugs and sprues on die cast components

### Pharmaceutical

- Vial counting
- Borosilicate vial defect inspection systems
- Manual packaging and aggregation from the folding box to the pallet
- Component verification, serialisation and device management systems
- Inspection of rubber stoppers and plungers for vials and syringes
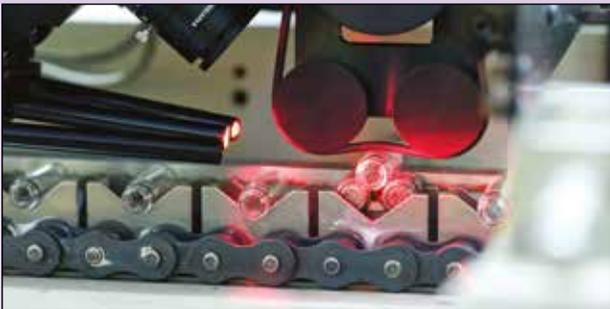


*'Vialchecker' from Isotronic GmbH*
*(Courtesy IDS Imaging Development Systems)*

### Food & Beverage

- Counting and checking bread rolls for defects as part of a bread packaging line
- Automated sorting of fresh fruit and seeds
- Slow-motion recording of filling and sealing processes in high speed bottling plants
- Checking the seal integrity of ice cream packaging

### Packaging

- Inspecting the integrity of aluminium food trays as part of container manufacturing
- Web Inspection systems to check the quality and content of the printing on each page
- Inspection of plastic film for defects resulting from the extrusion process
- Inspection of PET bottles, miniature vials, wide mouth containers and preforms

### Semiconductor & Electronics

- High-precision inspection processes for PCB sub-assemblies
- Checking for defects or incomplete machining on thread holes in hard disk drive cases
- Connector pin inspection

www.ukiva.org

# UKIVA DIRECTORY

## VISION TECHNOLOGY PROVIDERS

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## VISION SYSTEMS INTEGRATORS & CONSULTANTS

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# PRODUCT UPDATES



*The Imaging Source Series 38 cameras*



*CheckMate inspecting strawberry pack labels*

## The Imaging Source 38 Series camera range expanded

Alrad are pleased to announce that The Imaging Source are expanding their 38 Series Industrial camera family with the introduction of the new IMX540, IMX541 and IMX542 Sony Pregius S global shutter image sensors.

These high-resolution sensors all feature 2.74 µm pixels. The 24.5 Mpixel IMX540 sensor has a 1.2" format with 5328 x 4608 pixels in a 4:3 aspect ratio. The 20.4 Mpixel IMX541 sensor has a 1.1" format with 4152 x 4152 pixels in a 1:1 aspect ratio. The 16.1 Mpixel IMX542 also has a 1.1" format, but with 5328 x 3040 pixels in a 16:9 aspect ratio. These sensors are now in production with a USB 3.1 interface and GigE interface options will be available in the coming weeks.

## CheckMate label verification systems: out-of-the-box solutions

ClearView Imaging's CheckMate system is an advanced turnkey solution built to eliminate labelling issues on food and beverage production lines. With food and beverage producers under pressure to ensure every label is correct to avoid the threat of Emergency Product Withdrawals (EPWs) and resulting fines, the CheckMate range can detect incorrect over-printed data, incorrect label, wrong label position and poor print quality. Vitally, the CheckMate range can also provide full traceability and integrate to factory ERP or MES systems, if required.

Available in two versions, these field-proven out of the box solutions are easy to use, yet powerful. Built upon the Matrox Imaging Library X, CheckMate uses advanced algorithms such as String Reader (OCR/V) Geometric Model Finder (pattern matching) and Code Reader (1D & 2D barcode reading, verification and grading). CheckMate Flex is a 100% inline inspection system, deployable over pre-existing lines to save space. CheckMate QA is an offline system that can be deployed nearby on factory floors for label and packaging quality assurance.

# The World's First SWaP Optimised ½" / VGA InGaAs Sensor with VIS-SWIR Response

Raptor Photonics Owl 640 T is ultra-compact and rugged. The camera uses a Thermometric cooler to stabilise the sensor temperature with no fan being used

## Features:

- **½" Sensor Format |** Better for optical design, ideal for OEM integration into Electro-Optic systems

- **10µm x 10µm Pixel Pitch |** Compatible with VIS-SWIR illuminators, markers & pointers

- **<50 Electrons Readout Noise |** Enables a high VIS-SWIR detection limit

- **On-board Automated Gain Control (AGC) |** Enables clear video in all light condition

- **On-board Intelligent 3-point NUC |** Enables highest quality photos
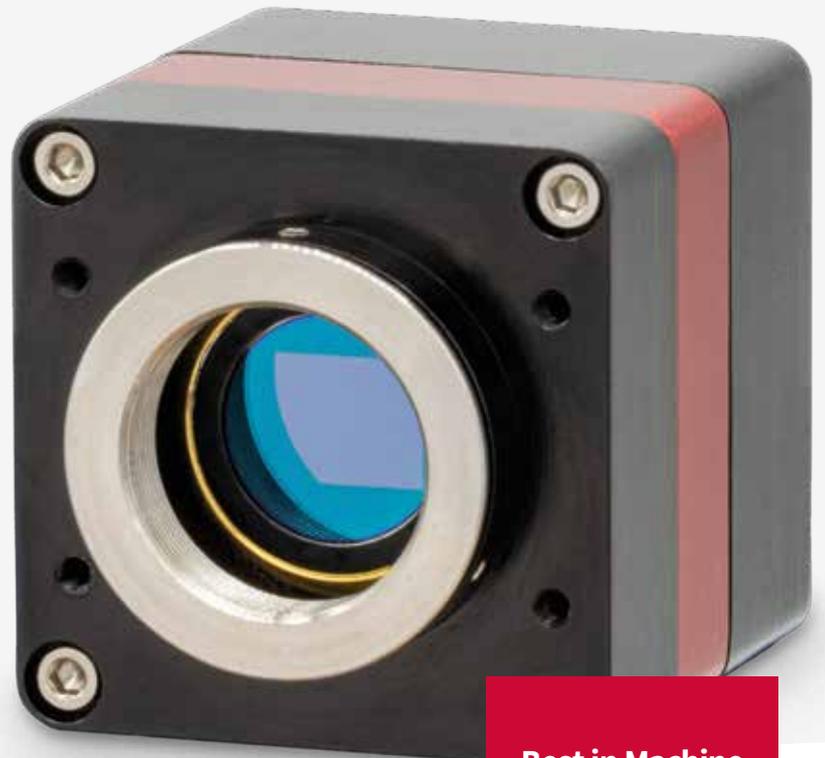
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To learn more about Zebra's industrial machine vision and fixed scanners portfolio, please visit **www.zebra.com/industrial-machine-vision-fixed-scanners**

# PRODUCT UPDATES

## Machine vision camera enclosure

The MVEC167 dust and waterproof machine vision camera enclosure is the latest addition to GeT Cameras' range of machine vision products. Its unique features make protecting an industrial camera and lens easy and affordable. The new camera enclosure supports 29x29mm cameras from most well-known manufacturers and has been tested in IP67 conditions.

In addition, the length of the lens tube is adjustable by adding or removing 15mm tube rings.

Moreover, the lens tube has been designed to have a bayonet fitting. This enables the lens tube to be opened and closed with a small twist and the lens settings can be changed without having to dismount and open the complete enclosure. The enclosure can also be used as general protection for the camera and lens so that operators cannot access the settings/hardware. The machine vision camera enclosure has no branding on it giving suppliers the opportunity to raise brand awareness amongst their customers, by labelling the enclosure with their own logo.


*MVEC167 camera enclosure*

## uEye XCP: Smallest industrial camera with housing and C-mount

The new XCP camera family in the uEye+ product series not only combines industrial quality and a favourable system price, but also fills a gap in the market as the smallest camera with housing and C-mount. The models measure just 29 x 29 x 17 mm and have a completely closed zinc die-cast housing with a screwable USB Micro-B connector. Thanks to cost-optimised electronics and compatibility with common lenses, they are perfect for price-sensitive applications.

The cameras are aimed at customers who value budget-friendly, extremely compact and lightweight camera models in industrial quality over extraordinary camera features. They are used, for example, for analysis tasks in the laboratory, as eyes in autonomously navigating vehicles in production or for visual support of robots in the field of automation. Versions are already available with the 2.3 MP AR0234 global shutter sensor or the 5 MP AR0521 rolling shutter sensor from ON Semiconductor. Other sensors will be introduced in 2022.


*uEye+ XCP camera*

*XT Series large diameter telecentric lens*



*Matrox Design Assistant X flowchart*

## KEYENCE
www.keyence.co.uk

### Emphasising superior imaging performance

The XT Series large diameter telecentric lens from Keyence makes it possible to perform accurate in-line 3D measurements and appearance inspections. The XT Series features a fully custom developed large-diameter telecentric lens and 4 high-speed controlled light projectors that enable inspection throughout the entire 60 mm 2.36" field of view with no blind spots. By prioritising quality hardware, stable imaging and inspection is achieved with no distortion regardless of part position and angle.

The XT Series offers 5x increased brightness to capture 2D and 3D images. The time between captures is 0.6 seconds. This is possible due to the newly developed lensing used in the R,G,B light source. The brightness and compact size are due to the design of the optical collimator and dichroic mirror. When capturing 2D images, monochrome images are captured with red, green, and blue lighting to maintain resolution and obtain true colour images. When capturing 3D images, the three colours are turned on all at once to ensure the highest brightness and fastest image capture.

## MATROX IMAGING
www.matrox.com

### New version of flowchart-based vision software

Version 2109, the latest version of the flowchart-based vision software, Matrox Design Assistant® X, features many new capabilities. The new software includes a range of new 3D steps and functionality; supports the new Matrox Iris GTX smart cameras; offers OPC UA communication to manufacturing systems; features a new step for enhancing image contrast; and simplifies project troubleshooting and optimisation.

Point clouds can now be visualised – optionally colour-coded, meshed, and filled – in addition to depth maps and profiles. New steps enable users to pull out a portion of a point cloud for closer analysis and calculate the volume of a depth map or a point cloud.

Matrox Design Assistant X provides Matrox Iris GTX users with a suite of tools for developing both traditional machine vision operations, as well as deep learning inference in the form of image classification and segmentation.

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F2.8 <196G
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# PRODUCT UPDATES

## Omron launches PCB inspection system

Omron has launched the new PCB inspection system VT-S10 Series, featuring 3D imaging from all angles and AI to automate high-precision inspection processes for PCB sub-assemblies, thus eliminating the need for specialist operator skills. Equipped with Omron's proprietary MDMC (Multi-Direction Multi-Colour) imaging technology, the VT-S10 Series automatically optimises irradiation angles, colours, and light intensity of illumination during the inspection of the PCB assembly taking characteristics such as the shapes of electronic components and soldering on the PCB into account. First tests show that this new technology can reduce the human-hours required for set up by approximately 70%. AI-assisted inspection dedicated to solder inspection is combined with quantitative inspection by MDMC to reduce both the required level of teaching skills and the chances of erroneous decisions. This PCB inspection system can automate inspections that have until now had to rely on human senses, significantly improving inspection accuracy.



*VT-S10 Series PCB inspection system*

## Sick SensorApps ensure smooth docking for pallets and dollies

The Sick Pallet Pocket and Dolly Positioning SensorApps enable rapid, damage-free guidance of automated and driver-assisted high-bay forklifts into pallet pockets, as well as the precise and efficient pick-up of dollies by automated guided vehicles (AGVs). Running on Sick's Visionary T-AP 3D time-of-flight snapshot camera, they promise to cut out delays associated with lining up both automated and manual forklifts to load pallets in high-bay warehouses, as well as positioning AGVs to collect dollies.

The solutions work by positioning the camera in front of the pocket or dolly chassis within a working range of 1.5m to 3m. The Sick Visionary T-AP 3D camera captures a 3D image, then pre-processes and evaluates the co-ordinates of the pallet pocket, or space under the dolly, before outputting to the vehicle controller. The information can also be sent to a driver display to aid manual forklift operation, particularly useful in high-bay warehouses.
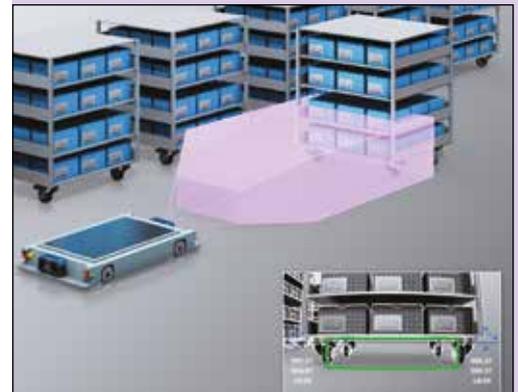


*Dolly Positioning SensorApp*

## Laser line profilers aid electric vehicle battery manufacture

Gocator® smart 3D laser profilers from LMI Technologies can be used during various stages of electric vehicle battery manufacturing in order to ensure component and assembly tolerances are met, and that maximum cycle life and safety are achieved. The 2100, 2300, 2400 and 2500 series of laser profilers provide a rich choice of resolution, scanning speeds, fields of view and built-in measurement tools including the surface barcode tool to match the individual inspections required. Some are equipped with shorter-wavelength blue lasers, which generate higher-quality scan data with less noise on highly specular battery surfaces such as polished metal.

Multiple cells are stacked together to form modules, which are combined to form battery packs. Components can be inspected for correct assembly and final weld quality from pre-assembly, cell, module and pack level through to inspection of the glue beads used to glue the completed battery to the mounting tray in the vehicle.



*Checking final weld quality on multiple battery cells*

## Unified platform for Zebra smart cameras and fixed industrial scanners

Zebra Aurora brings a new level of simplicity to controlling enterprise-wide manufacturing and logistics automation solutions. With this powerful interface, it's easy to set up, deploy and run Zebra's Fixed Industrial Scanners and Machine Vision Smart Cameras. The highly intuitive modern interface presents logical workflows for both beginners and experts. First-time users can easily navigate through the well-designed management platform, while experienced users will appreciate easy access to all functions and streamlined processes that reduce the time it takes to perform tasks.

Aurora offers single tool simplicity for reduced ramp up and training time. By simplifying the architecture of the industrial automation solutions, users only need to learn one tool, minimising training time and effort. In addition, Aurora's 'Learn-As-You-Go' facility offers built-in tutorials, walk-throughs and videos on all aspects of the software to answer any questions users may have.



*Aurora software*

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